

# काजू के सटीक ग्रंथ सूची 1995-2007

## ANNOTATED BIBLIOGRAPHY ON CASHEW

1995 - 2007



राष्ट्रीय काजू अनुसंधान केन्द्र

(भारतीय कृषि अनुसंधान परिषद्)

पुत्तूर - 574 202, दक्षिण कन्नड, कर्नाटक

NATIONAL RESEARCH CENTRE FOR CASHEW

(Indian Council of Agricultural Research)

PUTTUR - 574 202, DK, KARNATAKA, INDIA



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COMPILED AND EDITED BY  
R. ARULMONY

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## FOREWORD

The National Research Centre for Cashew (NRCC) was established in 1986 under Indian Council of Agricultural Research at Puttur, Karnataka. NRCC has been doing excellent research with respect to development of cashew cultivars and technologies and also compiling global information on cashew research. Many of the Centres under All India Coordinated Research Project on Cashew are in remote areas and have no access to the latest cashew literature. Therefore, it is pertinent that cashew literature is compiled in the form of Annotated Bibliography and made available to all the concerned. In this regard, Library of NRCC has now compiled the cashew literature from 1995 to 2007. The Annotated Bibliography on Cashew for the earlier period from 1985 to 1994 was brought out by NRCC in the year 1995.

I compliment the Director NRCC and the compiler Mr. R. Arulmony, Technical Officer - T 6 (Library) for their efforts and hope that this publication will be useful to all those who are connected with cashew research and development in the country.

(H.P. Singh)

## PREFACE

The National Research Centre for Cashew (NRCC) was established by Indian Council of Agricultural Research in 1986 at Puttur (Karnataka). The mandate of the Centre is to conduct mission oriented research on all aspects of cashew for improving productivity and quality with special reference to export, to serve as a national repository for cashew germplasm and a clearing house for research information on cashew, to act as centre for training in research methodologies and technology updating of cashew and to coordinate national research projects, to provide consultancy regarding cashew production technology, to generate quality planting material and to collaborate with national and international agencies for achieving the mandate.

In accordance with the mandate of this centre, NRCC Library is collecting and disseminating the research information on cashew to those who are connected with cashew research and development in India. Due to proliferation of knowledge and virtual 'Information Explosion' it is an uphill task for the researchers to keep themselves abreast in their field of interest. Therefore, specialised information services like compilation of 'Annotated Bibliographies' play an important role and the present publication is a welcome step in this direction. The period 1995 -2007 had been one of the most active and fruitful period in the history of cashew research. About 750 references published subsequent to the previous period of 1985 to 1994 are covered in this volume. It is hoped that this compilation will be useful to all those who are interested in cashew research and development in the country.

I appreciate Mr. R. Arulmony, Technical Officer - T6 (Library) for all the pains taking efforts in compiling the world cashew literature for the 13 years period for the benefit of all persons connected with cashew on one way or other.



(M. GOPALAKRISHNA BHAT)  
DIRECTOR

## COMPILER'S NOTE

The first bibliography on cashew was published in 1979. Subsequently, a bilingual compilation by Franco Giliani containing 1260 abstracts on cashew was published by Repubblica Italiana, Ministero Degli Affari Esteri, Istituto Agronomico per l'Oltremare in 1984. The third annotated bibliography on cashew was published by NRCC in the year 1995 covering the period from 1985 to 1994 with 569 entries. Therefore, cashew literature subsequent to 1994 is included in the present compilation which has 737 entries arranged author-wise alphabetically. In compiling this publication, the primary, secondary and abstracting journals subscribed by this Research Centre and other symposium proceedings and book chapters etc. were scanned. In addition to that, CD Databases and Internet were searched to collect the current literature published on cashew. The annotations are generally based on authors abstract. A list of acronyms and abbreviations used has been included. It also provides a detailed subject index and an author index for convenience of locating the needed references.

Constant encouragement and guidance rendered by Dr. M. Gopalakrishna Bhat, Director, NRCC is gratefully acknowledged. Sincere thanks are also due to Dr. Thimmappaiah, Principal Scientist (Genetics & Cytogenetics) & Library - in - Charge and Dr. K. V. Nagaraja, Principal Scientist (Biochemistry), NRCC for their sincere support and guidance. Help rendered by Mr. Hariya Naik, C.H., Supporting Staff, NRCC is very much appreciated.

**R. ARULMONY**

## **Acronyms and Abbreviations used**

Agric.	Agriculture
ARS	Agricultural Research Station
AICRP	All India Coordinated Research Project
APAU	Andhra Pradesh Agricultural University
BCKV	Bidhan Chandra Krishi Viswavidyalaya
CABI	Commonwealth Agricultural Bureaux International
CFTRI	Central Food Technological Research Institute
CIRAD	French Agricultural Research Centre for International Development
CITA	Central Institute of Tropical Agriculture
CPCRI	Central Plantation Crops Research Institute
CRS	Cashew Research Station
CSIR	Council of Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Organization
Dept.	Department
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuaria
FAO	Food and Agricultural Organization
GKVK	Gandhi Krishi Vignan Kendra
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
KAU	Kerala Agricultural University
KKV	Konkan Krishi Vidyapeeth
NRCC	National Research Centre for Cashew
ODA	Overseas Development Agency
OSDCDC	Orissa State Cashew Development Corporation
OUAT	Orissa University of Agriculture and Technology

PLACROSYM	Plantation Crops Symposium
RFRS	Regional Fruit Research Station
RRL	Regional Research Laboratory
RS	Regional Station
TNAU	Tamil Nadu Agricultural University
UACH	Universidad Autonoma de Chihuahua, Mexico
Univ.	University
UAS	University of Agricultural Sciences
W. B	West Bengal



001. ABDULLAH, R. 1997. **Phytosanitary regulations of Tanzania with specific example to cashew and coconut.** *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp. 515-517

This paper gives the background history of plant quarantine in Tanzania and lays emphasis on plant quarantine as a disease control measure. It describes the procedures of importation of clean plant materials and indicates effects of uncontrolled importation of plant materials. It specifically explains the import control of cashew and coconut in Tanzania. Plant quarantine services regulates movement of plant material in the country by abiding International Phytosanitary Regulations.

002. ABEYSINGHE, DC., SANGAKKARA, UR and JAYASEKERA, SJBA. 2003. **Intercropping of young cashew (*Anacardium occidentale* L.) and its effects on crop productivity and land utilization.** *Tropical Agricultural Research*. 15: 10-19 (Postgraduate Institute of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka.)

The feasibility of intercropping young cashew with annual food crops was evaluated in a field experiment conducted in Sri Lanka. Newly planted, two- and five-year-old cashew plantations were intercropped with pigeon pea cv. ICPL 87, maize cv. Ruwan, groundnut cv. Tissa, cowpea cv. MI 35 and mung bean cv. MI 5 in Maha season and pigeon pea, sesame, cowpea and mung bean in Yala season. The growth of cashew in all intercropping plots was comparable to that of sole cashew, except when pigeon pea was intercropped with newly planted

cashew. The growth and yield of the annual food crops intercropped with newly planted cashew and two-year-old cashew were not significantly different to sole annual food cropping. In contrast, the growth and yields of annual food crops were affected when intercropped with five-year-old cashew plants. This suggests that intercropping with annual food crops is not possible in older cashew plantations. Land Equivalent Ratio (LER) of all intercropping systems were greater than 1, indicating high yield advantages and efficient land use. Higher LER values were observed in cashew/maize and cashew/groundnut in the Maha season and cashew/sesame in the Yala season, respectively. Cost/benefit analysis indicated that intercropping with newly planted and two-year-old cashew with maize and groundnut in the Maha season and sesame in the Yala season is a profitable venture.

003. ADEBAJO, LO and DIYAOLU, SA. 2003. **Mycology and spoilage of retail cashew nuts.** *African Journal of Biotechnology*. 2(10): 369-373 (Department of Biological Sciences, Olabisi Onabanjo University, Ago-Iwoye, Nigeria.)

Thirty-two samples of retail cashew nuts from Lagos, Nigeria were examined on two media. The pH values (5.1-6.3) of all the samples were conducive for fungal growth and mycotoxin production. Moisture content levels ranged between 4.1 and 6.8%. Fifteen samples had moisture contents up to or above 5.8%, the highest level estimated to be 'safe' for the storage of the nuts. Fourteen fungal species, mostly toxigenic and belonging to 5 genera were isolated. Seven species were from genus *Aspergillus*, 3 from *Penicillium*, 2 from *Rhizopus* and one each from *Mucor* and

*Syncephalastrum*. The most predominant isolates were: *A. niger*, *A. restrictus*, *A. flavus*, *A. fumigatus* and *Aspergillus* sp. The mean and range of total fungal counts (CFU/g) in samples were: 3,368 (180 to 16, 300). At acceptable fungal levels of 103 and 104/g, only 14 and 28 samples, respectively, were deemed fit for human consumption. All the species recovered induced detectable loss in weights of the milled nuts, though to varying extents and would be expected to cause considerable spoilage of the nuts.

**004. ADEBOLA, PO. 1999. Effect of nut weight on germination and seedling vigour in cashew. Nigerian Journal of Tree Crop Research 3(2): 71-79**

The effect of nut weight on germination rate and subsequent seedling vigour of cashew was studied at the Cocoa Research Institute of Nigeria using current season nuts that were stored in to 3 different weight glasses of small (3-<6 g); medium(6-<8 g); and large(8-10g). Large and medium size nuts performed better than the small nuts in terms of germination percentage, overall seedling vigour and other growth parameters evaluated. Current season nuts weighing between 6.0 and 10.0 g are recommended as good quality planting materials for cashew farmers. Such nuts germinate uniformly and rapidly, producing vigorous seedlings that ensure the successful establishment of the young tree.

**005. ADEJUMO, TO. 2005. Crop protection strategies for major diseases of cocoa, coffee and cashew in Nigeria. African Journal of Biotechnology. 4(2): 143-150 (Dept. of Microbiology, Adekunle Ajasin University, P.M.B. 01, Akungba-Akoko, Ondo State, Nigeria.)**

A great percentage of people in the developing countries are engaged in agriculture, but the yields of their produce are low due to diseases that plague their crops. In Nigeria, crop protection measures that are cheap, simple, cost-effective and sustainable are desirable to combat Phytophthora pod rot (black pod) and cocoa swollen shoot virus diseases of cocoa, coffee leaf rust and coffee berry diseases, inflorescence blight disease of cashew in order to make farming profitable and sustainable. Disease control strategies include the use of resistant cultivars, chemicals, biological, botanicals, cultural, physical controls and application of biotechnology, each of which is discussed in this paper.

**006. ADENIYI, AC and ASHAMO, MO. 2006. Biodeterioration of processed cashew nut in different packaging materials. Annals of Plant Protection Sciences 14(2): 389-392**

Fifty grames of processed cashew nuts were stored in different packaging materials for 12 weeks in an ambient temperature of  $28 \pm 2$  °C and relative humidity of  $78 \pm 2\%$  to investigate biodeterioration. Proximate compositions were reduced in all packaging materials, while moisture content increased from 2.6% in fresh nuts to 8.6% in nuts stored in hessian bag. Bacterial growth increased from 0.0 cfu/g in fresh nuts to 330.0 cfu/g in jute bag. Microorganisms isolated included : *Bacillus kaustophilus* and *Bacillus subtilis*. Nylon packaging proved best with least value in terms of microbial growth and moisture content, and higher value of proximate compositions.

**007. ADEWUMI, BA. 2000. Design and testing of a manually operated cashew**

**decorticator.** *Nigerian Journal of Tree Crop Research.* 4 (2): 20-32 (Agricultural Engineering Department, Federal University of Technology, Akure, Nigeria.)

A manually operated machine for decorticating or shelling cashew seeds was designed, fabricated, tested and evaluated. The major components of the machine include a frame, cutting handle, splitting handle, springs, and cutting blades. The total compressive load and torque required for the machine operation were calculated to be 395 N and  $8 \times 10^{-4}$  Nm, respectively. The spring has a coil diameter of 1.2 cm with a maximum deflection of 6.8cm, helical angle of  $11.3^\circ$  and stiffness of 0.17 Nm<sup>-1</sup>. The machine has a power requirement of 182.4 W. Steamed cashew seeds were used to test the machine. The seeds were classified into five size grades with mean lateral dimension of 2.33, 2.61, 2.85, 3.23 and 3.28 cm. The beans were steamed for one hour and samples were collected for test at 20 minutes interval. The performance of the machine was compared with hand shelling using parameters such as shelling capacity (C), shelling efficiency (eta) percentage broken nuts (B) and percentage unshelled seeds (S). The values of C, eta, B and S for the machine ranged from 194-309 nut/h, 70-95, 7-32 and 0-10%, respectively, while the respective values for hand shelling were 25-90 nut/h, 20-60, 44-67 and 10-40%. It was observed that the performance parameters (C, eta, B and S) of the machine were influenced by seed size and steaming period. Stepwise multiple regression analysis was employed in establishing a relationship between the performance parameters (dependent variables) and the size of the seeds and steaming period (independent variables).

**008.** ADEYEMI, AA. 1998. **Effects of intercropping on weed incidence in cashew (*Anacardium occidentale*) plantations.** *Nigerian Journal of Tree Crop Research.* 2 (1): 83-94 (Cocoa Research Institute of Nigeria, P.M.B. 5244, Ibadan, Nigeria.)

The effects of intercropping cashew (*Anacardium occidentale*) with maize (*Zea mays*), cassava (*Manihot esculenta*), cowpea (*Vigna unguiculata*) and plantain (Musa, AAB CV Agbagba) within the first three years of establishment were investigated in Ibeku, Umuahia ( $5^\circ 29'$  and  $7^\circ 33'F$ ), Nigeria. The treatments consisted of cashew/plantain/cassava/maize, cashew/plantain/cassava, cashew/plantain/maize, cashew/cassava/maize, cashew/maize/cowpea, cashew/plantain, cashew/cassava and cashew alone. Weeding frequency and weed dry weight were determined under the various cropping systems. Weed suppression was better in intercropped plots than cashew alone. Consequently, the number of weedings per annum and weed dry weight in intercropped plots were lower than those of cashew grown alone by 39-54 and 36-42%, respectively. Among the treatments, weed suppression was best in plots carrying cashew/cassava and cashew/plantain/cassava mixtures with a 56-60% reduction in the frequency of weeding per annum. Weed succession was markedly affected by intercropping leading to an alteration in the weed spectrum and sequence.

**009.** AGOSTINI-COSTA, T DA S., JALES, KA and GARRUTI, D DOS S. 2004. **Anacardic acid content in cashew apples from *Anacardium microcarpum* and eight clones of *Anacardium occidentale* from North Eastern Brazil.** *Ciencia Rural* 34 (4): 1075-1080

Anacardic acid, a phenolic compound present in cashew apple and in some medicinal plants, is being associated to some specific biological effects. The purpose of this study was to determine anacardic acid content in peduncles of *A. microcarpum* and 8 clones of *A. occidentale* from the North Eastern Brazil, evaluating some physicochemical and sensory characteristics of these peduncles. Cashew apple from BRC 189 clone of early cashew tree presented the highest values of anacardic acid. Cashew apples from *A. microcarpum* and END 189, END 183, EMBRAPA 50, 51 and CCP 09 clones of early cashew tree did not differ from the control (CCP 076 clone). Cashew apple from CCP1001 clone presented the minor values of anacardic acid. Physicochemical and sensory analyses showed evidence that CCP 09 and CCP 1001 clone are not appropriate for fresh consumption.

**010.** AGOSTINI-COSTA, TS., JALES, KA and ABREU, LN. 2003. **Determination of anacardic acids in cashew apples.** *Revista Brasileira De Plantas Medicinai* 5 (2): 77-81

A study was conducted to obtain the total anacardic acids from natural cashew nut shell liquid (CNSL), to standardize the analytical methodology for these compounds in cashew fruits, and to analyse the amount of anacardic acids in fruits of 3 dwarf cashew clones. The total anacardic acids were purified in silica gel or citric acid chromatographic column (95:5). Their analytical extractions from cashew fruits were based on Bligh-Dyer extraction with modifications. The extract was purified in silica gel mini-column and quantified in the ultraviolet. The linear range was between 20 and 160 µg/ml of the total acid in hexane. The repeatability of the technique was less than 5%

and the recovery was between 94 and 105%. Anacardic acids contents present in cashew fruits was in the range 16.5-30.4 mg/100g.

**011.** AIYELAAGBE, IOO. 1994. **Fruitcrops in the cashew-coconut system of Kenya: their use, management and agroforestry potential.** *Agroforestry Systems* 27: 1-16 (Farming Systems Division, National Horticultural Research Institute, P.M.B.5432, Ibadan, Nigeria.)

Between 67-100 of farmers interviewed were interested in planting more fruit trees on their farms. Envisaged cash generation was a major reason for their interest. Preferred species were generally adapted exotics. Preference was in the order of *Mangifera indica*, *Citrus sinensis*, *C. reticulata*, *Cocos nucifera*, *Anacardium occidentale*, *Carica papaya*, *Passiflora edulis* var. *flavicarpa*, *Ananas comosus* etc. Locational differences existed in exact order of preference within the groupings. A fruitcrop based agroforestry intervention is recommended for increasing the productivity of the cashew-coconut system.

**012.** AJAV, EA. 1996. **The design and testing of a low-cost cashew-nut cracker for peasant farmers.** *Tropical Agriculture*. 73 (3): 180-186 (Department of Agricultural Engineering, Faculty of Technology, University of Ibadan, Ibadan, Nigeria.)

A low cost cashew nut cracker was designed, fabricated, and tested. Construction materials were locally available and the cost affordable to peasant farmers in Nigeria. The machine consists of the main frame, a mild steel table (600 mm X 900 mm) and cracking jug assembly composed of the assembling plate, and the pillar pole, cutting case, knives or

blades, hand lever, and springs (tension and return). The machine was tested using small, medium, and large nuts. Machine efficiencies obtained were 69.4, 75.5, and 75.7% for the 3 sizes, respectively. It was concluded that even a simple device, such as the one fabricated, would considerably improve the capacity for processing cashew nuts in Nigeria.

**013.** AKARANTA, O., DONBEBE, W and ODOZI, TO. 1996. **Plywood adhesives based on red onion-skin extract modified with cashewnut-shell liquid.** *Bioresource Technology* 56: 279-280 (Dept of Pure and Industrial Chemistry, University of Port Harcourt, Nigeria.)

Red-onion-skin-formaldehyde resins modified with cashewnut-shell liquid were prepared and used in the formulation of wood adhesives. Evaluation results showed that the adhesives had better water resistance and shear strength than those based on red-onion-skin-extract- formaldehyde resins.

**014.** AKENA, F. 1997. **Uganda cashew industry status report.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.*

In the 1970s, around 1.2 million cashew trees were planted in 16 districts of northern and eastern Uganda. Total bearing trees are estimated at 115,000, and average nut yield at only 3 Kg /tree, equivalent to some 300 t/year of marketable nuts. The main production constraint is low yields due to unselected seeds, incidence of diseases, and poor husbandry practices. The current estimated crop of a few hundred tonnes is either utilised for home consumption or lost. Although in 1992 GOU removed all controls on cashew marketing, no private trading has yet occurred.

**015.** AKINWALE, TO. 1999. **Comparative study of the physico-chemical properties and the effect of different techniques on the quality of cashew juice from Brazilian and local varieties.** *Nigerian Journal of Tree Crop Research* 3(1): 60-66

The properties were compared of red and yellow cashew apples from a local and a Brazilian type grown in Nigeria. The pH of both provenances was about 4.0. Specific gravity was 1.04-1.05. Brazilian type apples were larger and heavier but percentage juice yield was similar in the different provenances. Ascorbic acid content was higher in the local type. It declined when apples were processed using steam but steaming improved the palatability of the juice.

**016.** ALEXANDER-LINDO, RL., MORRISON, EYSA and NAIR, MG. 2004. **Hypoglycaemic effect of stigmast-4-en-3-one and its corresponding alcohol from the bark of *Anacardium occidentale* (cashew).** *Phytotherapy Research* 18(5): 403-407 (Department of Basic Medical Sciences (Biochemistry), University of the West Indies, Mona, Kingston, Jamaica.)

Intravenous administration of the hexane extract of the bark of *Anacardium occidentale* (cashew) in normal, healthy dogs produced a significant lowering of the blood glucose levels. Pursuit of the hypoglycaemic principle(s) in the hexane extract resulted in the isolation and characterization of two compounds, stigmast-4-en-3-ol (1) and stigmast-4-en-3-one (2). These compounds were purified by chromatographic methods and the structures were characterized by spectroscopic methods. Both compounds produced significant hypoglycaemic activity after intravenous

administration at a dose of 1.3 mg/kg body weight. The bark of the cashew plant, *A. occidentale*, exhibited a hypoglycaemic effect probably due to the presence of these compounds.

**017.** ALIYU, OM. 2005. **Application of tissue culture to cashew (*Anacardium occidentale* L.) breeding: an appraisal.** *African Journal of Biotechnology*. 4 (13)(Special Issue): 1485-1487 (Department of Plant Breeding, Cocoa Research Institute of Nigeria, P M B 5244, Ibadan, Nigeria.)

A summary of the previous works on the *in vitro* culture of cashew is highlighted, with emphasis on the critical factors that influence the explants response and plantlet regeneration. The recalcitrant nature of cashew has been attributed to the limited success recorded so far in the *in vitro* culture of the crop and abnormal development has been reported in the calluses derived from its explants. Browning of explants in cashew was found to be due to the presence of high secondary metabolites and it has been reduced through frequent transfer of explants, addition of activated charcoal and dark treatment. Explants necrosis has also been traced to the effect of strong sterilization. Meanwhile, the use of explants from *in vitro*-germinated seedlings or fungicidal-treated young flush has been found to improve the success rate significantly. The use of MS base salt supplemented with two-step treatment of cytokinins enhances the response of cashew explants and development of derived plantlets.

**018.** ALIYU, OM. 2006. **Phenotypic correlation and path coefficient analysis of nut yield and yield components in cashew.** *Silvae Genetica* 55(1): 19-24

Relationship between cashew nut yield and nine agronomic traits comprising 7 reproductive and 2 vegetative characters were studied in 59 selected genotypes over the production seasons. Phenotypic correlation analysis showed that nut per panicle ( $r = 0.844$ ), number of nuts per tree ( $r = 0.988$ ) and number of hermaphrodite flowers per panicle ( $r = 0.863$ ) were positively correlated with nut yield and could be used as primary components for improving yield. Although correlation analysis showed insignificant association between nut weight and nut yield, path analysis revealed that the trait had significant positive direct effect (0.317) on nut yield. The subtle indirect effects of nut weight and leaf size on nut yield were more important than their direct effects and could be classified as secondary components. Both the direct and indirect effects of weight of the whole fruit and tree canopy on nut yield were negative and appeared detrimental.

**019.** ALIYU, OM and IHAMMED, LA. 2000. **A study of nut and apple development in cashew.** *Nigerian Journal of Tree Crop Research* 4(2): 1-10

Growth and development of cashew nut and apple 3-9 weeks after pollination were studied at Ibadan, Nigeria. On each of the ten genotypes used for this study, 20 developing fruits at the week of pollination were randomly selected. Quantitative data were collected on the following variables: nut length, widths of the lower and upper ends of the nut, apple length, circumferences of the lower and upper ends of the apple and the dry matter content (DM) of the apple. The results revealed an initial similar growth patterns and a later differential growth patterns between the nut and apple of cashew. The growth of the nuts showed a simple

sigmoid growth curve in terms of length and circumferences of the lower and upper ends, against weeks from pollination, thus comprising four distinct stages of development. The developmental stages of apple showed a sigmoidal growth curve comprising 4 stages (receptacular, slow-growth, rapid growth and ripening). The %DM and the fresh weight of the apple are negatively correlated ( $r = -0.92$ ).

**020.** ALIYU, OM and AWOPETU, JA. 2005. *In vitro* regeneration of hybrid plantlets of cashew (*Anacardium occidentale* L) through embryo culture. *African Journal of Biotechnology* 4(6): 548-553

Embryos from immature nuts of cashew (*A. occidentale*) were cultured *in vitro* to regenerate improved hybrid plantlets. Explants (embryo) were excised from developing F1 hybrid immature nuts derived from a diallel cross among 10 accessions (CSI 58, CSI 18, CSI 66, CC05, CC06, CC 11, CSO 03, CSO 16, CSO 23 and CSO 25) and harvested at 2, 4, 6 and 8-weeks after pollination (WAPo) for *in vitro* culture. The explants were surface-sterilized, aseptically dissected, cultured in to pure basal Murashige and Skoog (MS) agar medium and MS medium supplemented with 1 micro M each of NAA, benzyladenine (BA) and gibberellic acid (GA<sub>3</sub>), and subsequently observed for germination and survival rates until successful ones were transferred to the field. The age of explants had significant effects on the germination and survival rates. Explants 6 weeks old or older showed better germination rate and the highest survival percentage. Only the MS medium supplemented with 1 micro M gibberellic acid supported germination and growth at 2- WAPo, suggesting the essentiality of GA<sub>3</sub> as a growth regulator to very young

cashew embryos. The analysis also showed that factors such as medium composition, age of embryo and genotype (accession) significantly affected the germination rate of cashew embryos. The medium composition was only critical for embryos at a very young age. Germinated explants simultaneously produced shoots and roots, and were ready.

**021.** ALMAGUER, VG and CHI BONILLA, JY. 1994. *Cultivation of cashew in Campeche State, Mexico. Proceedings of the Interamerican Society for Tropical Horticulture* 38: 176-185 (Dept of Fitotecnica, UACH, Chapingo, CP 56230, Mexico.)

Information and research on cashews, including their various industrial and medicinal uses, is reviewed with a view to the greater exploitation of the crop in Campeche, Mexico, where conditions are very suitable for its cultivation.

**022.** ALMEIDA, AG and ALMEIDA, FCG. 1994. *Effect of N, P, and K fertilization on productivity in dwarf early air-layered cashew under irrigation. Turrialba* 44(3): 168-178

In 2-year trials with young cashew trees of the clone 076 (from air-layers) planted at 357/ha in podzolic soil, N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O alone or in combination were applied at respective rates of 90: 100:50 g/tree in the first year and at 180: 200: 100 g/tree in the second year. The N was applied as urea, P<sub>2</sub>O<sub>5</sub> as triple superphosphate and K<sub>2</sub>O as potassium chlorate. The control plots received no fertilizer. The trees were drip irrigated for 15 and 30 min. / day in the first and second year, respectively. Application of P<sub>2</sub>O<sub>5</sub> or K<sub>2</sub>O alone and of N+ P<sub>2</sub>O<sub>5</sub> + K<sub>2</sub>O significantly enhanced nut and peduncle

formation but N alone had a negative effect even compared with controls on yield. The results showed that the use of air-layering contributed to low experimental variability.

**023.** ALMEIDA, FAG., MARTINS JR, W and ALMEIDA, FCG. 2002. **Comparative phenology of two grafted clones of dwarf cashew tree in irrigation conditions.** *Ciencia Rural* 32(2): 221-228

An experiment was conducted to compare the phenology of grafted plants of the clones CP 076 and CP 1001 of precocious dwarf cashew tree under local irrigation conditions. Observations were performed on 10 plants of each clone planted in a clonal germplasm area at 6 m X 6 m spacing. Quantitative and qualitative growth, leaf abscission, flowering and fruitset were evaluated. The monthly averages of temperature, RH and wind speed, as well as the monthly total of insolation, solar radiation and rainfall, were registered during the whole experiment. Height, plant spread, leaf abscission and qualitative growth occurred in both clones, continuously throughout the experiment, as a consequence of irrigation. Flowering and fruit set were different for both clones. CP 1001, exhibited a much more defined periodicity than CP 076. Rain distribution was shown to have a greater effect on this behaviour than any environmental factor.

**024.** ALMEIDA, FAG. 1998. **Potential yield of grafted dwarf cashew trees under irrigated conditions.** *Revista Brasileira de Fruticultura* 20(3): 343-352

An experiment was conducted in Caucaia, Ceara, Brazil, from 1985 to 1991, with the purpose of evaluating the potential productivity of grafted precocious dwarf

cashew plants under localized irrigation conditions. Sixteen selected plants were used to study nut number, nut and peduncle average weight and yield as well as peduncle/nut ratio. The conclusion was that, by the time of growth stabilization in height and canopy spread of the plant, grafted precocious dwarf cashew trees under localized irrigation conditions may yield up to 7016 kg of nuts/ha/year and 55341 kg of peduncles/ha/year. More than 15 t. of nuts/ha and 131 t. of peduncles/ha may be harvested during the first 6 years of age.

**025.** ALMEIDA, FAG., SILVA, AZ., ALMEIDA, FCG and ALBUQUERQUE, J.J.L. 1995. **Comparative phenology of two dwarf cashew progenies under irrigation.** *Revista De La Facultad De Agronomia, Universidad Central de Venezuela* 21 (3/4): 157-178 (Universidade Federal do Ceara, Caixa Postal 12168, Fortaleza Ceara, Brazil).

A study was carried out from April 1987 to March 1993 on the dwarf cashew clones 1001 and CCP76 under irrigated conditions. Growth in height and spread were continuous for both clones, but greater for clone 1001 than CCP76. Leaf abscission occurred continuously in both clones throughout the study. Flowering and fruit set periods were mostly determined by rainfall distribution, but were generally more concentrated during the dry season, June to November.

**026.** ALVES, EF., CASTRO, PT-de., BEZERRA, FML and SANTOS, FJ-de-S. 1999. **Evaluation of growth parameters for dwarf cashew tree seedlings under different irrigation treatments.** *Engenharia Agricola* 19 ( 2): 142-150 (DENA/CCA/UFC, Campus do Pici, Caixa Postal 12.168, Brazil.)



This work was conducted in a green house at the EMBRAPA Tropical Research Station, Pacajus, CE, Brazil, to evaluate growth parameters for dwarf cashew tree seedlings (*Anacardium occidentale* L.), under different irrigation treatments. The experiment was analyzed in a randomized block design with five treatments and four replications. The irrigation treatments were based on evaporation from a class "A" evaporation pan. During the growth period, the average number of leaves, average stem diameter, average height of the plants and percentage of dead plants were observed. The results have shown that significant differences were observed in all the growth parameters.

**027. ALVES, RE., BEZERRA, FC and ABREU, FAP. 1999. Development and maturation of the apple of early dwarf cashew tree CCP-76. *Acta Horticulturae* 485: 25-30**

In January 1995, cashews (nut + apple) were harvested from clone CCP-76 at Pacajus, Brazil, and separated based on apple skin colour in to 7 developmental stage: green with green nut, green with ripe dry nut, light green, some yellow colour, yellow changing to orange, light orange, and deep orange. The following characteristics of the apple were evaluated : weight, length, upper and lower diameter, pH, and contents of SS, reducing sugars, titratable acidity, vitamin C, tannins and chlorophyll. After full development of the nut , the apple increased significantly in size. Best eating quality was associated with stage 7. Total chlorophyll decreased and vitamin C content increased during maturation. Tannins did not changed significantly and pH also remained stable. It is concluded that clone CCP-76 produces cashew apple of good eating quality both for fresh consumption and juice processing.

**028. AMBETHGAR, V. 2001. Indigenous entomofungi for biological control of stem and root borer infesting cashew. *South Indian Horticulture* 49 (special issue) : 281-284 (RRS, TNAU, Vridhachalam- 606001, India..**

A survey was conducted in cashew plantations in Cuddalore district, Tamil Nadu, during April 1999-March 2000, to determine the prevalence of indigenous entomopathogenic fungi and their efficacy as biological control agents against the cashew pest *P. ferrugineus*. Pathogenicity tests were conducted on *P. ferrugineus* grubs. Microscopical examinations confirmed the identity of 4 entomogenous fungi: *Aspergillus flavus*, *A.niger*, *Beauveria bassiana* and *Metarhizium anisopliae*. The rate of mycoses among infected grubs collected from the field during the study was in the range of 23.7-86.6%. The highest range of mycoses was observed during November 1999-March 2000.

**029. AMBETHGAR, V. and LAKSHMANAN, V. 1998. Tussock caterpillar *Lymantria obfusca* Walker on cashew. *Insect Environment* 4(3): 71-72 (Regional Research Station, TNAU, Vridhachalam 606 001, Tamil Nadu.).**

An outbreak of *Lymantria obfusca* was observed on cashew in the Cuddalore district of Tamil Nadu during January- February 1998. Population density was maximum (75-340 larvae/tree) during mid February. Damage was greatest in the older plantations.

**030. AMOAH, FM. 2005. The germination and early growth of cashew (*Anacardium occidentale*). *Tropical Science*. 45 (4): 149-152 (Cocoa Research Institute, PO Box 8, Akim-Tafo, Ghana).**

Cashew seeds soaked in water for 24 h and sown at 4 cm depth gave better germination and growth than cracked seeds or those sown at 8 or 12 cm.

**031.** ANANTHAKRISHNAN, G., RAVIKUMAR, R and GIRIJA, S. 2002. *In vitro* adventitious shoot formation from cotyledon explants of cashew. *Scientia Horticulturae* 93(3/4): 343-355

Excised cotyledons from mature embryos of cashew developed adventitious shoots from the proximal end when cultured on MS medium supplemented optimally with 22.2  $\mu$ M BAP and 3% sucrose. Initiation occurred only at the proximal end of the cotyledon. Differentiation of roots occurred on the same medium after the initiation of leaves. Histology revealed that there was no vascular connection between regenerated shoots and roots. Isolated shoots rooted after treatment on half-strength MS liquid medium containing IBA (122.6  $\mu$ M) for 72 h. Shoots were transferred to half-strength MS solid medium containing IBA (4.9  $\mu$ M) and IAA (5.7  $\mu$ M). About 55% of *in vitro* raised shoots developed roots.

**032.** ANANTHAKRISHNAN, G., RAVIKUMAR, R and GIRIJA, S. 2004. Selection of efficient arbuscular mycorrhizal fungi in the rhizosphere of cashew and their application in the cashew nursery. *Scientia Horticulturae* 100(1/4): 369-375

Mycorrhizal association in cashew grown in five different plantation areas of South India was investigated. The soil sample were collected from all locations. Physico-chemical properties of rhizosphere soils, arbuscular mycorrhizal fungal spore count and root colonization were recorded. Species isolated

were *Acaulospora*, *Gigaspora* and *Glomus*. The mycorrhizal spore density was maximum at Thanjavur and minimum at Kudumiyamalai. Root colonization percentage oscillated between 20 and 30%. The species of *Glomus*, *G. aggregatum*, *G. fasciculatum* and *G. mosseae* were the most abundant in the majority of the experimental sites. Hence these three species were selected and used for artificial inoculation studies. Of the three mycorrhizal fungi *G. fasciculatum* significantly increased shoot length, inter node number, number of leaves, stem diameter, root length and root number.

**033.** ANANTHAKRISHNAN, G. 1999. *In vitro* plant regeneration from embryo axis of cashewnut. *Plant Tissue Culture & Biotechnology Emerging Trends*: 123-128 (Proceedings of the symposium held at Hyderabad in 1997).

The embryonic axis and embryonic axis along with cotyledon segments of cashewnut were cultured on Woody plant medium supplemented with various concentrations of cytokinins. Maximum number of multiple shoots obtained from embryonic axis with cotyledon segment when cultured on Woody plant medium supplemented with 5mg/litre (BAP/AdS), whereas only single shoots were obtained from embryonic axis. Well developed shoots were transferred to rooting medium containing IAA+IBA. The regenerants were successfully transferred to the field.

**034.** ANANTHAKRISHNAN, G., RAVIKUMAR, R., ANAND, R P., VENGADESAN, G. and GANAPATHI, A. 1999. Induction of somatic embryogenesis from nucellus-derived callus of *Anacardium occidentale* L. *Scientia Horticulturae* 79(1/2): 91-99 (Dept o

Biotechnology, School of Life Sciences, Bharathidasan University, Trichirappalli- 620 024.).

Calli were induced from nucellar explants excised from 1-month old developing fruits of cashew. The medium used consisted of MS formulation containing  $6.78 \mu\text{M}$  2, 4-D. Differentiation of somatic embryos from calluses was noticed when they were transferred to MS liquid medium supplemented with  $4.52 \mu\text{M}$  2,4-D. Further studies on the ontogeny of somatic embryos showed that the cells destined to become somatic embryos divided in to spherical or filamentous pro-embryos. Subsequent divisions in the pro-embryo led to the globular, heart and torpedo stages of somatic embryo development.

**035.** ANIL, SR., THIMMAPPAIAH and IYER, ROHINI. 2000. **Vesicular arbuscular mycorrhizal association in cashew.** *Recent Advances In Plantation Crops Research* 13: 390-392 (Proceedings of PLACROSYM XIII held at Coimbatore, 1998).

Roots and rhizosphere soil samples were collected from NRCC Cashew Plantation, Puttur and screened for the presence of vesicular and arbuscular mycorrhiza (VAM). Pure cultures of the dominant species were made using sorghum as host plant. Roots collected from field grown trees as well as isolated seedlings were found naturally infected with VAM as revealed by the presence of vesicles, arbuscules and mycelium. Four species of VAM isolated from cashew soils were identified as *Glomus macrocarpum*, *G australe*, *G multicaule* and *Scutellospora nigra*. Among the 4 species, *G macrocarpum* and *S nigra* were widely distributed and found associated with

the roots of cashew trees as well as isolated seedlings. Hence, these two species could be used in the acclimatisation of micropropagated plants.

**036.** ANIL, S R and THIMMAPPAIAH. 2005. **Somatic embryogenesis from nucellar callus of cashew.** *Journal of Horticultural Science and Biotechnology*. 80(3): 327-337

Calli were initiated from bisected ovules with intact nucelli from 3 week-old immature cashew nuts (*Anacardium occidentale* L.) cvs. 'NRCC Sel-2', 'Ullal-1', 'Ullal-3', 'Goa 11/6', 'Vengurla-8' and 'Kanaka') cultured on half-strength Murashige and Skoog (1962) medium (MS) containing 2,4-Dichlorophenoxy-acetic acid (2,4-D; at  $1.0$  or  $4.0 \mu\text{M}$ ) alone, or a combination of 2,4-D ( $0.5$ ,  $1.0$  or  $4.0 \mu\text{M}$ ) with  $12 \mu\text{M}$  kinetin or  $10 \mu\text{M}$  spermine. Calli, which became brown after 4-6 weeks, differentiated in to somatic embryos on Raj Bhansali medium (RBM) containing 2,4-D ( $0.01$  or  $0.5 \mu\text{M}$ ) and  $30 \mu\text{M}$  kinetin or  $10 \mu\text{M}$  spermine. Somatic embryos were initiated in 2.2-27.7% of cultures of cultivars 'Goa 11/6', 'Kanaka' and 'Ullal-3' only. The number of somatic embryos increased more than 5-fold following suspension culture in RBM basal medium. Histological studies on nucellar calluses revealed differentiation of all the developmental stages of somatic embryogenesis: a pro-embryonic mass, and globular and heart-shaped embryos. Somatic embryos matured on half strength MS medium containing  $18.9 \mu\text{M}$  abscisic acid, and 60% germinated on liquid medium containing  $0.53 \mu\text{M}$  alpha-naphthalene acetic acid (NAA) and  $4.4 \mu\text{M}$  6-benzylamino purine (BAP) giving plantlets with a well-developed tap-root and a shoot with rudimentary green leaves.

**037. ANONYMOUS. 1995. Priyanka - a new high yielding cashew hybrid (H-1591) from Kerala Agricultural University. *The Cashew* 9 (4): 3.**

The cashew hybrid variety Priyanka, derived from a cross between BLA 139/1 and K30/1, has been approved for release in the state of Kerala. The trees grow to a height of about 8 m with spreading habit and extensive branching. Flowering is in Dec. - Jan. The apple weighs 135g and contains 57.4% juice. Priyanka is distinguished by its bold nut (10.8g) and large kernel (2.87g). It can give a mean yield of 16.9 kg/tree under good growing conditions.

**038. APPARAO, R. 2001. Cost of production of cashewnut in Srikakulam district of Andhra Pradesh. *The Cashew* 15(1): 21-28**

The study revealed that the establishment cost /ha for production of cashew nut in Srikakulam dist. of AP was Rs. 6686.87 during first year while the maintenance cost / ha. was Rs. 5697.92. The annual share of establishment cost was worked out to Rs.103.18. The labour cost account for about 78.58% while material cost account for 21.42% of the total cost of establishment of the cashewnut. In the case of the maintenance cost from sixth year the labour cost account for 45.54% while the material cost account for 54.46%.

**039. ARAUJO, MC-DE and FERRAZ, AC-de-O. 2006. Effect of moisture content, thermal treatment and deformation on decortication of cashew nuts 'CCP 76' by means of a guided single impact. *Engenharia-Agricola*. 26(2): 590-599 (Campus Amilcar Ferreira Sobral, Universidade Federal do Piaui, Piaui, Brazil).**

The mechanized system, of multiple impacts, used by the Brazilian cashew nut industry damages the kernels yielding to only 50 to 60% of whole kernels. To investigate the performance of shelling cashew nuts using an impact associated with a limited oriented deformation, a special device was designed and constructed. Initially it was found the maximum specific deformation corresponding to the best performance in shelling. With this value, called limit specific deformation, it was investigated the effect of several combinations of humidification and thermal treatment times, commonly used in the preparation of the nut of the clone CCP-76, for shelling, in the performance of a single oriented impact with limited deformation shelling. The cashew nuts were characterized by their dimensions and weight before and after preparation. The impact device showed to be effective and easy to operate. The largest index, of 77,55%, of liberated whole kernels was obtained to a specific deformation of 19%. After preparation nuts showed average mass loss of 25,7%, increase in length, width and thickness of 7,03%, 5,77% and 7,35%, respectively. For the answer surface methodology, no differences in shelling performance was observed among treatments.

**040. ARCHAK, SUNIL., GAIKWAD., AMBIKA B and SWAMY, KRM. 2003. DNA fingerprinting of Indian Cashew varieties using RAPD and ISSR techniques. *Euphytica* 230: 397-404**

Indian cashew breeding programme has produced 24 selections and 11 hybrids with increased yield and excellent nut characters. Molecular profiles of these varieties were developed using a combination of five RAPD

and 4 ISSR primers pre-selected for maximum discrimination and repeatability. A total of 94 markers were generated which discriminated all the varieties with a probability of identical match by chance of  $2.8 \times 10^{-11}$ . There was no correlation between the relationships based on molecular data and the pedigree of the varieties. Narrow range of average similarity values among major cashew breeding centres with only 3.6% of molecular variance partitioned between them was attributed to the exchange of genetic material in developing varieties. Difference in the average similarity coefficients between selections and hybrids was low indicating the need and scope for identification of more parental lines in enhancing the effectiveness of hybridisation programme.

**041. AROGBA, SS. 1999. Studies on kolanut and cashew kernels moisture absorption isotherm, proximate composition, and functional properties. *Food Chemistry* 67(3): 223-228**

Kolanut and cashew kernels were analysed and their moisture absorption isotherms, proximate composition and functional properties were compared. The dried powdered sample of kolanut contained 69% carbohydrate, 18% crude fat and 3.1% ash by weight, while the cashew sample had 51% crude fat, 36% crude protein, 0.3% ash and 3.4% carbohydrate. These differences significantly affected their relative water and oil absorption capacities, least gelation concentration, bulk density, and emulsion properties. However, both samples would retain nutritional integrity when stored in atmospheres with water activities of up to 0.68 for kolanut and 0.85 for cashew kernels.

**042. ASCENSO, JC and DUNCAN, IE. 1997. Cashew processing and marketing. *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp. 189-194**

Cashewnut manual processing methods were originally developed in India in the 1930s. The original process involved Drum Roasting. Shelling preparation methods were later modified with introduction of Hot Oil Bath to allow collection of CNSL and eventually the Steam Cooking system. In the 1960s mechanical processing was developed - the Oltremare and Sturtevant systems. Both these systems used HOB processes.

**043. ASSIDJO, NE., YESSOH, JM and SORO, A. 2005. Study of cashew nuts variability and proposition of an analytical method. *Global Journal of Pure & Applied Sciences* 11(3): 411-417**

Experiments were conducted to study the variability in time of cashew nut quality (during 1999 and 2000) and to determine the efficiency of existing analytical methods for quality determinations. The quality parameters (immature, mouldy, stung and partially damaged, and empty nuts) varied whereas other parameters such as nut count did not show any significant variation. In addition, empty and mouldy nuts were identified as the major factors in nut quality depreciation. Correlation coefficient analysis showed that the quality parameters could be divided into 3 groups according to their cause, i.e. nut count, empty and immature nuts of physiological origin, mouldy, stung and partially damaged nuts of fungal origin and stunted and buttered nuts which have no evident relationship with the other parameters. A sampling method with a sample

size of 400 nuts and a linear analytical method was proposed and proven more accurate and easy to use.

**044.** ASSUNCAO, RB and MERCADANTE, AZ. 2003. **Carotenoids and ascorbic acid composition from commercial products of cashew apple (*Anacardium occidentale* L.).** *Journal of Food Composition-and-Analysis*. 16(6): 647-657 (Departamento de Ciencia de Alimentos, Faculdade de Engenharia de Alimentos, Universidade Estadual de Campinas, Caixa Postal 6121, Campinas SP 13083-970, Brazil).

Carotenoids were determined by high-performance liquid chromatography (HPLC) and ascorbic acid (AA) by the official method of the Association of Official Analytical Chemists (AOAC) in cashew apple products found on the market of Campinas, Brazil. The following products, concentrated juice, frozen pulp, nectar, ready-to-drink, and sweetened concentrated juice, were analysed, showing AA contents from 13.7 to 121.7 mg/100 g and total carotenoid levels ranging from 8.2 to 197.8 micro g/100 g. beta -Carotene was the main carotenoid in the majority of the products, followed by alpha -carotene, beta -cryptoxanthin and 9-cis- +13-cis- beta -carotene in similar proportions. However, in 10 of the 60 samples analysed, another carotenoid pattern was found with the presence of auroxanthin, 5,8-epoxy-cryptoxanthin, 5,8-epoxy-lutein, zeta -carotene and two unidentified carotenoids. Cashew apple products were proved to be excellent sources of vitamin C, but not very good sources of carotenoids for the human diet.

**045.** ATHALYE, SS and PATIL, RS. 1998. **Bionomics, seasonal incidence and chemical control of cashew leaf miner.** *Journal of Maharashtra Agricultural Universities* 23 (1): 29-31

Studies on bionomics of *Acrocercops syngamma* revealed that the incubation, larval and pupal periods lasted for 4.57, 9.35 and 8.3 days, respectively. The life span of adult when fed on 10% sugar solution ranged between 3.4 and 7.47 days. The total duration of life cycle from egg to death of adult varied from 22.6 to 39.2 days with the average values of 26.90 for male and 32.65 for female. The incidence of the pest was observed throughout the year in cashews in Maharashtra. Infestation on cashew leaves peaked (18.21%) during September or post monsoon vegetative flush. One to 10 blistered patches and up to 15 larvae were found in a single leaf. Results of the field experiments conducted to test the efficacy of several insecticides against the pest indicated that the applications of 0.05% triazophos, 0.05% endosulfan and 0.0075% cypermethrin were equally effective against the larvae.

**046.** ATHALYE, SS., PATIL, RS and BHOLKAR, SR. 1998. **Efficacy of some insecticides against cashew leaf miner, *Acrocercops syngamma* Meyrick.** *Shashpa* 5(2): 223-223 (Dept of Agricultural Entomology, KKV,Dapoli- 415 712,Ratnagiri District, Maharashtra).

Evaluation of six insecticides against *Acrocercops syngamma* in cashews in Maharashtra, India showed that all the insecticides were significantly superior to the control in reducing percent leaf infestation. On the basis of the lowest cumulative mean percent leaf infestation (6.21) and percentage reduction over the control (47.34), 0.05 triazophos was found quite promising against *A. syngamma*. Phosphamidon at 0.04 was found to be the least effective insecticide.

047. ATMADJA, WR. 2003. **Status of *Helopeltis antonii* as a pest of some estate crops and its control.** *Journal Penelitian dan Pengembangan Pertanian*. 22(2): 57-63 (Balai Penelitian Tanaman Rempah dan Obat, Jalan Tentara Pelajar No. 3, Bogor 16111, Indonesia).

*Helopeltis antonii* is a main pest of estate crops (cashew, cacao, and tea), therefore its existence needs a serious attention. The life cycle of *H. antonii* was approximately 24 days and during its life it moulted 5 times. The pest destroys plant since the cultivation of seedling. The parts of the plant destroyed are the tip of the leaf, young leaf, bud, young stem and branch as well as flower, fruit and seed. The control of *H. antonii* using synthetic insecticide was proven effectively, however, it caused a negative impact so that, generally, it is applied as the last alternative. The other controls such as mechanical, physical, technical culture and biological control have not been applied optimally. The control using natural enemies is a good prospect to be developed since it is safe to the environment and is naturally provided.

048. ATTRI, BL. 1999. **Compositional and storage study of cashew apple.** *The Cashew* 13(2): 23-30

The effects of storage on physiological loss of weight (PLW), specific gravity of fruits and extracted juice were studied in 5 cultivars of cashew apple. The PLW increased with the increase in storage period in all the cultivars. Fruit specific gravity decreased during storage while juice specific gravity increased. The total tannins were reduced significantly from 0.33-0.47% to 0.03-0.05% after treating the extracted juice with gelatin (0.05%). The cashew apple residue contained 0.448-1.136% N, 0.072-0.554% P and 7.04-7.12% K; its protein content

varied from 2.8 to 7.1%. The extracted juice was preserved with 2000ppm KMS and analysed at different storage intervals at ambient temperature.

049. ATTRI, BL. and SINGH, DB. 1997. **Evaluation of different cultivars of cashew apple for physico-chemical characteristics.** *Journal of Plantation Crops* 25(2): 205-208 (Central Agricultural Research Institute, Port Blair 744 101, India.)

This study was carried out to evaluate some of the commercially important cultivars for physico-chemical characteristics of apple as well as for storage study of the extracted juice. A significant difference among cultivars was recorded in all the characters. The moisture was highest (86.0) in Andaman local and lowest (83.60) in Ansur Early whereas the dry matter was recorded minimum (14.0) in Andaman local and maximum (16.4) in the Ansur Early. The ash content of the apple varied with maximum (1.96) in Ansur Early and minimum (1.55) in Andaman local.

050. ATTRI, BL., SINGH, DB and SHARMA, TVRS. 1998. **Technology for the preparation of wine from cashew apple.** *Cashew Bulletin* 35(3): 7-11 (Central Agricultural Research Institute, Port Blair - 744101, Andamans, India.)

The technology for the wine production from cashew apple has been standardised. The extracted juice was treated with 0.5gelatin along with heating. The TSS was ameliorated with sugar syrup as well as 0.1diammonium hydrogen phosphate. The fermentation rate was better for a week and reduced thereafter due to more alcohol production. After 6 months storage the physicochemical characteristics and overall quality of the wine was assessed. It was

found that retention of ascorbic acid was better in wine having more alcohol whereas the titriable acidity and total phenols increased with higher alcohol.

**051.** AWETO, AO and ISHOLA, MA. 1994. **The impact of cashew on forest soil.** *Experimental Agriculture* 30: 337-341 (Dept of Geography, University of Ibadan, Ibadan, Nigeria).

The impact of a 20 year-old cashew plantation on a forest soil was evaluated by comparing the properties of soil under cashew with that under an adjoining logged rain forest. The levels of organic carbon, nitrogen, exchangeable calcium and magnesium, and available phosphorus were similar under logged forest and cashew, suggesting that organic matter and nutrient cycles in a cashew plantation are similar to those in a logged rain forest and that cashew has no significant adverse effect on soil organic matter and nutrient status.

**052.** AZEVEDO, DMP de., CRISOSTOMO, JR and ALMEIDA, FC. 1998. **Estimates of genetic correlations and correlated responses to selection in cashew.** *Genetics and Molecular Biology* 21(3): 399-402 (EMBRAPA Rondonia, BR 364km 5.5, Caixa Postal 406, 78900- 970, Porto Velho, RO, Brazil).

Genetic variance and genetic and phenotypic correlations were evaluated and 5 traits in 27 cashew trees grown at Pacajus Experiment Station, Ceara State in 1992. The characters studied were plant height (PH), North-South and East-West canopy spreads and primary and secondary branch numbers. All genetic and phenotypic correlations were positive and significant. Selection to increase

or decrease the average of any one of the characters studied affected the average of the others.

**053.** BADHE, VT and MAGAR, SS. 2000. **Influence of different conservation measures on runoff, soil and nutrient loss under cashew nut in lateritic soils of south Konkan region.** *Indian Journal of Soil Conservation* 32(2): 143-147 (Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli 415 722, M.S, India).

An investigation was carried out during 1991 to 1999 in Mulde, Sindhudurg (Maharashtra, India), to study the influence of land treatments on hill slope, viz., control (T1), intermittent bench terraces (T2), staggered trenches (T3), platform terraces (T4), rim trenches (T5), and vetiver (*Vetiver zizanioides*) grass bunds (T6), on growth and yield performance of cashew nut. The runoff, soil loss and nutrient loss were also estimated. The maximum runoff was recorded in T1 (555 mm) whereas minimum in T3 (69 mm). Similar trend was observed in case of soil loss. Minimum nutrient loss was in staggered trench treatment in the form of organic carbon (27 kg ha<sup>-1</sup>) and potassium (0.03 kg ha<sup>-1</sup>) whereas it was maximum under control treatment in the form of organic carbon (670 kg ha<sup>-1</sup>) and K<sub>2</sub>O (0.67 kg ha<sup>-1</sup>), respectively. There was no significant difference in growth characteristics and yield of cashew nut plants due to the influence of various soil conservation structures. The staggered trenches treatment group plants recorded the highest average yield (4.05 q ha<sup>-1</sup>) compared to control group (2.8 q ha<sup>-1</sup>). Thus, present investigation revealed that 230 trapezoidal shaped staggered trenches per hectare having dimensions of 4.5 m length, 0.60 m top width, 0.30 bottom width, 0.30



depth were most effective for reducing surface runoff and conservation of soil, nutrients and fertility of land under hilly terrain in lateritic soils of Konkan region of Maharashtra with annual rainfall of 3283 mm.

**054. BADHE, VT and POWAR, AG. 2004. Development and evaluation of hand operated cashew apple juice extractor. *The Cashew* 18 (1): 23-33**

A hand operated shearing type cashew apple juice extractor was developed and tested. The performance was evaluated in comparison with the conventional methods of juice extraction, viz., hand squeezing, wooden laddle and wooden basket press. The trials revealed that the juice extracting machine recorded the highest crushing capacity of 60Kg/h for both fresh and boiled cashew apples, followed by basket press with 22.5 and 20.00 kg/h wooden laddle with 7.50 and 8.77 kg/h and the lowest crushing capacity of 1.76 and 2.14 kg/h was recorded by hand squeezing method for both fresh and boiled cashew apples, respectively. The highest juice recovery was recorded in hand squeezing method (73.00%) followed by 62.00% in wooden laddle, 56.17% in the extracting machine and lowest of 43.32% in basket press. It is concluded that the extracting machine is the most efficient and economical among the methods tested. The machine is light in weight, dryable, portable and non-corrosive in nature.

**055. BADRINATH, MS, SUDHIR, K and CHIKKARAMAPPA, T. 1997. Soil fertility evaluation for cashew cultivation in coastal Karnataka soils. *The Cashew* 11(2): 22-27.**

Current levels of cashewnut per tree is alarmingly low and might be due to the several

factors limiting economic yield. Among these, application of inorganic fertilizers carrying P, K, Boron after the soil amelioration process with dolomitic limestone will not only raises the soil pH but favours the supplied plant nutrients in the available form to the rhizosphere.

**056. BALASUBRAMANIAN, D. 2003. Cashew industry in Mozambique: a general scenario. *The Cashew* 17(2): 39-45 (National Research Centre for Cashew, Puttur - 574202, Karnataka, India)**

In Mozambique, in 1997 there were about 15 cashew factories become operational but less than 50% of its installed capacity was utilized. The kernels are mostly exported to USA, EEC and South Africa. The basic requirements of high standards, brand name and marketing network have never been attempted in Mozambique. In 1994, World Bank recommended liberalized trade for cashew in view of inefficient production in the factories and lower farmers income, but not accepted by the people and Govt. of Mozambique. Studies conducted in Mozambique indicated that an improved management and small-scale processing units could elevate the position of cashew industry as whole. Finally an export duty has been fixed between 18% and 22% for the next five years and it is expected that the export tax gained would be utilized for the promotion of cashew farming in the country.

**057. BALASUBRAMANIAN, D. 2003. Cashewnut processing and its economic feasibility in Kolar district of Karnataka - a case study. *The Cashew* 17(4): 6-11**

Cashew nut processing units in Kolar dist. follows steam boiling of raw cashew nut

and conventional type drier is used to make kernel amenable for peeling. Gas fired kernel drier is introduced recently and its operational efficiency is yet to be determined. Kernel peeling is done at home level and finally stored in to 15 different grades. The cost benefit ratio of processing in this region has been worked out as 1: 1.28. Major interventions are required to develop quality standards for raw cashew nuts, developing skilled manpower at various stages of processing and refined technical parameters to enhance profitability. Considering under utilization of established facility, i.e. up to 12.5% of total production in this region, inefficient technical and management aspects and the huge investment incurred on raw nuts and machines, existing large-scale processing units are not successful in this region. As small-scale processing units generates employment for 3177 persons for the raw nut produced and profitability of business up to Rs. 88,390 per unit during season (EBIT) and the value addition is Rs. 11.04/Kg of raw nuts which is 16% more than existing system, it can be promoted to improve economic status and rural employment.

**058.** BALASUBRAMANIAN, D and NARAYANAN, L. 2006. **Moisture desorption characteristics of cashew kernels.** *The Cashew* 20(1): 13-19

Desorption isotherm of cashew whole kernels were determined at 60,70 and 80°C using water activity analyzer. Non-linear curve fitting technique is used to validate seven moisture sorption models viz., Oswin, Smith, Halsey, Henderson, Modified Henderson, Modified Oswin and Chung and Pfost. Desorption isotherms were of Sigmoid shape, typical for many biological products. Curve

fitting agreement of observed data for select isotherm models revealed that Smith equation is the best fit to describe desorption characteristics of cashew whole kernel. Temperature has a significant effect on desorption isotherms. The equilibrium moisture content of cashew kernels at constant water activity decreased with increasing temperature.

**059.** BALASUBRAMANIAN, D. **Quality index for cashew nut processing.** *The Cashew* 2002 16(3): 21-23

At all stages of cashew nut processing quantity and quality losses can occur. Normally the whole kernel outturn at packing is considered to be the quality indicator to assess the processing efficiency of the industry. Quality index is calculated by summing up values obtained by multiplying different grades proportion and corresponding standard price. Quality index helps to adopt better manufacturing practices and plant hygiene in order to further promote the industry on sound and scientific lines.

**060.** BALASUBRAMANIAN, D. 1999. **Quality maintenance and its improvement of raw cashew nuts.** *The Cashew* 12 (3):137-141

This paper listed the measures to be taken to improve the quality of raw nuts for successful processing. The farmers have to be educated on method and stage of harvest. Proportion of nuts have to be fixed on the basis of size of nuts and its moisture content. High degree of cleanliness has to be maintained in drying yard and storage godown. Raw nuts in warehouse should be monitored at regular interval for quality and it should be provided ventilation and sufficient aeration.

**061. BALASUBRAMANIAN, D., SREEKANTH, PD and RAO, EVVB. 2002. Speculation of raw cashew nut price - an overview. PLACROSYM - XV: 759-764**

Price information is essential as it provides cashew business to determine the trade operations economically viable either immediately or in a long term. The price variation of domestic and imported raw cashew nut with respect to time and the underlying factors for speculation are discussed. The seasonality of indigenous nuts, increasing global demand of kernels, higher share of raw nuts in the processing cost are the major reasons led to speculation. Kerala has been the nucleus centre of cashew trade in India and the market price in Kerala is considered as benchmark in other regional markets. The month-wise seasonal index for domestic raw nut varies with different cashew growing states. A pricing system based on raw nut quality would be much helpful for the growers to get remunerative price for their produce and the industry to turn out their operation for better economic results to remain in the international trade. Therefore, quality standards to fix up the price based on quality have to be drawn.

**062. BALASUBRAMANIAN, D. 2000. Cashew processing in Palasa of Andhra Pradesh - a case study. *The Cashew* 14 (4): 7-16**

Cashew nut processing units in Andhra Pradesh accounts for 17.65% of total industries in India. Cashew processing is labour oriented and follows drumroasting method. About 66.67% of cashew industries in Palasa region have capacity utilization between 0.64 - 1.44 tonnes per day. The average kernel percent recovery is calculated as 26.06% and an over

all cost of processing in this region is worked out to be Rs. 3845/- per ton of raw nut. The cost benefit ratio is found to be 1:1.36.

**063. BALASUBRAMANIAN, D. 2001. Cashew processing industries in India: overall analysis. *The Cashew* 15(2): 14-20**

The growing demand for kernels in the international market and the availability of cheap labour in India possessing the required skills in processing are the 2 important favourable factors in the rapid growth of cashew processing industry in India. Cleanliness of processing units has to be given utmost importance. Optimisation of every processing step has become urgent. The principal requirements for the development of mechanised cashew processing plants will be the efficiency in the production of unscorched kernels and maximum recovery of CNSL. Oil bath roasting which has additional advantage of obtaining the CNSL is to be adopted.

**064. BALASUBRAMANIAN, D. 2001. Cashew processing industries in Kerala: Quilon and Calicut. *The Cashew* 15(2): 28-35**

Cashew processing industries in Kerala are mostly concentrated in Quilon district. Most of the processors are following drum roasting as preliminary process. Kerala State Cashew Development Corporation and CAPEX are the two government organisation involved in cashew processing. CNSL extraction is also done using expeller. About 60% of the total kernel production is exported.

**065. BALASUBRAMANIAN, D. 2001. Physical properties of raw cashew nut. *Journal of Agricultural Engineering Research* 78(3): 291-297**

Physical properties of raw cashew nut from various growing States of India were evaluated as a function of moisture content. The average dimension of three principal axes (viz., length, width, thickness), mass ratio, equivalent diameter and sphericity were measured at a moisture content of 8.46% d.b. The 100 nut mass, porosity, bulk density, true density and coefficient of friction were determined for moisture contents ranging from 3.15 to 20.05% d.b. It was found that the 100 nut mass and true density of raw cashew nuts increased with increased moisture content. The coefficient of friction on various surfaces increased with increase in moisture content.

**066.** BALASUBRAMANIAN, D., NAGARAJA, KV and RAO, EVVB. 2001. **Status and prospects of cashew cultivation and its utilization in Konkan Region.** *Post Harvest Technologies and Prospects for Food Processing Industry in Konkan Region.* pp. 18-22 (Symposium proceeding, Panaji, Goa).

This paper highlights the status of cashew cultivation and its utilization in Konkan region and future strategies for cashew cultivation and processing.

**067.** BALASUBRAMANIAN, D. 2000. **Status report on cashew processing industries of Dakshina Kannada.** *The Cashew* 14(2): 12-25

In Dakshina Kannada district about 57% of the industries have the processing capacity between 100 to 500 tonnes/annum, far below the installed capacity. In this sector, women employees' accounts to 90-95% of the total work force. Steam boiling method of raw nut conditioning is being followed, as the kernel recovery is comparatively higher than all other

methods. CNSL is extracted by expeller method and practiced in very few industries.

**068.** BALASUBRAMANIAN, D. 1998. **Equilibrium moisture content of raw cashew nut.** *Cashew Bulletin* 35(2): 2-3 (National Research Centre for Cashew, Puttur-574202, India.)

The equilibrium moisture content of raw cashewnuts at different relative humidities were determined at 300°C. The increase in the moisture content and relative humidity exhibits disruption isotherm up to 74.12, but at 81.33 it followed absorption isotherm. Mold growth and deterioration took place after 28 days at 81.33 after the commencement of experiment. Based on the prevailing climatic conditions especially temperature and relative humidity, the moisture content of raw cashew nuts has to be brought down to calculated equilibrium moisture content to increase its storage life.

**069.** BALASUBRAMANIAN, PP. 1998. **National seminar on cashew,** Goa, India, May 1998. *The Cashew.* 12(3): 186 pp.

A total of 20 contributions presented at the seminar on cashew are presented, under the headings: (I) Development (3 papers); (II) Research (8 papers on production and cultural requirements of cashew); (III) Postharvest technology (5); and (IV) Marketing (4).

**070.** BALASUBRAMANIAN, PP. 1998. **Transfer of technology in Indian cashew promotion.** *The Cashew* 12(3): 121-126 (Director, Directorate of Cashewnut and Cocoa Development, Cochin - 16., Kerala).

Transfer of technology from research to the farmers field is one of the major responsibility of the Extension wing. The

farmers are the key factor responsible in modernising agriculture. This aspect is very much conspicuous in the case of cashew wherein a major sector of this farming community remains unaware of the technological advancements. The extension lacunae has been more responsible for the bad state of affairs of our cashew plantations. A greater role and co-operation of National and SAU researchers in monitoring the demonstrations, imparting training in their technologies are needed.

071. BANDANA-DHIMAN and MAHIPAL-SINGH. 2003. Molecular detection of cashew husk (*Anacardium occidentale*) adulteration in market samples of dry tea (*Camellia sinensis*). *Planta-Medica*. 69(9): 882-884 (Division of Biotechnology, Institute of Himalayan Bioresource Technology, Palampur, India.)

Species-specific PCR primers were developed from the intergenic spacer regions of 5S ribosomal RNA genes and were used successfully in the detection of adulteration of cashew husk (*A. occidentale*) in tea (*C. sinensis*) samples. This is the first report of detecting adulteration in tea using molecular tools. Application of this approach in detecting adulteration of other biological materials in tea, medicinal herbs and the composition of admixtures of ayurvedic herbs has been discussed..

072 BANDYOPADHYAY, A. 1998. Technologies for cashewnut production for West Bengal. *The Cashew* 12 (3): 115-120 (Dept of Spices & Plantation Crops, R.R.S., B.C.K.V., Jhargram, Midnapore, West Bengal.

In West Bengal 80% of area under cashew is concentrated in the Midnapore East

and West districts. Midnapore East comes under subtropical coastal saline humid ecoclimate and West on the other hand is situated in red and laterite zone. Seedling plantations of non-descript origin, non-uniform plant population per unit area and poor orchard management practices are some of the major constraints limiting cashew production in this area. To overcome the constraints some suggestions are also listed in this paper.

073. BARBOSA-e-SILVA, KM., ALMEIDA, FAG and LIMA-e-SILVA, PS. 2004. Peduncle and fruit yield, in six cropping seasons, of early dwarf cashew tree clones irrigated with different water regimes. *Revista-Brasileira-de-Fruticultura*. 26(3): 474-477 (Departamento de Biologia, UERN, Faculdade de Ciencias Biologicas e Naturais, C.P. 130, Mossoro-RN, CEP 59.625-900, Brazil).

The objective of this work was to evaluate peduncle and fruit yield in clone MS 076 and in a clonal population of drip-irrigated, early dwarf cashew trees propagated by layering, in six cropping seasons. In order to meet the increased water requirements of the crop resulting from plant growth and development, irrigation during the dry season was performed daily according to the following water regime: 15 min/plant/day during the 1st year, 30 min/plant/day during the 2nd year, 45 min/plant/day during the 3rd year and 60 min/plant/day during all subsequent years. Water was supplied by one drip emitter/plant, at an (adjustable) flow rate of 36 L/h. The research was carried out in Fortaleza-Ceara, Brazil, and a random block design was utilized, with five replicates and split-plots. The clones were assigned to plots and the cropping seasons were considered as subplots. The clonal population

was superior to the clone only with regard to number of nut shells (NNS), and solely in the first season. The clone was superior to the population as to NNS and peduncle yield (PY) in the second season, and also in terms of the three evaluated traits - NNS, PY, and nut shell yield, in the last three cropping seasons..

**074. BARBOSA-e-SILVA, KM., LIMA-e-SILVA, PS and ALMEIDA, FAG. 2004. Regression equations for plant height estimation in cashew trees. *Revista-Ceres*. 51(295): 405-409 (Universidade do Estado do Rio Grande do Norte, Cx. P. 70, 59600-97 Mossoro, RN, Brazil).**

Regression equations for the estimation of plant height based on the mean canopy diameter of an early dwarf cashew tree clone (CP 076) and a clonal population, irrigated and propagated by layering (rooting), were developed. The population consisted of clones from 5 different matrices. Plant height and diameter were measured quarterly from March 1990 to June 1996. The distance from the ground level to the highest point of the canopy was considered as plant height. The mean value of diameters measured in the north-south and east-west directions were considered as the canopy diameter. The equations for the estimation of plant height (h) based on the canopy diameter (d) of clone CP 076 and of the clonal population were  $h=0.5167 d$  and  $h=65.3277+0.3756 d$ , respectively..

**075. BARROS, L De M. 2000. Selection of dwarf cashew clones for commercial plantation in Ceara state. *Pesquisa Agropecuaria Brasileira* 35(11): 2197-2204**

Results are presented from the evaluation of 30 rainfed dwarf cashew clones at Pacajus,

CE, Brazil from April 1990 to Feb. 1997. The experimental design was randomized blocks with 4 replications and 4 plants/plot, spaced 7m X 7m. Clones CAP 01, CAP 05 and CAP 12, on average 70% taller than the controls had a medium canopy size, intermediate that of the common type and that of the dwarf type. Canopy diameter in CAP 10, CAP 06 and CAP 26 was 63% higher than the controls, while CAP 02, CAP 07, CAP 24 and CAP 25 showed the lowest values of this trait. Nut yield of CAP 12, CAP 18 and CAP 26 was respectively, 1510, 1281 and 1262 kg/ha in the fifth year, i.e. 175% higher than that of the best control.

**076. BASAVARAJ, N and HEGDE, NK. 1998. Initial performance of cashew selection under up-ghat conditions. *Karnataka Journal of Agricultural Sciences*. 11: (2): 546-547 (Division of Horticulture, College of Agriculture, Dharwad-580005, India.)**

Data on nut yield and plant characteristics are tabulated for 4 released varieties and 7 promising selections of cashew (*Anacardium occidentale*) grown at a village near Sirsi (at an altitude of 620 m) during 1992. Highest yield per plant (0.19 kg) was given by the hybrid variety VH19, which is dwarf (plant height of 1.66 m).

**077. BASHIRU, RA. 1997. Vegetative propagation of cashew - review of work done in Tanzania. *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp.302-308**

Different techniques of vegetative propagation like side grafting, tip-grafting and top-working, chip-budding and stooling were investigated. Results of trials on tip-cleft (or

wedge) grafting show that grafting green-brownish dormant scions on to seedling rootstock of age above 2 weeks together with proper protection from desiccation by wrapping with clear polythene tape gave a success rate of 60-100 in the year. The technique has been recommended for mass propagation and the Oct.-Dec. period was found to be the most suitable for carrying out grafting for field planting.

078. BEENA BHASKAR., SALAM, MA and WAHID, PA. 1995. **Nutrient offtake in cashew.** *The Cashew* 9(3): 9-16

Annual offtake of major and micronutrients was studied in six cashew varieties. The quantities of the harvested dry matter and nutrients through apple, kernel and shell varied with varieties Vridhachalam 26/2 and H - 1600. The harvested dry matter was partitioned between apple, kernel and shell in the order of 51.8, 15.5 and 32.8 per cent respectively. The offtake of N,P,K, Ca, Mg, S, Fe, Mn, Zn and Cu was the largest through apple. While harvesting a Kg of nut, the tree loose through apple and nut 64.1g N, 2.05g P, 24.7g K, 4.19g Ca, 1.57g S, 525.7 mg Fe, 63.6g Mn, 87.8mg Zn and 26.5mg Cu. The partitioning of major and micronutrients between apple, kernel and shell was also assessed.

079. BEENA BHASKAR., SALAM, MA and WAHID, PA. 1995. **Root activity of cashew varieties of cashew in relation to phenological phases.** *Journal of Plantation Crops* 23(1): 35-39

In a trial on an Ultisol, the  $^{32}\text{P}$  soil-injection technique was used to study root activity in 4 cashew cultivars (5-year-old trees) during 4 phenological stages. Highest root

activity and peak absorption of N, P and K occurred during the flushing and early flowering phase which extended from Sep. to Dec. It is adjusted that the onset of this phase is the most appropriate time for fertilizer application in a cashew orchard. Root activity was lowest during the maturity and harvesting phase (Mar. - June). However, irrigation during this period enhanced  $^{32}\text{P}$  uptake by the roots. The 4 cultivars tested did not differ in root activity.

080. BEHRENS, R. 1997. **The spacing of cashewnut trees.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp. 48-52

Spacing of cashewnut trees depends on physical factors as line or clone used, soil, rainfall, topography and also on social factors as objective of the plantation, available land, labour and tradition. Densities between 40 to 2500 trees/ha are currently recommended. Spacing varies from 2m x 2m square to 15m x 15m square or triangular. Planting in rows with spacing of 5m x 20m has become very popular in Senegal. In Africa, plantations under small farmers conditions should have final densities of 40 to 80 trees/ha.

081. BERTORELLI, M and LUNA-COLL, J. 1999. **The cashew: a crop with multiple uses.** *FONAIAP-Divulga.*, No.64, 24-26 (FONAIAP, Centro de Investigaciones Agropecuarias, del Estado Anzoategui, El Tigre, Venezuela).

A botanical description is given of cashew (*Anacardium occidentale*) and notes are included on agronomic aspects, cultivation of cashew in Venezuela and uses of cashew. Arthropod pests of cashew are also listed.

**082. BEZERRA, FC. 1999. Evaluation of nutritional status of dwarf cashew clones CCP-76 and CCP-09. *Revista Brasileira de Fruticultura* 21(2): 208-211**

Micronutrient contents in the leaves of the dwarf cashew clones CCP-76 and CCP-09 were evaluated monthly during one year in a study carried out at the Pacajus Experiment Station in Pacajus, Brazil, from March 1994 to April 1995. The macronutrient concentrations in the leaves of both clones decreased in the following order. N>K>Ca>Mg>S>P. There was no difference between the clones as to the contents of N, Ca and S; however, CCP-09 showed higher concentrations of P, K and Mg. The variation pattern of macronutrient content was similar for both clones. N, P, K, Mg and S increased up to the beginning of the reproductive phase and decreased shortly afterwards during flowering and fruiting season.

**083. BEZERRA, MA., OLIVEIRA, RA., LACERDA, CF De., PRISCO, JT and GOMES-FILHO, E. 2004. Photosynthesis of early dwarf cashew plants under salinity stress. *Proceedings of the Interamerican Society for Tropical Horticulture*. 47: 149-152 (Embrapa Agroindustria Tropical, C.P. 3761, 60.511-110, Fortaleza, CE, Brazil).**

The effect of salinity on the gas exchange of dwarf cashew, 'CCP 76', was studied under greenhouse conditions. The young plants were irrigated with saline solutions (0.5, 1.0, 2.0, 3.0 and 4.0 dS/m), directly on the roots or on the leaves. After 15 and 30 days, photosynthetic rate (A), stomatal conductance (gs), transpiration (E) and internal/external concentration of CO<sub>2</sub> (Ci/Ce) were evaluated using an infrared gas analyser. The electrical conductivity of the soil solution (ECsd) and leaf

Na<sup>+</sup> and Cl<sup>-</sup> contents were determined after 30 days. At the end of the experimental period, salt concentration in the drainage solution was approximately twice that of the irrigation solution. The most conspicuous effects were observed on plants that received the salts on the leaves, where the leaf Na<sup>+</sup> and Cl<sup>-</sup> contents increased by 118 and 220%, respectively. Photosynthetic rate (A) was inhibited as the salinity of the irrigation solution increase. This behaviour was observed for gs and E, but in smaller intensity. After 30 days, there was an increase in the relationship Ci/Ce, suggesting that the photosynthesis inhibition was also related to non-stomatal limitations.

**084. BHAIKAMKAR, MS, MEHTA, PG and SAWANT, PA. 2004. Adoption of recommended cashew cultivation technologies by the cashew growers. *The Cashew* 18(2): 7-12**

Data were collected from 180 cashew growers of Sindhudurg district, Maharashtra to determine the level of adoption of recommended cashew cultivation practices and the constraints to adoption. Results revealed that 58.33% of the respondents had a medium level of adoption, while 21.11% and 20.56% belonged to the high and low adoption categories, respectively. High cost of inputs was one important constraint to adoption of improved cultivation practices.

**085. BHARATHI, TS., MELANTA, KR. and VENKATESH, J. 1998. Effect of different media on container grown cashew grafts. *Cashew Bulletin* 35(5): 3-4 (UAS, GKVK, Bangalore -560 065.)**

Maximum number of leaves (9.00) maximum height of grafts (24.13 cm) and maximum survival of grafts (80) were recorded



in treatment T4, when observed on 120 days after grafting. This treatment was a mixture of sand, coir dust, soil and compost in the ratio of 1:0.5:1:1(v/v). Very low success was recorded in T1, T6 and T7. The grafts were raised inside a green house located in the Horticultural Garden, G.K.V.K., Bangalore.

**086. BHAT, MG. 2004. Present status, constraints and opportunities in import and export of cashew.** In: *First Indian Horticultural Congress*, 6-9th November 2004, New Delhi. *Invited Lectures Abstracts* p.128.

India exports annually about 1 to 1.27 lakh tones of cashew kernels worth Rs. 1,855 to 2006 crores and about 6 to 7 thousand tones of cashew nut shell liquid worth Rs. 7 to 8 crores. Indian cashew kernels are ranked as best in quality. There is an urgent need to increase the production and productivity of cashew in order to make the price of Indian cashew internationally competitive for enabling us to earn substantial foreign exchange and to keep our supremacy in International cashew trade.

**087. BHAT, MG. 2007. Achievements, constraints, opportunities for cashew development in India with special reference to North Eastern Hilly Region.** In: *2nd Indian Horticultural Congress*, 18 -21st April 2007. Barapani, Meghalaya. *Souvenir & Abstracts* p. 24.

There are certain constraints which limit the increase in the productivity of cashew. Research programmes are being reoriented in the country in order to increase the productivity per unit area and reduce the cost of production so as to make Indian cashew Internationally competitive. There should be concerted efforts for transferring the technologies to farmers' fields. Cashew is now fast spreading to non-

traditional areas and farmers' are evincing keen interest in this crop. There is great scope to expand area under cashew in North Eastern Hilly Region.

**088. BHAT, MG. 2007. Cashew research achievements & development strategies.** In: *Zonal Agricultural Research Station, Brahmavar. Silver Jubilee Souvenir*. p. 37-44.

In this paper author described the research achievements on cashew in the field of crop improvement, crop management, crop protection, post harvest technology and transfer of technology. The future research strategies are also enlisted.

**089. BHAT, MG. 2007. Cashew Research in Emerging Development Scenario.** In: *6th National Seminar - Indian Cashew in the Next Decade - Challenges and Opportunities.*, 18-19 May, 2007, Raipur. *Souvenir*. p. 14-24

India export more than 1.25 lakh tons of cashew kernels and earning over Rs. 2500 crores as foreign exchange. But it produces only 50% of raw nuts required by processing industries. So there is an urgent need to enhance domestic cashew nut production and become self sufficient in raw nut production. India has large number of cashew production technologies. There should be concerted efforts for transferring these technologies to farmer's field. There is great scope to expand area under cashew in NEH Region. By 2016 India can hopefully become self-sufficient in raw nut production.

**090. BHAT, MG., NAGARAJA, KV., BHAT, PS and NAYAK, MG. 2004. Advances in production technology for cashew in India.** *Golden Jubilee Souvenir*, ARS, Ullal, Karnataka, pp.17-23

In this paper, authors explained about the research achievements on cashew in India since 1950 and mentioned about the future strategies to be followed in the field of crop improvement, crop management, crop protection and post harvest technology to enhance the production and productivity of cashew in India.

**091.** BHAT, MG., KUMARAN, PM and THIMMAPPAIAH. 1998. **Pollination technique in cashew.** *The Cashew* 12(4): 21-26 (National Research Centre for Cashew, Puttur - 574 202, D.K., Karnataka.).

This paper gives the refined technique of pollination in cashew including procedure for emasculation, protecting the stigma from contamination and careful handling of the controlled hand pollination. A diagrammatic description with sequence of pollination technique is also depicted in this paper.

**092.** BHAT, MG., RAO, EVVB and SWAMY, KRM. 1999. **Genetic resources of cashew and their utilization in improvement.** In: *Improvement of Plantation Crops*. Edited by MJ. Ratnambal., PM. Kumaran and K. Muralidharan. CPCRI, Kasaragod. p.91-98.

The extent of genetic improvement that could be achieved in a crop mainly depends on the richness and diversity of genetic resources existing in that crop and its accessibility to the researchers. In India, as all the cashew plantations were raised from the limited initial introductions, the genetic base available in the country is very narrow. One of the immediate priorities of the Indian cashew germplasm programme is to enhance the genetic variability in the collections. Therefore it is essential to increase the efforts to introduce diverse cashew types from Central America and Brazil where

considerable variability including the dwarf types suitable for high density planting is reported to exist.

**093.** BHAT, MG., BHAT, PS., NAGARAJA, KV and NAYAK, MG. 2004. **Research accomplishment of National Research Centre for Cashew.** *Golden Jubilee Souvenir*, ARS, Ullal, Karnataka, pp. 24-30

In this paper authors presented the overall research achievements made from NRCC par with the mandate of the Centre.

**094.** BHAT, MG., NAYAK, MG and NAGARAJA, KV. 2006. **Prospects of cashew in next decade with special reference to North Eastern States.** *The Cashew* 20(2): 27-42 (National Research Centre for Cashew, Puttur - 574 202, D.K., Karnataka.).

This paper dealt with the urgent need to enhance domestic cashew nut production and become self sufficient in raw nut production. There is great scope to expand area under cashew in North Eastern Hilly Region. As the soil fertility is very high and also soil is rich in humus and organic matter content in NEH Region, the cost of cultivation in NEH Region would be less than the traditional area.

**095.** BHAT, MG., YADUKUMAR, N and NAYAK, MG. 2007. **Cashew technologies developed.** In: *Horticulture summit - 2007: Stakeholders' Meet for Accelerated Development of Horticulture*, June 16-19, 2007, Lucknow. *Souvenir*. P.108-111.

This paper dealt with the several useful agro-techniques such as soil and water conservation, high density planting, vermicomposting, softwood grafting, pruning and intercropping for general adoption by the

cashew growers in the country to increase the production and productivity of cashew.

**096. BHAT, MG., YADUKUMAR, N and NAYAK, MG. 2007. Cashew Research Achievements, Technologies Developed and Research and Development Strategies.** National Seminar on Research, Development and Marketing of Cashew, 20-21st Nov. 2007, Goa. *Souvenir and Extended Summaries*. p. 3-14 (National Research Centre for Cashew, Puttur - 574 202, DK, Karnataka)

India is the largest producer, processor, consumer and exporter of cashew in the world. Cashew is a very important plantation crop of India having very significant role to play in India's economy. Cashew fetches substantial foreign exchange. The country is at present exporting annually about 1.20 lakh tons of cashew kernels worth about Rs. 2500/- Crores. At present, area under cashew in the country is about 8.55 lakh hectares. India produces about 60-70 lakh cashew grafts annually through soft-wood grafting technique which has revolutionized the availability of planting material in cashew in the country. There are over 100 Regional Cashew Nurseries which are coming under both public and private sector. Most of the area under cashew is in east-coast and west-coast regions of the country. In India cashew is grown mainly in Maharashtra, Goa, Karnataka and Kerala along the west coast and Tamil Nadu, Andhra Pradesh, Orissa and West Bengal along the east coast. It is also grown to a limited extent in non-traditional areas such as Bastar region of Chattisgarh and Kolar (Plains) region of Karnataka and in NEH region. At present Maharashtra is ranking first in area, production and productivity in the country. About 40 thousand hectares of area can be

brought under cashew in Chattisgarh state while the present area under cashew is very negligible (about 2813 ha) in that state. Location specific research programmes in the 8 cashew growing states are conducted through All India Coordinated Research Project on Cashew (AICRP on Cashew) whose head quarters also is located at National Research Centre for Cashew (NRCC), Puttur. There are 8 centres and one sub-centre under AICRP on Cashew located all over the country. In recent times, India is facing stiff competition from Vietnam and Brazil in international cashew trade.

**097. BHAT, PS and RAVIPRASAD, TN. 2006. Studies on endosulfan and carbaryl residues in cashew kernels.** *Journal of Plantation Crops* 34(3): 373-376

Carbaryl and endosulfan were the recommended insecticides for the management of tea mosquito bug in cashew. The usage of endosulfan is withdrawn, while, carbaryl is still popular amongst cashew farmers. In the present study, methodologies were standardized for estimation of carbaryl and endosulfan residues in kernels of cashew nuts. The kernel of the nuts collected from plots sprayed with endosulfan and carbaryl at recommended concentration and double the recommended concentration were found to be free from residues of these insecticides. The kernel obtained from nut samples collected from the farmer's fields of Dakshina Kannada district of Karnataka were also free the residues of both these insecticides. The kernels of the samples collected from major cashew growing areas of Tamil Nadu, Orissa and Maharashtra and Karnataka were free from the residues of carbaryl and endosulfan.

098. BHAT, PS and RAVIPRASAD, TN. 2007. **Management of tea mosquito bug *Helopeltis antonii* Sig. with newer insecticide/products.** *National Seminar on Research, Development and Marketing of Cashew*, 20-21st Nov. 2007, Goa. *Souvenir and Extended Summaries*. p. 56 (National Research Centre for Cashew, Puttur - 574 202, DK, Karnataka)

A study was undertaken to find out alternate insecticide/product effective against tea mosquito bug *Helopeltis antonii* Sig. at NRCC, Puttur during 2004-07. The insecticide fenpropathrin was effective at low concentration of 0.02 per cent during all the three years and the performance was on par with the recommended insecticides such as cyhalothrin (0.003%). The damage ratings in Phalada III C1 and Spray Oil (1 and 2 %) were higher than the recommended insecticide. There was no reduction in the population of predatory mirid and total number of predators in the trees treated with fenpropathrin at both at 0.02 and 0.03 per cent concentration.

099. BHAT, PS., SUNDARARAJU, D and RAVIPRASAD, TN. 1994. **Evaluation of Neem, Pongamia and some other plant products against TMB, a serious pest of cashew.** In *National Workshop on Non-Pesticidal Approach to Pest Management*, held at Hyderabad. (Abstracts) P.24. (NRCC, Puttur-574 202, Karnataka).

Certain products of neem, pongamia, *Annona squamosa* and *Taphrosia vogelii* were evaluated against tea mosquito bug, a serious pest of cashew for knock down action, residual toxicity and feeding deterring properties. Emulsion of pongamia oil in water showed maximum knock down action with 90.8.

100. BHATNAGAR, A, GUPTA, CR and RAO, SS. 1996. **Seasonal distribution and incidence of insect complex associated with cashew in Bastar Plateau zone.** *The Cashew* 10 (4): 23-25

A survey of insect complex of cashew conducted in the forest plantation of Bastar Plateau Zone revealed that 21 insect species are associated with the crop. Tea mosquito bug, leaf minor, leaf and blossom webber, bark eating caterpillar and termite were the regular insect pests associated with the crop.

101. BHATNAGAR, A and SHARMA, S. 2004. **Seasonal occurrence of insect pests of cashew in Bastar.** *The Cashew* 18(1): 34-35

The seasonal occurrence of insect pests of cashew at the Bastar Plateau Zone of Chattisgarh, India was investigated in 1999 and 2000. The following insect pests were recorded : tea mosquito bug, stem and root borer, termite, leaf miner, leaf folder, leaf and blossom webber, and unidentified aphid and apple and nut borer. The tea mosquito bug, stem and root borer and termite were the dominant insects associated with cashew, with percent incidence values of 7.9 - 52.6, 2.5-30.0 and 5.0 - 50.0%, respectively. Tea mosquito bug incidence was highest in March, while stem and root borer incidence was highest in April and May. Termite incidence was high in dry and humid months. The incidence of the other pests was observed at low level.

102. BHATTACHARJEE, P., SINGHAL, RS and GHOLAP, AS. 2003. **Compositional profiles of  $\gamma$ -irradiated cashew nuts.** *Food Chemistry* 80(2): 159-163

Insect infestation of the cashew nut, leading to economic losses is a frequently

encountered problem. The present work aims to combat this problem by using low dose  $\gamma$  irradiation and evaluating the effect of such treatment on the physico-chemical profiles of cashew nuts. Cashew nuts irradiated at 0.25, 0.50, 0.75 and 1.00kG  $\gamma$  and stored under ambient conditions were analysed periodically every 2-months for 6 months with respect to the changes in 10- kernel weights, colour characteristics and proximate composition. Visual inspection showed no insect infestation for six months, even at 0.25 kG  $\gamma$ , while the control sample was totally infested. This was evident from the 10-kernel weights, which decreased gradually with time of storage. This study underlines the use of 0.25kG  $\gamma$  of irradiation for preservation of cashew nuts.

103. BHATTACHARJEE, P., SINGHAL, RS and GHOLAP, AS. 2003. **Hydrocarbons as marker compounds for irradiated cashew nuts.** *Food Chemistry* 80(2): 151-157

Volatile long chain hydrocarbons, such as 1-tetradecene, 1-hexadecene and 8-heptadecene, could serve as marker compounds in cashew nuts irradiated at 0.25-1.00kG  $\gamma$ . Monitoring these markers over a strong period of 6 months under ambient conditions showed them to be persistent. The concentrations of the markers increased linearly with radiation dose at all storage periods of the study. However, their concentration decreased marginally with storage at all the dose levels.

104. BHATTACHARYA, A. 2005. **Age-dependent pollen abortion in cashew.** *Current Science*. 88(7): 1169-1171 (Palynology Laboratory, National Botanical Research Institute, Lucknow 226 001, India.)

The effect of plant age on pollen abortion of *Anacardium occidentale* was studied. Using

Alexander's stain, which differentiates aborted and non-aborted pollen grains, the proportion of aborted pollen versus plant age, size variation in aborted and non-aborted pollen grains, and number of pollen grains per flower were estimated. Aborted pollen was smaller than non-aborted pollen, regardless of plant age. The proportion of aborted pollen, varied from 22.5 to 46.8%, showing a steady increase with plant age, and the number of pollen grains per flower also increased with age. These results support the qualitative prediction that pollen abortion gradually increases with ageing, reflecting an increase in genetic load with age.

105. BHATTACHARYA, A. 2004. **Flower visitors and fruit set of *Anacardium occidentale*.** *Annales-Botanici-Fennici*. 41(6): 385-392 (Palynology Laboratory, National Botanical Research Institute, Rana Pratap Marg, Lucknow - 226 001, India.)

The flower visitors, pollination and fruit set of cashew (*A. occidentale*) were studied in a field experiment conducted in Lucknow, India. The investigation involved monitoring of flower visitors, assessment of floral rewards for pollinators and breeding experiments to establish the role of flower visitors on the fruit set of the crop. The yield of fruits was low due to the lack of appropriate pollinators and the possible role of ants in pollen damage. Bees (*Apis cerana indica*, *A. florea*, *A. dorsata* and *Bombus spp.*), flies (*Chrysomya megacephala* and *Musca*), butterflies, beetles and ants (Formicidae) visited the flowers. The relative abundance of visitors coincided with nectar availability. Breeding manipulation by bagging experiments indicated that bees are efficient pollinators, increasing fruit set, while ants decreased fruit set by damaging the viable

pollen. Effective fruit production requires more activities of bees and management to reduce ant damages in *A. occidentale* L.

**106. BICALHO, B. 2000. Application of high temperature gas chromatography-mass spectrometry to the investigation of glycosidically bound components related to cashew apple volatiles. *Journal of Agricultural and Food Chemistry* 48(4): 1167-1174**

Free and bound volatile components of Brazilian cashew apples were obtained by simultaneous distillation - extraction and XAD-2 absorption. According to GC-MS analyses and retention indices, 62 free volatile constituents were characterized and quantified. They were esters, terpenes, hydrocarbons, fatty acids, aldehydes, alcohols, lactones, ketones, phenols and norisoprenoids. The glycosidically bound volatile precursors were analysed by high temperature GC-MS, after room temperature silylation. Several conjugated alcohols and cinnamic acids were detected and reported as cashew apple glycosyl constituents for the first time.

**107. BICALHO, B. 2001. Volatile compounds of cashew apple (*Anacardium occidentale* L.). *Zeitschrift Fur Naturforschung. Section C, Biosciences* 56(1/2): 35-39**

The volatile compounds of a widely consumed Brazilian cashew apple variety were recovered by headspace extraction or simultaneous distillation - extraction. Several compounds including esters (29), terpenes (16), hydrocarbons (9), carboxylic acids (7), aldehydes(7), alcohols (3), ketones(2), lactones(2) and norisoprenoids(1) were characterised and quantified by gas chromatography-mass spectrometry analyses.

**108. BINDU, N and BEEVI, SP. 2002. Comparative evaluation of biochemical constituents in susceptible and less susceptible cashew types: a case study induced by TMB infestation. *The Cashew* 16(1): 29-36 (College of Horticulture, KAU, Vellanikkara, Trichur, Kerala.).**

The four biochemical constituents namely, starch, sugar, phenol and orthodihydroxy phenol, estimated from tender twigs of cashew has differed significantly among the ten varieties tested. However, higher quantities of phenol, OD phenol, starch and low sugar content was noticed in most of the less susceptible cashew types, as compared to susceptible types. From the present study it could be inferred that the biochemical components are not entirely responsible for the degree of susceptibility of cashew types to TMB infestation. However, comparatively high phenol and OD phenol along with low sugar content in the hybrids H-3-17, H-856 and other types like A-6-1 and A-26 2 might have contributed for their tolerance.

**109. BINDU, N., BEEVI, SP and VARMA, AS. 1998. Shoot die-back in cashew incited by the tea mosquito bug as influenced by the fungus *C.gloeosporioid*. *The Cashew* 12(4): 13 (Dept of Entomology, College of Horticulture, Vellanikkara-680 654, Kerala.).**

The predominantly occurring fungus isolated from the necrotic lesions of the TMB affected cashew shoots, panicles and nuts was *Colletotrichum gloeosporioides*. The role of this fungus in aggravating the shoot die-back when inoculated on the grafts infested by TMB is clearly established. Spraying of Bordeaux mixture one percent was found to be effective in preventing the progression BLA 39/4. Neem

oil and pongamia oil sprayed on grafts at 2 concentration was found to be effective in preventing the feeding by TMB.

110. BISANDA, ETN and MWAIKAMBO, LY. 1997. **Cashew Nut Shell Liquid resins as matrix in plant fibre reinforced composites.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp. 217-221

CNSL has been polymerised by condensation polymerization process with formaldehyde in the presence of a caustic soda catalyst. The resulting polymer was then tested to establish its thermal stability using thermal gravimetric analysis (TGA) and differential scanning calorimetry (DSC). The results show that the polymer exhibits thermal stability up to about 230°C, and has a glass transition temp. of about 71°C. The resin was subsequently used to bind plain woven sisal fibre mats in to composites. The CNSL based polymers have thus proved suitable for reinforcement of plant fibres in making composite.

111. BLAIKIE, SJ., O'FARRELL, PJ and MULLER, WJ. 2002. **Assessment and selection of new hybrids from the Australian cashew breeding programme.** *Australian Journal of Experimental Agriculture* 42(5): 615-623

This paper reports on the evaluation of 2 sets of hybrids produced in 1991 and 1992, which were planted on commercial cashew orchards in Northern Territory, and were assessed in terms of yield and quality during 1998 and 1999. Large differences in performance were measured between families. Depending on the site and hybrid set, the best family yielded 2-5 times more than the least-productive family. Also kernel weight and

kernel recovery, key characteristics of quality, varied significantly between families. Genetic analyses indicated that the traits studied had relatively high heritabilities, suggesting considerable scope for further improvement by breeding.

112. BLAIKIE, SJ, CHACKO, EK and LU, P. 2001. **Productivity and water relations of field-grown cashew: a comparison of sprinkler and drip irrigation.** *Australian Journal of Experimental Agriculture* 41(5): 663-673

A 3-year experiment compared sprinkler irrigation with alternatives, including no irrigation or drip irrigation in which 115 or 230 l/tree per week was applied by drippers placed near the tree trunk and near the canopy drip line throughout the dry season. Measurements of soil water to 1.3m, leaf gas exchange, chlorophyll fluorescence, tree sap flow and yield were made. Data collected in the first 2 years showed that the water requirement of the trees increased progressively as the crop load and evaporative demand increased during the dry season. During the final year of the study, additional sprinkler and drip treatments, in which water applications were progressively increased during the dry season, were introduced. The productivity of cashew in this experiment was strongly influenced by irrigation treatments, ranging (over all years) from 42 to 160 g nut/m<sup>2</sup> canopy surface area. Depletion of plant-available water in the root zone was associated with a reduction in photosynthesis mediated by partial stomatal closure. These effects of soil drying were evident in all irrigated treatments during the mid and late stages of the dry season but were more severe in treatments receiving the least water.

113. BLAIKIE, SJ and CHACKO, EK. 1998. Sap flow, leaf gas exchange and chlorophyll fluorescence of container - grown cashew trees subjected to repeated cycles of soil drying. *Australian Journal of Experimental Agriculture* 38(3): 305-311

An experiment was conducted to measure the sap flow, leaf chlorophyll fluorescence and leaf gas exchange on all trees in an experimental plot. The water use of trees in drying soil was measured using Granier's sap flow system. Sap flux density of drying trees declined progressively over a 4-day period to a minimum level that was only 10% of the sap flow in the well-watered trees. Measurements of leaf gas exchange showed similarly large reductions in photosynthesis and transpiration, which were associated with a low (0.05 mol m<sup>-2</sup>s<sup>-1</sup>) stomatal conductance in the drying trees. After rewatering, sap flow and leaf gas exchange recovered to the high levels of the well-watered trees over 3-4 days. Similar behaviour was observed during the second drying period. When stomatal conductance and net photosynthetic rate progressively declined during the period following irrigation, the quantum yield of photochemical energy conversion in photosystem II, psII, remained almost constant. It is possible that by providing a pathway for electron flow as an alternative to CO<sub>2</sub> assimilation during this period, photorespiration played an important role in avoiding photoinhibition.

114. BOGGETTI, B., JASIK, J and MANTELL, SH. 2001. *In vitro* root formation in *Anacardium occidentale* microshoots. *Biologia Plantarum* 44(2): 175-179 (Wye College, University of London, Wye, Ashford, Kent, TN255AH.)

Cultural conditions affecting the induction of rhizogenesis *in vitro* were evaluated in shoot-node-derived microshoots of cashew cultivars CP 1001 and AC4. The application of auxins was essential for the formation of adventitious roots in microshoots, with the greatest induction effect when either IBA or IAA was used. Duration of auxin exposure was studied. When IBA (10-300µM) was applied for 24h, 5days or continuously, the best results were obtained with 100µM IBA applied for 5days. 2iP at low concentrations (0.3-1µM) in the medium supported root formation, whereas GA3 (2-50µM) suppressed the rhizogenic response to subsequent auxin treatment. The presence of activated charcoal in the medium had no effect.

115. BOGGETTI, B., JASIK, J and MANTELL, SH. 1999. *In vitro* multiplication of cashew using shoot node explants of glasshouse-raised plants. *Plant Cell Reports* 18: 456-461. (Unit for Advanced Propagation Systems, Horticulture section, Wye College, Uty of London, TN25 5AH, UK.)

Using glasshouse-raised plants (1 month, 1 year, and 5 years old), factors affecting shoot development from shoot nodes of 2 Brazilian and one Tanzanian elite selections of cashew were assessed. Sprouting of buds decreased strongly with increasing age of mother plants. Solidified media, mainly when purified agar was used gave better results than liquid medium. MS salts containing 1/2 - strength macroelements were the most suitable for bud sprouting and shoot elongation. Vitamins and sucrose concentration did not have a significant effect but by replacing 20 g/L sucrose with glucose or maltose all estimated parameters were improved.



**116.** BOMA,F. and TOPPER,CP. 1997. **Evaluation of different sulphur types for the control of powdery mildew on cashew in Tanzania.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp. 228-235

This paper presents the results of a number of trails designed to evaluate the efficacy of sulphur dust originating from various sources and water based sulphur formulations. In order to improve overall efficiency of controlling mildew with sulphur, dose rates and application frequency have also been researched. Water based sulphurs performed better than dusts but there were no significant differences between the sulphur dusts from different sources. The level of mildew control increased with increasing dose rate and application frequency.

**117.** BOMA, F and TOPPER, CP. 1997. **Evaluation of the factors causing die back on cashew trees in Masasi and Tunduru of Tanzania.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp. 175-178

The objective of the work was to find out the possible factors responsible for the wide spread death of young shoots described as 'DIE BACK syndrome'. The panicle and top most leaves turn brown. Pyrethroid insecticides, a-cypermethrin and Lambda cyhalothrin kept *Helopeltis* population and nut damage low and prevented the occurrence of black lesions, the precursor of DIE BACK, on the shoots. The fact that DIE BACK syndrome was controlled using insecticide shows that insects, *Helopeltis* spp in particular, plays an important role.

**118.** BOMA, F., TOPPER,CP and STATHERS, T. 1997. **Population dynamics of major pests attacking cashew trees in the southern zone of Tanzania.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp.185-187

The objective of this work was to study the population dynamics of major insect pest of cashew in order to determine the rate and timing of population increase and periods when cashew trees are likely to be subjected to high pest pressure and possible economic damage. Work done has show that a 3 to 4 months period from Sept. - Jan. exists when *Helopeltis* populations are low and that the trees are relatively safe from damage. Population then tend to increase along with the increasing number of red- flushing shoots, reaching their peak in August.

**119.** BURIKAM, INTAWAT and CHAYOPAS, PARNPEN. 1995. **Sequential sampling plan for treatment decisions on cashew thrips (Insecta:Thysanoptera).** *Kasetsart Journal* 29(2): 167-175 (Dept of Entomology, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand.).

A sequential sampling plan was developed for treatment decisions on cashew thrips in Thailand from 1993-94. The data was drawn from cashew shoots or inflorescences grown at Nakhon Pathom and Ubon Ratchathani provinces by using the tray beat method. The negative binomial distribution with a common K value of 0.7569 was used to devise a sequential sampling method in order to classify thrips populations as light and treatment not recommended versus outbreak with insecticide treatment required. Operating characteristic and average sample number curves were also calculated.

**120.** CABRAL, JE-De-O and SOUZA-NETO, J. 2004. **Evolution of competitive performance of Brazilian cashew nut agribusiness.** *Proceedings of the Interamerican Society for Tropical Horticulture*. 47: 153-156 (Embrapa Agroindustria Tropical, Fortaleza, Ceara, Brazil).

This paper assesses the evolution of the competitive performance of Brazilian cashewnut agribusiness, based on the analysis of Brazilian participation in world cashew exports and in total world exports. It is shown that Brazil maintained an outstanding competitive position during the study period. However, the market was dominated by few countries. In addition, Brazil's international market share varies from 15% to 32%, while its comparative advantage varies from 15% to 31%.

**121.** CARDOSO, JE., FELIPE, EM and CAVALCANTE, M-de-JB. 2000. **Rainfall index and disease progress of anthracnose and black mold on cashew nut plants (*Anacardium occidentale*).** *Summa-Phytopathologica*. 26 (4): 413-416 (Embrapa Agroindustria Tropical, CP 3761, CEP 60.511-110, Fortaleza, CE, Brazil).

The effect of rainfall was investigated on the occurrence and severity of anthracnose (*Colletotrichum gloeosporioides*) [*Glomerella cingulata*] and black mould (*Pilgeriella anacardii*) of cashew nuts in Brazil. Over 2 years 30 clones were evaluated monthly. Rainfall led to increased susceptibility to both diseases and susceptibility increased with number of rainy days.

**122.** CARDOSO, JE, PAIVA, JR and CAVALCANTI, JJV. 2006. **Evaluation of resistance in dwarf cashew to gummosis in north eastern Brazil.** *Crop Protection* 25(8): 855-859

Environmental conditions in semi-arid zones are highly favourable for severe outbreaks of cashew gummosis, caused by *Lasiodiplodia theobromae*. Management of gummosis is very difficult as no practical and adequate method has been successful under these conditions. Twenty eight genotypes were selected from an open-pollinated population of dwarf cashew, cloned by grafting, and screened in field experiments for yield, quality and gummosis tolerance under high disease pressure. After 3 years, 4 clones were selected and planted in a similar experiment with the best commercial clone as the control treatment. In both experiments, data were statistically analysed as estimated disease severity and area under disease progress curves. Gummosis was highly correlated to nut yield. Most genotypes were susceptible to gummosis and only one clone (CAPC 42) showed a consistent and stable resistance in both experiments.

**123.** CARDOSO, JE., SANTOS, AA and ROSSETTI, AG. 2004. **Relationship between incidence and severity of cashew gummosis in semiarid north-eastern Brazil.** *Plant Pathology* 53(3): 363-367

The incidence - severity relationship for cashew gummosis, caused by *Lasiodiplodia theobromae*, was studied to determine the feasibility of using disease incidence to estimate indirectly disease severity in order to establish the potential damage caused by this disease in semi-arid north-eastern Brazil. Epidemics were monitored in two cashew orchards, from 1995 to 1998 in an experimental field composed of 28 dwarf clones, and from 2000 to 2002 in a commercial orchard of a single clone. The 2 sites were located 10KM from each other. Logarithmic transformation achieved the best

linear adjustment of incidence and severity data as determined by coefficients of determination for place, age and pooled data. A very high correlation between incidence and severity was found in both fields, with different disease pressures, different cashew genotypes, different ages and at several epidemic stages. Thus, the easily assessed gummosis incidence could be used to estimate gummosis severity levels.

**124 . CARDOSO, JE and FREIRE, FCO. 1998. Spread and control of gummosis in cashew trunks cut for topworking. *Fitopatologia Brasileira* 23(1): 48-50**

Gummosis of cashew nut tree is a serious disease of stressed plants, caused by *Lasiodiplodia theobromae*, an opportunistic pathogenic fungus which seldom infects well managed plantations. Recently, a generalized occurrence of gummosis in cashew trunks and buds cut for topworking was detected in an orchard of 200 trees in the town of Mossoro, Brazil. An experimental trial was established to determine the efficiency of pathogen spread through topworking practices and the protective effect of benomyl and copper oxychloride. The trial was conducted in a highly infested orchard of 5-6-year -old cashew trees in the town of Pio IX, Piaui State. The results showed that disease slowed down progressively from the initially cut trees, although almost all trunks had become infected by that time. Benomyl significantly reduced disease progression either alone or combined with copper oxychloride.

**125. CARDOZA, V and D'SOUZA, I. 2002. Induction, development and germination of somatic embryos from nucellar tissues of cashew. *Scientia Horticulturae* 93(3/4): 367-372**

Fully developed somatic embryos were induced from nucellar callus in cashew.

Nucellar tissue cultured on MS medium with 0.5 mg/l picloram with 20 g/l sucrose gave rise to embryogenic callus and procmbryos. The proembryos when cultured on MS medium with 0.5 mg/l picloram and 1mg/l putrescine gave rise to globular embryos. Globular embryos matured to form heart-shaped and well-developed cotyledonary stage embryos on MS medium with 30 g/l sucrose and 0.5 mg/l ABA. The mature embryos germinated on MS medium devoid of growth regulators.

**126. CARDOZA, V and D' SOUZA, L. 2000. Salt tolerance of *in vitro* induced multiple buds of cashew. *Recent Advances In Plantation Crops Research* 13: 55-56 (Proceedings of PLACROSYM- XIII, 1998.)**

Multiple buds were initiated from cotyledonary nodes of cashew on MS medium supplemented with 10mg/l BA, 40g/l sucrose, 5g/l maltose besides sodium chloride (0.05-1.5%). The level of salt tolerance was correlated to the number and length of multiple buds. The number and length of buds decreased gradually with an increase in sodium chloride concentration. Concentration above 1.5% was detrimental to buds.

**127. CARNEIRO, PT., FERNANDES, PD and GHEYI, HR. 2002. Germination and initial growth of precocious dwarf cashew genotypes under saline conditions. *Revista Brasileira De Engenharia Agricola E Ambiental* 6(2): 199-206**

The effects of four levels of electrical conductivity of irrigation water (ECw: 0.7, 1.4, 2.1 and 2.8 dS m<sup>-1</sup> at 25°C), containing Na:Ca:Mg in equivalent proportions of 7:2:1, on the germination and initial growth stage of 5 clones of precocious dwarf cashew, i.e. CCP 06, CCP 09, CCP 1001, EMBRAPA 50, and EMBRAPA 51, during the first 50 days were

studied in greenhouse. The majority of variables were found to be influenced by ECw and clones; however, no significant interactive effect was observed for the variables. In the treatment ECw 1.48 dS m<sup>-1</sup>, 90% of relative total biomass production was obtained; this value may be considered as a threshold tolerance for precocious cashew during the initial growth. In general the clones EMBRAPA 51 and CCP 1001 showed the least and the highest growth, respectively.

**128. CARNEIRO, PT., FERNANDES, PD and GHEYI, HR. 2004. Salt tolerance in precocious dwarf cashew rootstocks: physiological and growth indexes. *Scientia Agricola* 61(1): 9-16**

A greenhouse experiment was conducted to evaluate the effects of 4 salinity levels established through electrical conductivity of irrigation water (ECw:0.7, 1.4, 2.1 and 2.8 ds m<sup>-1</sup>, at 25°C) on the growth and physiological indexes of 5 rootstocks of dwarf precocious cashew cultivars (CCP-06, CCP-09, CCP-1001, EMBRAPA 50 and EMBRAPA 51). Plant height; leaf area; root; shoot and total dry weight; water content of leaves; root/shoot ratio; leaf area ratio; absolute and relative growth rates and rate of net assimilation were evaluated. The majority of the evaluated variables were affected by ECw, and the effects varied among the clones. However, no significant interactive effects were observed for factors. ECw of 1.39 dSm<sup>-1</sup> was considered the threshold tolerance for the precocious cashew rootstocks. Dwarf-precocious cashew is moderately susceptible to soil salinity during the formation phase of rootstock. Clones EMBRAPA 51 and EMBRAPA 50 recorded the lowest and highest development indexes, respectively.

**129. CARNEIRO, PT. 2002. Germination and initial growth of precocious dwarf cashew genotypes under saline conditions. *Revista Brasileira de Engenharia Agrícola e Ambiental* 6(2): 199-206 (Dept. Engenharia Agrícola, UFP, Brazil.)**

The effects of 4 levels of electrical conductivity of irrigation water, containing Na:Ca:Mg in equivalent proportions of 7:2:1, on the germination and initial growth stages of 5 clones of precocious dwarf cashew, i.e. CCP06, CCP09, CCP1001, EMBRAPA 50, and EMBRAPA 51, during the first 50 days were studied in green house. The experiment was carried out in a RBD and 4x5 factorial scheme with 4 replications. The germination and growth variables were evaluated. The majority of variables were found to be influenced by ECw and clones; however, no significant interactive effect was observed for the variables.

**130. CARVALHO, MGR., RAJU, VK and PUSHPALATHA, PB. 2003. Sensory quality of cashew apple wine as influenced by pre treatments and clarifying agents. *The Cashew* 17(1): 10-14**

This paper listed the various pre-treatments and clarifying agents tried in order to select the most ideal one for the reduction or removal of tannins from the cashew apple juice prior to preparation of cashew apple wine (feni).

**131. CASTELLANO, G., QUIJADA, O., JIMENEZ-PEREZ, N and BRICENO, E. 2004. Plant parasitic nematodes associated with cashew, tamarind and acerola crops in Zulia State and response of two cashew cultivars to the nematode *Meloidogyne incognita*. *Fitopatologia-Venezolana* 17(1): 6-8 (Instituto Nacional de Investigaciones Agrícolas (INIA-Zulia), Maracaibo, Venezuela. )**

A survey of plant parasitic nematodes associated with cashew (*Anacardium occidentale*), acerola (*Malpighia glabra*) and tamarind (*Tamarindus indica*) trees was conducted in Zulia State, Venezuela. Some 150 soil and root samples were collected and analysed. *Helicotylenchus dihystra* and *Hoplolaimus seinhorsti* [*Basirolaimus seinhorsti*] were found most frequently in both red and yellow cashew cultivars. *Hemicriconemoides strictathecatus*, *Rotylenchulus reniformis* and *Xiphinema brasiliensis* were associated with tamarind trees. In acerola, root knot nematode (*Meloidogyne incognita*) at a higher frequency and *Hemicriconemoides strictathecatus* were observed, and roots infected with *M. incognita* were severely damaged, as manifested by the number of galls. The decrease in yield in acerola may be attributed to damage by *M. incognita*. To determine the reproductive capacity of *M. incognita* in cashew trees, plants of yellow or red cultivars were inoculated with 16 eggs/cm<sup>3</sup> of soil. The reproduction rate in both cultivars was <1, and galls were not observed in roots. This indicates that nematode was not able to reproduce in cashew trees.

132. CAVALCANTE, AAM., RUBENSAM, G and ERDTMANN, B. 2005. **Cashew (*Anacardium occidentale*) apple juice lowers mutagenicity of aflatoxin B1 in *S. typhimurium* TA102.** *Genetics and Molecular Biology* 28(2): 328-333

Cashew (*Anacardium occidentale*) is a medicinal plant native to Brazil and also yields a nutritious fruit juice. Its large pulpy pseudo-fruit, referred to as the cashew apple, contains high concentrations of vitamin C, carotenoids, phenolic compounds and minerals. Natural and

processed cashew apple juice (CAJ/cajuina) are amongst the most popular juices in Brazil, especially in the north-east. Both juices have antioxidant potential and suppress mutagenicity of hydrogen peroxide. In the present study we evaluated the inhibitory effects of CAJ/cajuina on Aflatoxin B1 (AFB1)-induced formation, using the Salmonella/microsome assay with the experimental approaches of pre-, co- and post-treatments. Both CAJ/cajuina suppress AFB1-induced mutagenesis in strain TA102 when applied in co- and in post-treatment. Possible mechanisms for anti-mutagenicity in co-treatment are (a) interaction with S9 enzymes, (b) metabolism to non-mutagenic compounds of AFB1 or (c) inactivation of S9 potential. Total suppression of AFB1 mutagenicity was observed in co-treatment with both CAJ and cajuina. Post-treatment anti-mutagenicity of both juices suggests a modulation of activity of error-prone DNA repair. CAJ/cajuina may be considered promising candidates for control of genotoxicity of AFB1 and may thus be considered as health foods with anti-carcinogenic potential.

133. CAVALCANTI -JUNIOR, AT and FRAGA, AC. 1998. **Moisture determination in cashew nuts.** *Ciencia E Agrotecnologia* 22(3): 273-278 (Departamento de Agricultura, UFLA, Caixa Postal 37, 37.200-00, Lavras, MG, Brazil.).

Cashew nuts harvested from clone CCP-76 (early dwarf clone) grown at the EMBRAPA Experimental Farm at Pacajus, Ceara, Brazil were dried, (whole or cut) for 24-144 h at 105°C. Drying time significantly influenced final moisture value. The minimum drying times, without loss of precision in moisture determination, were 60 h for cut nuts and 96 h for whole nuts.

134. CAVALCANTI-JUNIOR, AT and ROSSETTI, AG. 2004. **Humidity of storage of the cashew-nuts.** *Revista-Ciencia-Agronomica*. 35(2): 384-389 Embrapa Agroindustria Tropical, Fortaleza, CE, Brazil.

The cashew nuts, after being harvested, still retain high water content. To be stored and marketed, their water content should be reduced to values close to that of the hygroscopic balance. In this study, samples of dried and humid nuts were stored in airy and humid conditions with the purpose of determining the hygroscopic curve. It was verified that more than 70% of the cashew nut humidity can be explained by relative humidity of the air and that the degree of humidity at the equilibrium points assumes two different values during the year: 11.4% in the dry season and 13.6% in the rainy season, with annual average of 12.5%. A regression equation indicating the hygroscopic curve for cashew nuts is presented.

135. CAVALCANTI, JJV. 2000. **Diallel analysis to evaluate inter populational cashew tree hybrids.** *Pesquisa Agropecuaria Brasileira* 35(8): 1567-1575

The objectives of this work were to obtain information related to the components of means of cashew tree populations, through partial diallel analysis, and verify the potential per se of two distinct groups of parents, one of them made up by clones of dwarf cashew tree and the other one by common cashew tree, and the heterosis of their respective hybrid combinations. A randomized complete block experimental design with four replications was used. Hybrid combinations CCP76 X CP07, CCP09 X BT0N and CCP09 X CP77 are the most promising, enabling establishment of base populations for breeding programmes of cashew tree.

136. CAVALCANTI, JJV., PINTO, CABP., CRISOSTOMO, JR and FERREIRA, DF. 1997. **Combining ability of cashew tree (*Anacardium occidentale* L.) in relation to early nut yield.** *Revista-Ceres*. 44 (254): 466-472 (EMBRAPA/CNPAT. 60.511-110 Fortaleza, CE, Brazil.)

A partial incomplete diallel design experiment between 4 early commercial clones and 5 common cashew genotypes was conducted at Pacajus Experimental Station, Ceara, Brazil, in 1991, aiming to select early genotypes of cashew. Cashew nut yield was evaluated in two-year old plants. Significant sums of squares associated with the estimates of GCA and SCA effects indicated the importance of these components in genetic variability to the trait under study, with predominance of GCA. The precocious dwarf cashew genotype CCP09 and the matrix of common cashew BT0N contributed the most to increase early nut yield. The crosses CCP09 X BT0N and CCP76 X BT0N had the greatest SCA and averages. Thus they should be used to select promising clones for commercial use.

137. CHATTERJEE, ML and GHOSH, SN. 1995. **New pest of cashew in West Bengal.** *The Cashew* 9 (4): 25

Severe incidence of *Holotrichia serrata* was recorded during the crop seasons of 1990-91 and 1991-92 in cashew in West Bengal. Control measures are outlined.

138. CHATTERJEE, ML. 1997. **A study of cashew leaf miner infestation and their control by different insecticides.** *Cashew Bulletin*. 34(7): 9-11 (Regional Research station, B.C.K.V. Jhargram-721507, West Bengal.)

The leaf miner (*Acrocercops syngramms* M) infestation on cashew in West Bengal is recorded up to 18-20% . To study the different level of infestation at different age group of plants and study the effectiveness of certain commonly available pesticides in controlling this pests a trail was conducted during the year 1985-88 at the RRS, Jhargram.

**139. CHATTOPADHYAY, N and GHOSH, SN. 1996. Fruit set and fruit drop in cashew in Jhargram conditions. *Environment & Ecology* 14(1): 144-146**

A study was conducted in 1990 with the promising cashew cultivars TN-16 and BLA 39/4 and the local cultivar Red Hazari. When averaged for each cultivar, there were 302.2 - 404.5 flowers/ panicle , out of which 22.33 - 41.50% were hermaphrodite, BLA 39/4 had the highest number of flowers. Fruit set under natural conditions ranged from 5.03% to 10.07% (BLA 39/4). Total fruit drop was 12.23 - 16.67%. Fruit drop was highest at the mustard stage , followed by the pea stage, and was quite low beyond the pea stage.

**140. CHATTOPADHYAY, N and HORE, JK. 1994. Studies on physico-chemical characteristics of cashew apple. *Orissa J. Agric. Res.* 7(3/4): 67-70 (RRS, BCKV, Jhargram-721 507, West Bengal.)**

The physico-chemical characteristics of cashew apples of 12 improved types collected at RRS, BCKV, Jhargram, were studied during the year 1990-91. Significant variations were observed in different parameters. The type H-2/16 produce heavier apple(51.07g) of greater diameter(3.97cm) with highest specific gravity(1.20), maximum juice recovery percentage(68.69) and TSS content (19.7). The

maximum acidity (0.32) and reducing sugar content (9.56) was associated with M-26/2. The longest apple(5.55cm) with high ascorbic acid content(366.3mg/100ml of juice)was produced by II-1610.

**141. CHATTOPADHYAY, N and GHOSE, S.N. 1994. Studies on the effect of time and extent of pruning in increasing the yield of cashew. *Journal of Plantation Crops* 22(2): 111-114 (BCKV (RRS), Jhargram-721 507, W.B.).**

A pruning study was carried out with a view to improving the nut production in old and neglected cashew orchards, at the RRS, Jhargram, during 1990-92. Results indicated that pruning of leader shoots in July encanced the production of productive laterals and increased the number of bisexual flowers per panicle. The fruits per panicle and yield per tree were the highest in the trees pruned in July. The next best time of pruning leader shoots is in June.

**142. CHAVAN, SS., LAD, BL., DESHPANDE, RS and DHONUKSHE, BL. 1997. Tissue culture studies in cashew. *Annals of Plant Physiology* 11(1): 67-70 (Plant Biotechnology Unit, College of Agriculture, KKV, Dapoli-415 712 (M.S.).**

Tissue culture studies in cashew (cv.Vengurla) were carried out to optimise culture media composition, culture conditions, establishment of aseptic cultures, and to develop a protocol for soil establishment of plantlets. The best establishment of cultures(90 and 60, respectively) was observed when axillary buds (large 20mm or small 10mm) were used as explants on half-strength MS medium, supplemented with 10 ppm BA+5 ppm NAA + 5 ppm GA3 + 0.25g/ litre.

**143. CHOPRA, VI. and PETER, KV. 2005. Handbook of industrial crops.** Handbook of industrial crops.; xiv + 535 pp. (Indian Agricultural Research Institute, India. )

Industrial crops such as arecanut, cardamom, cashew, cinchona, cocoa, coconut, coffee, oil palm, palmyra (*Borassus* spp.), rubber, tea and wattle (*Acacia* spp.) are important components of economy and export trade of many countries, both developing and developed. This handbook aims to collate information on this important crop group from the viewpoints of evolutionary biology and commercial agriculture. All aspects of cultivation and trade are included in addition to available information on evolution and adaptation. The origin, history, distribution, botanical description (including plant morphology), taxonomy, cytology/cytogenetics, germplasm collection and exchange, genetic improvement through breeding and selection, growing conditions, nutrient requirements, diseases and pests, propagation, harvesting and processing of the 12 industrial crops are discussed. Future prospects are given.

**144. CORREIA, D and ROSA, M-de-F. 2003. The use of coir dust for preparation of substrates for grafted dwarf cashew seedlings.** *Revista-Brasileira-de-Fruticultura*. 25(3): 557-558 (Embrapa Agroindustria Tropical, Doutorado USP/Esalq, Caixa Postal 3761, CEP 60511-110, Fortaleza (CE), Brazil.)

Mature and immature coir dust were used for preparation of substrates for grafting dwarf cashew rootstocks obtained from CCP06 seeds and vegetative shoots from adult plants of CCP76. Coir dust from either mature or immature fruits was suitable for seedling

growth, and could replace low humid gley soil at 20%. Both substrates exhibited the possibility of removing cashew seedlings from liner pots and provided exemplary root aggregation to substrates..

**145. CRAMER, C. 1999. Can Africa industrialize by processing primary commodities? The case of Mozambican cashew nuts.** *World Development Oxford*. 27 (7): 1247-1266 (School of Oriental and African Studies, London, UK).

It is noted that industrialization strategies based on vertical diversification into processing of primary commodities have long been appealing to low-income countries. The performance of such strategies is mixed. An aggregate-level literature is divided on the advisability of low-income countries processing commodities for export, especially for countries relatively poor in human capital. While this general literature usefully illuminates the policy debate over processing cashew nuts in Mozambique, commodity and country specific factors reveal the weaknesses of conducting debate at too aggregated a level. It may be that the most significant constraints on processing industrialization are political rather than purely technical or economic.

**146. CRISOSTOMO, I.A., ROSSETTI, AG and PIMENTEL, CRM. 2004. Nut yield, industrial characteristics and economic evaluation of rain-fed CCP 76 dwarf cashew clone as affected by nitrogen and potassium fertilization.** *Revista-Ciencia-Agronomica*. 35(1): 87-95 (Embrapa Agroindustria Tropical, Rua Dra. Sara Mesquita 2270, CEP 60511-110, Fortaleza, CE, Brazil).

A rainfed trial was conducted during May 1995-December 2002 in Brazil using cashew dwarf clone, CCP 76, to evaluate the yield,



industrial characteristics and economic value of the crop under different N and K rates. N (urea) was applied at 0, 51.0, 102.0 and 153.3 kg/ha per year, while K (potassium chloride) was applied at 0, 24.5, 49.0 and 73.4 kg/ha per year. The nut yield increased from the first to the seventh year. A maximum nut yield of 1753 kg/ha was obtained in the seventh year with a supply of 55.83 and 31.20 kg/ha per year N and K, respectively. An equation expressing the N and K requirements of the crop is presented. Nut quality was not affected by N and K. A profit of US\$ 355.36 was obtained with a supply of 21.9 and 8.5 kg/ha per year of N and K, respectively.

**147. CROXFORD, AE., ROBSON, M and WILKINSON, J. 2005. Characterization and PCR multiplexing of polymorphic microsatellite loci in cashew and their cross-species utilization. *Molecular Ecology Notes* 10 (11): 1-3**

Cashew is the most economically important nut crop in the world, and yet there are no sequence tagged site (STS) markers available for its study. Here we use an automated, high-throughput system to isolate cashew microsatellites from a non-enriched genomic library blotted on to membranes at high density for screening. Sixty-five sequences contained a microsatellite array, of which 21 proved polymorphic among a closely related seed garden population of 49 genotypes. Twelve markers were suitable for multiplex analysis. Of these, 10 amplified in all three related tropical tree species tested: *Anacardium microcarpum*, *Anacardium pumilum*, and *Anacardium nanum*.

**148. CRUZ, FS Jr and FLETCHER, RJ. 2001. Identification of superior cashew trees for Northern Australian conditions. *WANATCA-Yearbook*. (25) : 62-69 (University of**

Queensland, Gatton College, Qld 4345, Australia.)

One hundred and thirty-five well-buffered cashew trees originally derived from seedlings were evaluated for nut yield characteristics during the 1993-94 fruiting seasons at Cashews Australia, Dimbulah, Far North Queensland, Australia. Wide variation in total nut yield per tree/year, nut number per tree/year and mean individual nut weight was observed. The frequency distribution of the population was positively skewed towards higher values of the different nut yield components. Total nut weight/tree was positively correlated with nut number/tree ( $r=0.803$ ) but it was not significantly correlated with mean nut weight/tree. Nut number/tree was negatively correlated with mean nut weight ( $r=-0.563$ ). Four trees (cultivars TN 10203, TN 12310 and TN 20216 TN 21406) were selected as superior trees, each producing average nut yields of more than 6.0 kg/tree/year and mean individual nut weights of more than 6.0 g.

**149. D'SOUZA, L. 1999. Rejuvenation-a major problem in micropropagation. *Plant Tissue Culture & Biotechnology: Emerging Trends*: p. 22-28 (Proceedings of the symposium held at Hyderabad in 1997).**

The problem associated with micropropagation of mature tree species are reviewed with particular reference to micropropagation of cashews and oil palm.

**150. DAS, S., JHA, TB and JHA, S. 1996. *In vitro* propagation of cashew nut. *Plant Cell Reports* 15(8): 615-619**

*In vitro* plant propagation was developed for seedling shoot tips, leaf axils and cotyledonary nodes of cashew. Factors affecting

multiplication rate included age of explant source, explant type, medium composition, light requirement and transfer frequency. Cotyledonary nodes produced more buds than other explants types. Nodes had a 90% viability when transferred daily to fresh medium containing activated charcoal for 7 days while exposed to continuous dark. Cultures were then exposed to low light illumination with weekly transfers. The phytohormone composition producing the most buds was 2.32 $\mu$ M kinetin, 9.12  $\mu$ M zeatin and 4.40 $\mu$ M BA. The highest frequency of rooted shoots was obtained by treating shoots with *Agrobacterium rhizogenes*. Plants were also recovered by induction of roots using auxin treatment on propagated shoots.

**151. DEORUKHAKAR, AC., VEERKAR, PD and TALATHI, JM. 1995. Yield gap and constraints in technology adoption of cashewnut cultivation in the Konkan region. *The Cashew* 9(4): 13-17**

The motivation of farmers for adoption of package of practices as recommended for cashewnut cultivation alongwith rejuvenation of existing orchards of cashew will enhance productivity levels of cashewnut and reduce the yield gap as observed in the study area. The shortfalls on the part of input supply agencies and imparting training in the use of recommended package of practices must be given priority by extension agencies in planning and implementing agricultural development programmes particularly in Konkan region.

**152. DESAI, AR. 2001. A new cashew variety for Goa. *Journal of Plantation Crops* 29(1): 59-61**

Goa-1 is a selection derived by clonal evaluation of a local germplasm collection

Balli-2. The high yielding feature of this selection is attributed to the higher number of flowering laterals canopy (15.9), male to bisexual sex ratio of 10:1. The apple characteristics of this selection are far superior compared to the present commercial varieties grown in Goa. Medium and bold nut size and excellent kernel recovery (29.8-30%) of export grade (W210-W240) coupled with higher nut yield are the important features of this variety.

**153. DESHPANDE, SB., HALDANKAR, PM and PATIL, BP. 2003. Evaluation of pollen parents as pollinizer varieties in cashew nut. *The Cashew* 17(1): 23-29**

An experiment was conducted to assess the effect of different bold nut pollen varieties of cashew viz: BT1, BT22 and BR65 on fruitset and fruit retention of small seeded varieties V2 and V5 from 1995-1998. The study indicated that the pollen varieties differ in their influence on fruitset and fruit retention in female parents. Among the different pollen genotypes BT1 was found to be the potential pollinizer type which gave 14.93 and 13.5% fruit retention in V2 and V5 respectively which was on par with BT22 when crossed with V2 (14.19%). More studies are suggested to exploit the benefit of pollinizer varieties in cashew nut.

**154. DESHPANDE, SB., HALDANKAR, PM. and RAO, EVVB. 2002. Evaluation of high density planting in cashew. *The Cashew* 16(1): 23-28**

A field experiment was conducted for 3 years (1998-2001) to assess the optimum crop geometry for maximizing profit from cashew plantation during early initial years of plantation. Nine spacing combinations studied revealed that the growth parameters were not appreciably influenced due to spacing

treatments. The yield per block and per hectare in respect of the high density (5x5m) treatments were remarkably high. The wide spacing (10x10m) recorded the lowest yield. The economic evaluation revealed that the gross income, gross expenditure and net profit were considerably higher from the high density (5x5m) treatments.

**155. DHANARAJ, AL., RAO, EVVB and SWAMY, KRM. 2002. Using RAPDs to assess the diversity in Indian Cashew germplasm. *Journal of Horticultural Science & Biotechnology* 77 (1): 41-47**

Over one thousand clonal accessions of cashew are maintained in the National Cashew Gene Bank at NRCC, Puttur, Karnataka, India and Regional Cashew Gene Banks in the AICRP on Cashew centres. In the present study RAPD markers have been used to estimate the diversity among 90 cashew accessions from the NCGB. A dendrogram was constructed using Ward's method, squared Euclidean distance which confirmed that the diversity of Indian cashew collections can be considered to be 'moderate' to 'high'. A core collection has been identified based on the study which represents the same diversity as the entire population. This could be the first step towards more efficient germplasm management of cashew in India.

**156. DIXIT, SREENATH., SWAMY, KRM and YADUKUMAR, N. 1997. Communication behaviour of cashew demonstration farmers. *The Cashew* 11(3): 3-7**

Majority of demonstration farmers did not take active part in dissemination of cashew cultivation information to neighbouring farmers. One of the factors contributing to the effectiveness of demonstration is the

communication behaviour of demonstration farmers. Demonstration farmers need to acquire information on technologies, process it and disseminate the same to other farmers whom the extension agencies cannot contact individually for want of time and resources.

**157. DIXIT, SREENATH and RAO, EVVB. 2000. Kisangoshti - an interface with cashew farmers. *The Cashew* 14(1): 24-31**

Cashew farmers who had tried new ideas and innovations in the recommended technologies were short listed and invited to give a talk in front of farmers' gathering on the field day in order to create a wide awareness of these practices.

**158. DIXIT, SREENATH and RAO, EVVB. 1999. Problems in cashew cultivation: farmers' perspective. *The Cashew* 13(3): 3-16**

This paper deals with the problems faced by the farmers' in cashew cultivation and analysed, based on the questionnaire issued to them. The questions asked were deals with all aspects of cashew cultivation and the problems they faced for higher production. The remedial measures were suggested.

**159. DIXIT, SREENATH., RAVIPRASAD, TN and YADUKUMAR, N. 1998. Cashew plant protection campaign. *The Cashew* 12(1): 21-23 (NRCC, Puttur-574202, D.K., Karnataka.).**

Campaigns could be used as a powerful educational tool not only to educate the farmers on the technology but also on the support government is extending to them for adopting it. It can be equally educative to researchers in terms of providing them the much needed feedback to reorient their efforts. The campaign

gave insight into other problems the farmers are facing, especially that of CSRB besides building a tempo among farmers for taking up timely measures for TMB management.

**160. DORAJEERAO, AVD., RAVISANKAR, C and REDDY, MLN. 2002. Morphological and yield characters of certain promising clones of cashewnut under Bapatla conditions. *South Indian Horticulture* 50(1/3): 151-158**

Fourteen clones were evaluated for different morphological and yield characters under the agroclimatic conditions of Bapatla, India. Majority of the clones showed upright canopy nature. Mean canopy spread varied from 3.30m (HY303) to 5.43m (T.NO. 10/19). Leaf colour at immature stage was pink with different shades and at mature stage it was light green or dark green depending on the clone. Leaf area varied from 60.31 cm<sup>2</sup> (HY 255) to 101.15cm<sup>2</sup> (T.No. 10/19). Flowering season was between Dec. and March. Number of flowering laterals per m<sup>2</sup> was maximum (21.25) in the highest yielding clone M 44-3. Apple colour varied from red, orange red, orange yellow and yellow. Majority of the apples were round or round to conical. Nut weight varied from 4.40 (HY 255) to 12.00 g (H 320). Nut length appeared to be more related to nut yield than nut width.

**161. DORAJEERAO, AVD. 2000. Influence of flowering phases on nut yield of different cashew clones. *Journal of Plantation Crops* 28(1): 55-60**

The influence of flowering phases of nut yield was carried out on 14 cashew clones at CRS, Bapatla. The different clones were grouped in to 3 main groups; 1- clones having 2 phases; 2-clones having 3 phases; and 3-

clones having 4 phases. Each group was divided in to 2 subgroups depending on the sequence of male and mixed phases. Clones like M44-3, M15-4 having longer mixed phases and higher proportion of hermaphrodite flowers recorded greater nut yield. Early flowering clones were high yielders under local agro-climatic conditions of Bapatla.

**162. DORAJEERAO, AVD. 1999. Study on floral characters of different cashew clones. *The Cashew* 13(1): 37-41**

Five year old trees of 14 cashew clones were studied during 1997-98. Numbers of male and hermaphrodite flowers were counted along with the duration of flowering. Information on panicle shape, sex ratio and fruit set was recorded. Wide variation in these characteristics was noted. Short flower durations, broader panicle shape, and a high proportion of hermaphrodite flowers was noted in the highly productive clones M44-3, M15-3, HY367, T.No 10/19 and HY2/16.

**163. DWIVEDI, RP . 2000. Orissa Cashew gains momentum. *The Cashew*. 14 (3) 14-19. (House No. 18, Pawani Complex, Jagamohan Nagar, Jagamara, Bhubaneswar 751 030, India.)**

An overview of cashew production, processing, and marketing in Orissa, India, is presented. Some suggestions to develop the cashew sector are outlined.

**164. DWIVEDI, RP . 1998. Cashew development challenges and opportunities: Orissa component. *National seminar on cashew*, Goa, India, May 1998. In: *The Cashew*. 12: (3): 165-168.**

A perspective is given on cashew production in Orissa state, India, and the

opportunities and challenges facing the sector. Orissa accounts for 18% of the national cashew area and nearly 11% of the country's total output of 420 000 t in 1996/97. There is vast scope for expansion in several districts and for replanting in zones with plantations of 28-32 years. Challenges facing the sector are listed: training, extension, marketing, financial assistance, improvement and modernization of industrial units.

**165. EAPPEN,T., RAO, DVKN and KARTHIKAKUTTYAMMA, M. 2005. Influence of plantation crops on soil properties in Tripura. *Natural Rubber Research*. 18(1): 67-80 (Rubber Research Institute of India, Kottayam - 686 009, Kerala, India.)**

The impact of different plantation crops on soil properties in Tripura (India) was studied in comparison with barren land. Multivariate analysis indicated that there were significant differences among tree crop plantations. The analysis of variance of repeated measures showed that Ca, Mg, K, P, and pH varied significantly in different years while P and K did not show significant difference among plantations. The highest quantum of leaf litter was added by sal (*Shorea robusta*) followed by teak (*Tectona grandis*), rubber (*Hevea brasiliensis*), acacia (*Acacia auriculiformis*) and cashew (*Anacardium occidentale*). The nutrient contents in the litter did not follow any general trend. The variability in the soil properties was due to different types of plantations while the location did not contribute much. The leaf litter addition and consequent Mg content of soil was influenced by the location. Cluster analysis showed that rubber and sal formed the initial cluster with lowest distance between them while teak alone formed

the second cluster. Acacia and barren land formed another cluster, which was distant from all the others. It is suggested that the rubber plantations in Tripura are comparable to forest tree plantations particularly sal and teak in terms of the parameters observed.

**166. EGBEKUN, MK. 1999 . Changes in ascorbic acid contents in oranges and cashew apples with maturity. *Ecology of Food & Nutrition* 38(3): 275-284**

Oranges and cashew apples of different maturity were collected from a number of trees growing at 3 locations in the Idah and Igalamela areas of Kogi State. Juice was extracted from the fruits and changes in ascorbic acid content of the juice with fruit maturity were determined. The ascorbic acid was extracted with 5% metaphosphoric acid and determined by titration. Maturity was judged on the basis of size, colour and firmness of the fruits. The results showed that ascorbic acid contents varied with maturity and location and peaked at the ripe stage and decreased as ripening progressed. Juice yield varied from 34 to 48% (oranges) and 28 to 44% (cashew apple).

**167. FAIADE, KO., AKINWALE, TO and ADEDOKUN, OO. 2003. Effect of drying methods on osmotically dehydrated cashew apples. *European Food Research and Technology*. 216(6): 500-504 (Department of Food Technology, University of Ibadan, Ibadan, Nigeria.)**

Matured ripe cashew apples were transversely cut into 10 mm, 15 mm and 20 mm slices and immersed in sugar solutions of 52 degrees Brix, 60 degrees Brix and 68 degrees Brix, for 10 h. The osmotic temperature was maintained at 27 degrees C in a water bath.

Osmosed samples were subsequently dried in either an air-oven (50 degrees C) or a vacuum-drier (50 degrees C), both for 6 h. The instantaneous moisture content (d.b) of osmosed cashew apples decreased with increasing immersion time and osmotic solution concentration, but also increased with increasing slice thickness. The water loss, solids gain and percentage weight reduction increased with increasing osmotic solution concentration and immersion time, but decreased with increasing slice thickness. Osmotically dried samples received high acceptability. Sample pre-osmosed in 60 degrees Brix and 68 degrees Brix solutions were significantly better ( $P>0.05$ ) than those pre-osmosed in a 51 degrees Brix solution. A significant difference ( $P>0.05$ ) between the osmo-oven and osmo-vacuum dried cashew apples could not be ascertained (under the conditions of the investigation).

**168. FANG, F., HO, CT and SANG, SM. 2005. Determination of sphingo lipids in nuts and seeds by a single quadrupole liquid chromatography - mass spectrometry method. *Journal of Food Lipids* 12(4): 327-343**

A liquid chromatography-mass spectrometry method with atmospheric pressure chemical ionization positive ion mode was developed to separate, identify and quantify ceramide and cerebroside species including cashews. The ceramides found in the samples contained mainly trihydroxy bases, especially 4-hydroxy -8- sphingenine (t18:1). Both nonhydroxy fatty acids and hydroxy fatty acids were found, and these were mostly very long chain fatty acids ( $C>20$ ). Cerebroside of the plant samples had both dihydroxy and trihydroxy bases, with dihydroxy base 4,8-

sphingadienine (d18:2) dominating. The fatty acids were composed mainly of  $\alpha$ -hydroxy fatty acids. Using an external calibration method, the major cerebroside found in the plants examined was quantified. This is the first report of sphingo lipid content in most of the species studied.

**169. FANIMO, AO., ODUGUWA, OO., ALADE, AA and ADESEHINWA, AK. 2003. Growth performance, nutrient digestibility and carcass characteristic of growing rabbits fed cashew apple waste. *Livestock Research for Rural Development*. 15(8): article 3 (University of Agriculture, P M B 2240 Abeokuta, Nigeria.)**

The nutritive value of dried cashew apple waste (CAW) was investigated in this study. A basal (control) diet was formulated to meet requirements of growing rabbits and three other diets were formulated by substituting 10, 20 and 30% of the basal diet with CAW. Thirty-six 6-week-old rabbits were fed these diets and growth performance was recorded. Faecal apparent digestibility of nutrients was measured in 12 rabbits. Rabbits fed diets with 20 and 30% CAW gained weight ( $P<0.05$ ) faster than those fed the control diet. Feed efficiency increased with levels of CAW in the diets with rabbits on 30% CAW being most efficient. Crude protein digestibility decreased ( $P<0.05$ ) with increased level of CAW. There were no significant differences ( $P>0.05$ ) in the blood metabolites except cholesterol level which increased ( $P<0.05$ ) with CAW inclusion in the diets. Inclusion of CAW also increased ( $P<0.05$ ) the relative weights of kidney, liver and carcass cut parts. It is inferred that dried CAW can be included in growing rabbit diets up to 30% of the dry matter.

**170. FASINA, AS. 1998. Suitability evaluation of major soils in Lagos state for cashew and coconut production. *Nigerian***

*Journal of Tree Crop Research*. 2 (2): 19-31 (Department of Crop Production & Horticulture, School of Agriculture, Lagos State Polytechnic, Nigeria).

The major soils of Lagos as located on three land types in SW Nigeria were evaluated for suitability for cashew and coconut cultivation using field data from 40 pedons representing 21 soil series. The results indicates that 59% and 41% of the sites were marginally and moderately suitable for coconut production, respectively. For cashew production, 63%, 7% and 9% were highly suitable (S1), moderately suitable (S2) and marginally suitable (S3) respectively, while 21% were not suitable (NS). The major limitations to coconut production was climate (low rainfall) and soil physical characteristics (soil texture) for cashew. The land evaluation method was useful and accurate in evaluating these soils.

**171. FERNANDEZ, M and SUDHEER, SV. 2003. Cashew kernel packaging: an eco-friendly and cost effective alternative. *The Cashew* 17(3): 32-36**

Cashew kernel packaging has evolved from the days of wooden cases to flexi-packaging. A comparative analysis is made of packaging of cashew kernels in tin containers and flexi-bags, in terms of cost-effectiveness and eco-friendliness. The additional investment involved in changing over from tin packaging to flexi packaging works out an amount ranging from Rs. 4.57 lakhs to 11.66 lakhs, depending up on the capacity of machine installed. This investment can be recouped within a span of 56 to 96 days based on the type of machine installed. Flexi-packaging is cost effective to both processor- exported and the importer and is eco-friendly.

**172. FERNANDEZ, M and SUDHEER, SV. 2002. Comparative analysis of cashew nut shelling methods in Kerala. *The Cashew* 16(4): 39-45**

This paper attempts to find out the better combination of processing methods between drum roasting shelling and steam-cooking and de-shelling by using hand-cum-pedal operated sheller combinations. A survey revealed that steam-cooking and de-shelling using hand-cum-pedal operated sheller combination, saves 29.66% of the labour cost and earn more.

**173. FERNANDEZ, M. 2001. Cashew nut: a health friendly nut. *The Cashew* 15(4): 8-11**

Cashew nut is a storehouse of nutrients. It contains protein 21%, fat 47%, moisture 5.9%, carbohydrates 22%, phosphorus 0.45%, iron 5mg for every 100gm and other mineral elements. nutritionally it stands at par with milk, egg and meat. The fat it contains is unsaturated fatty acids. Regular consumption of cashew nut is good for heart health, blood sugar, cold and flu, ageing etc.

**174. FERNANDEZ, M and SUDHEER, SV. 2002. Managerial efficiency in the procurement of raw cashew nuts: an evaluation. *Cashew Bulletin* 40(7): 3-7 (Sr.Lecturer, Dept. of Commerce, FMN College, Kollam, Kerala).**

Cashew factories in the private, public and Co-operative sectors operative within the same environment and the managements of all the three enjoy the same freedom in choosing the sources and methods of procurement. However, the composition of the decision making group, their experients and methods of procurement present a widely varying picture. Quick and prompt individual decisions are the

hallmark of the private sector, in contrast to the time consuming group decisions of the management in the public sector. The sources and methods of procurement are also factors that show the glaring disparity between the managerial efficiency of the private and public/co-operative sectors.

**175. FERREIRA, MAD and MIDIO, AF. 1998. Application of the CB method and fluorodensitometry for examining cashew-nuts for possible aflatoxin contamination. *Alimentaria*. 35 (293): 63-65 (Departamento de Farmacia, Centro de Ciencias da Saude, Universidade Federal do Ceara, Brazil.)**

A study was made to determine whether the CB method, previously recommended for the determination of aflatoxins in peanuts [groundnuts] and other commodities, could be applied, with some slight modifications, to aflatoxin estimation in cashew-nuts. Cashew nut samples (50 g) were spiked with aflatoxins B1, B2, G1 and G2 at levels of 21.5, 12.6, 19.2 and 17.8 µg/kg, respectively, and extracted according to the BC method as recommended by AOAC. TLC plates were submitted to double development and the aflatoxins were determined by fluorodensitometry. Mean recoveries of all mycotoxins ranged from 46 to 137; mean recovery of aflatoxin B1 was 137.33±1.15 µg/kg and for aflatoxin B2 was 98.33±8.39 µg/kg. Late re-examination of TLC plates by visual comparison showed no interfering background although differences in the intensity of fluorescent spots were noted.

**176. FIALHO, JS, BUENO, DM and CAVALCANTE, JR AT. 2005. Methodology development to obtain cashew tree haploids through rising of anthers. *Revista Ciencia Agronomica* 36(2): 195-202**

Culture media and environments were investigated aiming to develop methodologies to obtain haploids of cashew tree through anther culture. Floral button explants were taken from early dwarf clone CCP 76. Incidence of oxidation and contamination, as well as development, it was observed that anthers showed good development when kept initially at dark and then transferred to the previous medium, but with different concentrations or proportions, or when transferred to a medium known to favour anther growth after initial induction. Overall, activated coil added to the nutrient medium inhibited oxidation in detriment of the anthers managed under light, whose places were switched every 4 days within the same Petridish, and presented higher incidence of oxidation. The best degree of development was reached in MS and MS/4 media and also, when thidiazuron was added in the concentration of 0.005µM. The results showed that the studied anthers developed callus, but without the presence of embryogenic cells, suggesting the need of further studies, such as switching medium after initial dark shock.

**177. FIGUEIREDO, RW., LAJOLA, FM and ALVES, RE. 2001. Change of firmness, pectins and pectolytic enzymes during the development and maturation of fruits of early dwarf cashew: CCP - 76. *Proceedings of the Interamerican Society for Tropical Horticulture* 43: 82-86**

A research was carried out to evaluate the changes in pectin content, and the activity of pectolytic enzymes, PME, and polygalacturonase (PG) during the development and maturation of early dwarf cashew. Cashew was harvested at seven stages of maturation, from



an irrigated commercial orchard in the municipality of Mossoro, Brazil. The fruits and nuts were harvested according to the following characteristics: 1= green; 2= green fruit with dry nut; 3= light green, 4= beginning of yellow colour, 5= light orange; 6= orange; and 7= deep orange. Cashew fruit firmness dropped from 65.61 to 8.43 N during development and maturation, and total pectin content decreased from 0.16 to 0.12%. PME reached its maximum activity in stage 3 and then remained almost constant, while PG activity consistently increased up to the end of maturation.

**178.** FIGUEIREDO, RW., ALVES, RE and FILGUEIRAS, HAC. 2002. **Changes in cell wall constituents of the cashew apple for early dwarf clone CCP 76 during development and maturation.** *Acta Horticulturae* 2(575): 697-704

The apples were harvested at seven stages of development and maturation, according to the aspect of both apple and nut for stages 1 and 2 and of the apple for stages 3-7: 1 green apple with green nut; 2-green apple with mature and dry nut; 3-light green, 4-beginning of yellow colour, 5-yellow with orange shade; 6-light orange; 7-deep orange. The apples were evaluated for firmness, and the isolated cell wall material (CWM) was analysed for cellulose, hemicellulose, total uronides, degree of pectin esterification and bound calcium. The amount of CWM decreased during development and maturation, and was positively correlated to apple firmness as well as to the content of bound calcium.

**179.** FIGUEIREDO, RW., LAJOLA, FM and ALVES, RE. 2002. **Physical-chemical changes in early dwarf cashew pseudofruits during development and maturation.** *Food Chemistry* 77(3): 343-347

Cashews were harvested in July 1997 from clones of early dwarf cashew trees installed under irrigation in Mossoro, Brazil and sorted according to apple size and skin colour, in to seven development and maturity stage. The following characteristics were analysed in the apples: weight, length, upper and lower diameters, pulp firmness, pH, soluble solids, titratable acidity, vitamin C, tannins, total carotenoids, total chlorophyll, total pectin, total calcium, anthocyanins, starch, soluble calcium and reducing sugars. Pseudofruits increased significantly in size after the full development of the nuts. The peak of consumption quality, i.e. highest soluble solids, reducing sugar content, and highest SS/TA ratio was at the end of stage seven.

**180.** FIGUEIREDO, RW., LAJOLA, FM and ALVES, RE. 2007. **Quality of Cashew pseudofruits treated with calcium at postharvest and stored under refrigeration.** *Pesquisa Agropecuaria Brasileira* 42 (4): 475-482

A study was conducted to evaluate the effects of postharvest calcium applications on chemical and physicochemical characteristics, quality attributes and calcium tissue concentration of early dwarf cashew pseudofruits stored under refrigeration and modified atmosphere. The cashews were immersed in water and in different calcium chloride solution concentrations (0.5, 1 and 2% (w/v)) for 2 minutes. Cashews were put in polystyrene trays, packed in polyvinyl chloride (PVC) and stored at  $5 \pm 1^\circ\text{C}$ ,  $88 \pm 3\%$  RH for 25 days. The total soluble solids and soluble sugars decreased during storage. The pseudofruits, independent of the calcium chloride concentration, showed a tendency to decrease the total titratable acidity and vitamin

C, and an increase of pH during storage. The anthocyanins content showed no variation in treated cashew pseudofruits. Small reductions in less polymerized polyphenolic fraction were observed during the storage period. The calcium chloride concentrations 0.5 and 2.0% slightly increased tissue calcium concentration until the 15th storage day, and decreased, afterwards until the end of the experiment.

**181.** FILGUEIRAS, HAC., ALVES, RE and MOSCA, JL. 1999. **Cashew apple for fresh consumption: research on harvest and post harvest technologies in Brazil.** *Acta Horticulturae* 485: 155-160

Cashew apple losses are estimated to be as high as 90%. The physiological aspects of cashew apples that affect perishability are discussed and handling techniques for achieving an extension of postharvest life are outlined.

**182.** FILHO, M-De-SMS., LIMA, JR., SOUZA, ACR and NETO, MAS. 1999. **Effect of bleaching, osmotic process, heat treatment and storage on ascorbic acid stability of cashew apple processed by combined methods.** *Ciencia-e-Tecnologia-de-Alimentos*. 19: (2): 211-213. (Pesquisadores da Embrapa Agroindustria Tropical - Rua Sara Mesquita, 2270, CEP 60511-110, Fortaleza, CE, Brazil.)

Cashew apples were processed by combined methods. Major physical and chemical changes were pH decrease, soluble solids and reducing sugars increase. Ascorbic acid loss was 23.3% after bleaching, 31.7% after one day osmosis, 35.5% after five day osmosis, 69.0% after heat treatment and 87.3% after 60 days storage at ambient temperature ( $\approx 28^{\circ}\text{C}$ ).

**183.** FOLTAN, II and LUDDERS, P. 1994. **Flowering and sex expression in cashew.** *Angewandte Botanik Berichte* 5: 203-207

Floral characters were studied in 4 cashew cultivars in Northern Australia in 1992. Flowering covered a period of nearly 4 months. Ullal-1 was the only cultivar with an early and short period of hermaphrodite flower appearance, a desirable character for producing a relatively short fruiting phase, particularly when fruits are to be harvested mechanically. Shading led to enhanced formation of hermaphrodite flowers, while exposure to sun light resulted in a shift towards differentiation of male flowers, indicating temperature effects on sex ratio. The correlation between the number of hermaphrodite flowers and final fruit set was largely dependent on the genetic composition of the examined sample and may therefore not serve as a reliable criterion for selection of high yielding genotypes.

**184.** FOLTAN, H and LUDDERS, P. 1995. **Flowering, fruit set, and genotype compatibility in cashew.** *Angewandte Botanik* 69(5/6): 215-220

Studies on flowering, fruiting and genotype compatibility in seven cultivars were carried out in Darwin, Australia, during July - Oct. 1992. Significant differences between the cultivars concerning flower numbers, initial fruit set, abscission rate and the number of mature fruits per panicle were observed. The proportion of hermaphrodites averaged 14% across all cultivars. Less than 41% of the perfect flowers showed initial fruit set and only 1-18% developed mature fruits. Maximum fruit set was attained within the first 3-4 weeks of the fruiting period. Fruits deriving from flowers opening later were usually shed. A competitive advantage of the first - fertilized and most advanced fruits is suggested. The number of hermaphrodite flowers is not a reliable criterion for selection of high yielding genotypes. Hand

pollination studies revealed no indications of self incompatibility, although it may not be absolutely excluded. Cultivars were mutually compatible. Superior combining ability as either male or female parent was indicated in some cultivars.

**185. FORSBERG, L . 2000. Nutcracker culture. An exploratory study of cashew processing women in south-eastern Tanzania. Minor Field Studies International Office, Swedish University of Agricultural Sciences. No. 102, 56 pp (Swedish University of Agricultural Sciences, International Office, Box 7070, SE-750 07 Uppsala, Sweden.)**

During recent years, small-scale cashew processing has been taken on as an income-generating activity by a number of people, mainly women, in south-eastern Tanzania. This study attempted to reach for the women's own perspective on their situation as cashew processors and get them to express their needs. Emphasis is placed on the businesses' organisational features and the women's struggle to make their businesses income-generating and compatible with their life and obligations. The networks put in place by the actors and the culture of the cashew processing sector are considered central to this exploration, and the learning experience is emphasised as an important part of the inquiry. The study is based on the case study of four cashew processing businesses in south-eastern Tanzania. A participatory methodology guided the field study that was conducted during July 1999, and the results presented stem from both participatory exercises and interviews. By acknowledging the capacity of the cashew processing women, it becomes clear that their businesses have a life reaching beyond present

development support. The entrepreneurial spirit that constitutes the foundation of some of the businesses, proves that there is a demand-driven development of cashew processing, although initially sparked by external intervention and still in need of support. The blend of external and internal forces shaping the development of the businesses are reflected in their complex networks. To successfully manage their businesses, the women rely on many different sources for securing credits, technology, input, and markets. The social capital must be well maintained and the door is always open for the support of development institutions.

**186. FRAGOSO, HA. 1999. Macronutrient removal by both cashew nut and apple of two dwarf cashew clones. Revista Brasileira De Ciencia Do Solo 23(3): 603-608**

The macronutrient removal by both cashew nut and apple was evaluated in orchards of two dwarf clones in a field without irrigation and fertilization on a red-yellow podzolic soil in Ceara, Brazil from March 1994 to April 1995. The CCP-76 and CCP-09 cashew clones did not differ with regard to the macronutrient quantities removed by the cashew nut and cashew apple except for Ca. This macronutrient was removed in greater quantity by the apples of the CCP-76 clone. The order of macronutrient removal by the cashew nuts and the apples was N>K>Mg>P>S>Ca and K>N>Mg>P>S>Ca, respectively.

**187. FREIRE, FCO and KOZAKIEWICZ, Z. Filamentous fungi, bacteria and yeasts associated with cashew kernels in Brazil. Revista Ciencia Agronomica 2005 36(2): 249-254**

During the past 10 years a study has been conducted on the occurrence of fungi, bacteria and yeasts associated with cashew kernels in Brazil. Over a 1000 samples from farmers and retailers have been examined. This paper lists the microorganisms isolated so far. A total of 79 fungal, 18 bacterial and 1 yeast species have been confirmed. Members of *Aspergillus* and *Penicillium* are dominant. Species potentially toxigenic such as *Alternaria alternata*, *Aspergillus clavatus*, *Aspergillus flavus*, *Aspergillus parasiticus*, *Aspergillus ochraceus*, *Aspergillus ustus*, *Penicillium citrinum* and *P. oxalicum* were frequently isolated. Among the bacteria, those of the genus *Bacillus* were dominant. *Pichia guilliermondii* was the only yeast confirmed. Measures aiming to reduce microbial contamination of kernels during processing and to improve hygienic conditions in big plant as well as in small processing units are discussed.

**188.** FREIRE, FCO., KOZAKIEWICZ, Z and PATERSON, RRM. 1999. *Mycoflora and mycotoxins of Brazilian cashew kernels. Mycopathologia.* 145(2): 95-103 (Centro Nacional de Pesquisa de Agroindústria Tropical, (EMBRAPA/CNPAT), CEP 60.511-110, Fortaleza, Ceara, Brazil.)

Kernel samples of common and dwarf cashew nuts harvested in Brazil in 1996, were highly contaminated with field and storage fungi. In general, dwarf cashews were more contaminated than common cashew nuts. 37 fungal species were identified; *Aspergillus niger* was the dominant species isolated from dwarf kernels, followed by *A. flavus*. *Penicillium brevicompactum* and *P. glabrum* were the most frequently isolated penicillia, with higher contamination recorded from dwarf kernels. *Chaetomium globosum* was recorded at a high

level. Nine species were recorded from cashew kernels for the first time. Multi-mycotoxin analysis by TLC and HPLC were positive for mycotoxins and other secondary metabolites particularly from the infected samples. HPLC was only carried out on dwarf cashews; aflatoxins were not detected by quantitative IPLC.

**189.** FREIRE, FCO. 2000. *Mycoparasitism of the cashew black mould agent by Acremonium sp. Agrotropica* 11(1): 25-30

The mycoparasitism of a new species of *Acremonium* on the cashew black mould agent (*Pilgeriella anacardii*) was studied by light and scanning electron microscopy. Before penetration the micoparasite hyphae coiled around the host hyphae, conidia, conidiophores and ascomata. Penetration occurred directly through the cell walls without appressorial formation and no signs of indentation or reupture were ever observed. Production of a toxic substance, possibly an antibiotic, might be involved in cell wall breakdown.

**190.** FREIRE, FCO. 1996. *Occurrence of C.scoparium, Psplendens and Phytophthora sp.associated with death of cashew seedlings. Agrotropica* 8(3): 69-72 (EMBRAPA, CNPAT, 60060-510, Fortaleza, Ceara,Brazil.).

Foot and root rot, leaf blight, yellowing and wilt of cashew seedlings were detected in nursery bags at the Agroindustrial Exptl Station in Ceara State, Brazil. After isolation and successful pathogenicity tests, fungi were identified as *C. scoparium*, *P. splendens* and *Phytophthora* sp. This is the first record of these fungi on cashew seedlings in Brazil. Better drainage of nursery bags, combined with suitable levels of irrigation and inspections gave good disease control. Metalaxyl was also successfully used to control *Phytophthora*.

**191.** FREITAS, BM and PAXTON, RJ. 1996. **The role of wind and insects in cashew pollination in NE Brazil.** *Journal of Agricultural Science* 126(3): 319-326

The pollination requirements of cashew, an andromonoecious tree, were studied in NE, Brazil, where cashew is indigenous. Bagging and caging experiments, controlled hand pollination and emasculation of flowers showed that the wind plays little role in cashew pollination and that cashew is self-fertile, although only pollen from the large stamen, either male or hermaphrodite derived, can effect pollination. Insects appear to be the major pollinators of cashew, in agreement with the pollination syndrome suggested by the morphology of its flowers. Direct observation of insects visiting flowers and counts of pollen grains adhering to such insects suggest that the honey bee, although a non native insect, is the major pollinator of commercially grown in NE Brazil.

**192.** FREITAS, BM. 1997. **Changes with time in the germinability of cashew pollen grains found on different body areas of bees.** *Revista Brasileira De Biologia* 57(2): 289-294 (Departamento de Zootecnia-CCA, Universidade Federal do Ceara, C.P.12168, Campus do Pici, 60355-970,CE.).

The percentage germination of cashew pollen grains collected from flowers was higher (93.7) than percentage germination of pollen grains collected from the frons, ventral mesothorax and ventral metathorax of *Apis mellifera* and *Centris tarsata*. Average percentage germination of cashew pollen on the bodies of *A.mellifera* and *C.tarsata* at the time of capture of specimens was 50.0 and 50.3 and 6 h later it had decreased to 22.1 and 22.4. The

results suggest that the germination potential of pollen on the pollinator's body is an important component of its pollinating ability.

**193.** FREITAS, BM and PAXTON, RJ. 1998. **A comparison of two pollinators:the introduced honey bee *A.mellifera* and *C.tarsata* on cashew in North East Brazil.** *Journal of Applied Ecology* 35(1): 109-121 (Dept de Zootecnia-CCA, Universidade Federal do Ceara,CP 12168,Campus do Pici,CEP 60355-970,CE,Brazil.).

Aspects of the flowering biology of wild cashew were studied in the north-east of Brazil, where this species is endemic. Comparison was made among two bee species, *Apis mellifera* and *Centris tarsata*, in their pollination of cashew flowers using a number of measures including single bee visits to marked flowers. Cashew flowering is protandrous within a day. Despite cashew's single ovule per flower, high nut set demands a high rate of pollinator visitation during the peak time of stigma receptivity. Provision of additional bee pollination in commercial orchards is recommended to obtain good nut yields.

**194.** FREITAS, BM. 1997. **Number and distribution of cashew pollen grains on the bodies of its pollinators, *Apis mellifera* and *C.tarsata*.** *Journal of Apicultural Research* 36(1): 15-22 (Departamento de Zootecnia-CCA, Universidade Federal do Ceara,CP 12168,Campus do Pici,CEP 60355-970).

The number of distribution of cashew pollen grains on the bodies of *A.mellifera* and *Centris tarsata* were studied at a site in NE Brazil. There was a significant difference between the number of pollen grains found on

the bodies of male (average 1805 pollen grains) and female (2271) *C. tarsata* and foraging honey bees (1241). Microscopical studies of 9 parts of the bees bodies showed that cashew pollen was unevenly distributed and that it tended to remain on the body parts up on which it was initially deposited. Areas of the body which had greater densities of cashew pollen had touched cashew stigmas.

**195.** GARRUTI, DS., FRANCO, MRB and SILVA, MAAP da. 2003 . **Evaluation of volatile flavour compounds from cashew apple juice by the Osme gas chromatography - olfactometry technique.** *Proceedings of the 10th Weurman Flavour Research Symposium, France* . pp. 614-617. ISBN 2-7430-0639-0.

The headspace volatile components of cashew apple from a commercial Brazilian dwarf cultivar were separated by high resolution gas chromatography and identified by GC- MS. Five judges evaluated the GCeffluents using the Osme technique . Esters methyl 3-methylbutanoate, ethyl 3- methylbutanoate, methylbutanoate, ethyl butanoate, ethyl trans- 2-butanoate and methyl 3-pentanoate were important to the sweet, fruity, and cashew- like aroma. Cis-3- hexenol, hexanal, and 2-methyl-2-pentenal presented different green notes. The olfactometric analysis revealed chromatographic regions where sulfur- like odours were perceived by the sensory panel. The most intense unpleasant odour in cashew apple was due to 2- methylbutanoic acid, which was described as very stinky.

**196.** GARRUTI, DS., COSTA, TSA., PADILHA, VA., LIMA, MV and JALES, KA. 2004. **Evaluation of the peduncles of four cashew genotypes.** *Proceedings of the Interamerican Society for Tropical Horticulture.*

47: 137-140 (Embrapa Agroindustria Tropical, Fortaleza, CE, 60511-110, Brazil.)

Four commercial genotypes of cashew apple [*Anacardium occidentale*] (CCP09, CCP76, CCP1001 and BRS189) plus the microcarpum species [*A. microcarpum*] were subjected to sensory and chemical evaluations. Samples were discriminated by aroma intensity, sweetness, cashew flavour, softness, juiciness, astringency, throat irritation, tannin, anacardic acid, soluble solids and sugar contents, and pH. Astringency and throat irritation correlated positively to tannin content and acid taste and to each other. CCP76 showed high intensity of sweet aroma, sweetness, softness, and juiciness. CCP09 apples were characterized by poor sweet taste, low intensity of cashew flavour and low juiciness. Microcarpum cashew apples were very sweet but poor in aroma and juiciness.

**197.** GARRUTI, DS., OLIVEIRA, MEB., COSTA, TSA and JALES, KA. 2004. **Effect of cashew nut processing on the burning sensation caused by anacardic acids.** *Proceedings of the Interamerican Society for Tropical Horticulture.* 47: 141-142 (Embrapa Agroindustria Tropical, Fortaleza, CE, 60511-110, Brazil.)

Cashew nut samples from either mechanized and semi-mechanized shelling processes were evaluated, in both natural and roasted forms, for anacardic acid content and sensory sensations in the mouth and throat. In general, cashew nuts from semi-mechanized process showed higher anacardic acid content and burning sensation intensity. The roasting procedure (in vegetable oil) resulted in a reduction of anacardic acid level, corresponding to a significant reduction in the burning sensation intensity. Anacardic acid content highly correlated with the attribute "burning during chewing".

**198. GEETHA, K and REGUPATHY, A. 1999. Harvest time residue of quinalphos 20 AF in/ on cashew fruits and nuts. *Pesticide Research Journal* 11(1): 65-67**

In a field study of Tamil Nadu with cashews, residue levels of quinalphos 20 AF, applied 4 times at monthly intervals at 0.5, 0.2 or 0.1% were below detectable limits of 0.05 and 0.01ppm in both the fruits and the nuts, respectively, at harvest time.

**199. GEMAS, V and BESSA, A. 2006 . Influence of various carbohydrates in shoot development in nodal culture of Guinean cashew genotypes. *Plant Cell, Tissue and Organ Culture* 85(1): 103-108**

The influence of various carbohydrates in shoot development was studied in single nodal culture of Guinean cashew genotypes. Both apical and axillary nodal sections from one and half- year old stock plants of elite selected cashew from Guinea- Bissau were used as explants. Six types of carbohydrates were tested separately at concentration of 83 $\mu$ M. Sucrose, maltose and fructose showed the best performance and were additionally tested at concentrations of 0.83 and 167 $\mu$ M in order to evaluate the optimal concentrations that promotes growth. These results indicated that the inclusion of a carbohydrate source is essential for shoot development. The combination of maltose and fructose (each at 83 $\mu$ M) promoted both the highest percentage of developed shoots and the highest shoot length when compared with the results obtained using these 2 sugars separately. With this study, we found a one-step carbohydrate combination that allowed overcoming the low yield of well developed shoots observed in the current propagation system in Guinean cashew genotypes.

**200. GHOSH, DK., BANDOPADHYAY, AK and SEN, SK. 1994. Response of Auxinic and Non-Auxinic chemicals on rooting of cashewnut air layers. *Environment and Ecology* 12(1): 79-81 (Dept of Horticulture, BCKV, Mohanpur-741 252, West Bengal.)**

Application of ascorbic acid at 1000 ppm and ethrel at 1000 ppm recorded 100 % rooting in cashewnut air layers. Ascorbic acid and ethrel in general synergized the action of both IBA and NAA in increasing first order roots in air layers. However, ascorbic acid at 5000 ppm antagonized root promoting action of NAA.

**201. GHOSH, SN. 1999. Effect of rain-water harvesting on nut yield of cashew. *Journal of Plantation Crops*. 27 (3): 225-229 (Regional Research Station, Bidhan Chandra Krishi Viswavidyalaya, Jhargram - 721 507, West Bengal, India.)**

The efficacy of constructing different types of water harvesting pits and trenches around cashew trees was investigated at Jhargram in 1994-97. Average nut yields over the 3 years were highest (3.7 kg/tree) with a circular trench 4 feet from the trunk with a width of 9 inches and a depth of 9 inches which was mulched with dry cashew leaves.

**202. GHOSH, SN, CHATTOPADHYAY, N and HORE, JK. 2000. Effect of plant spacing on yield of cashew. *Recent Advances in Plantation Crops Research* 13: 157-159 (Proceedings of PLACROSYM - XIII, 1998.)**

An experiment was carried out in the red laterite tract of West Bengal to study the effect of different plant spacings viz; 5x5m, 6x6m, 8x8m, 10x10m, 6x6x6m, 8x8x8m, 10x10x10m and 10x5m on yield of cashew cv. Red Hazari. The highest yield was recorded from the plants

spaced at 8x8m throughout the period of investigation followed by 10x5m rectangular planting. The unit area yield had markedly increased with the increase in plant density and it was highest at a plant density of 400 plants/ha (5x5m) followed by 321 plants/ha (6x6x6m) and minimum at 100 plants/ha (10x10m).

**203. GHOSH, SN. 1995. Studies on effect of watering during flowering and fruiting on yield of cashew. *The Cashew* 9(3): 5-8**

The trial included 30 litres of watering at intervals of 10,20, 30, 40, 50 and 60 days during the period from 31st January to 31st March. Watering at 50 days interval gave highest fruit set and its retention which consequently resulted 395.6 per cent (Av. of 2 years) more yield as compared to control. Shelling percentage was improved to some extent due to watering and application of water at 50 days interval showed better result.

**204. GHOSH, SN. 1998. Effect of foliar feeding of different commercial products of hormone and micro-nutrient on nut yield. *Environment & Ecology* 16(4): 962-963 (Regional Research Station, BCKV, Jhargram-721 507.).**

Seedling of cashew cv. Red Hazari were planted at the RRS at Jhargram, West Bengal in 1981. In a study conducted in 1993-94, 3 growth regulator products, Miraculan, Planofix (NAA) and Vipul and 4 micronutrient products (Arogen, Multiplex, Plantaid and Tracel) were sprayed during panicle emergence and at fruit set. Of the different commercial growth regulator products, Planofix applied in water at 0.22ml/litre significantly improved the nut yield (by 70.7in 1993 and 83.9in 1994) compared with the control. Multiplex (at 7.50ml/litre) also improved nut production in both years.

**205. GIRIDHAR-PRABHU. 1998. Cashewnuts - is India's global leadership sustainable? National seminar on cashew, Goa, India, May 1998. *The Cashew*. 12: (3): 169-184. (Achal Industries, Mangalore, India. )**

India's position as a leading supplier of cashews in the world market is outlined, and the paper considers whether this position is sustainable. Projections of Indian and global supply for the period 1999-2010 suggest that India's position will be maintained. The major competitive threat would be Vietnam. Brazil is reported to be stable in production and any buoyancy in production or exports is not expected. Some of the problems faced by the industry in India are listed. It is concluded that there is a need to tackle several areas including: export marketing; overcoming fiscal and infrastructural problems; processing innovation; research and development on the needs of manufacturers; and grower education.

**206. GODON, P and NGUYEN-GIA-QUOC. 1997. Systems of intercropping rubber and cashew. *Agriculture-et-Developpement*. No. 15, 169-174 (CIRAD-CA, 34032 Montpellier Cedex 1, France.)**

The political and economic background to land utilization and agricultural development in Vietnam is outlined and recent expansion of tree crops and intercropped systems is described. On the basis of trials on acid soils at 3 basaltic hill and plateau sites in 1991-94, recommendations are made for improvement of yields of intercropped maize, rice and leguminous crops grown between established rubber trees. Application of lime to counteract Al toxicity significantly increased crop yields but application of 2 t thermophosphate/ha to correct Al toxicity and also supply P, Ca and



Mg was even more effective. Various types of cultivation were compared: on the undegraded red soil of the plateau, chisel cultivation gave good results, whereas on degraded slopes, direct drilling allowed efficient utilization of fertilizers by rice crops grown without irrigation. Optimum management systems are proposed for successful cultivation of rubber, cashew and coffee with a suitable balance between cash and food crops to achieve a stable system of agriculture in these high basaltic regions of Vietnam.

207. GODSE, SK, BHOLE, SR and MUNJ, AY. 2003. **Chemical control of mealy bugs of cashew.** *The Cashew* 17(2): 15-17

In recent past mealy bug is observed to be destructive in many cashew orchards from Konkan region and Goa. To control the menace of mealy bugs, this paper recommends the following pesticides, methyl parathion (0.05%), lambda cyhalothrin (0.005%), chlorpyrifos (0.05%), DDVP (0.05%), monocrotophos (0.05%) and profenphos (0.05%).

208. GODSE, SK and BHOLE, SR. 2003. **Management of tea mosquito bug, infesting cashew with some newer pesticides.** *The Cashew* 17(1): 15-18

The experiment was conducted during 1998-99 to 2000-01 at Regional Fruit Research Station, Vengurla, Dist., Sindhudurg (M.S). The efficacy of insecticides viz; chlorpyrifos (0.05%), triazophos (0.01%) and profenphos (0.05%) were studied against cashew tea mosquito bug in comparison with recommended spray schedule. The pooled results of three years showed that the pesticide triazophos (0.01%) and profenphos (0.05%) were observed to be equally effective to that of

spray schedule. However, pesticide profenphos was equal in cost wise with recommended spray schedule.

209. GODSE, SK., BHOLE, SR and PATIL, BP. 2005. **Population fluctuation studies of tea mosquito on cashew and its relation with weather parameters.** *Journal of Agrometeorology* 7(1): 107-109

The population dynamics of *H. antonii* on cashew (cv. Vengurla-1) was studied in Konkan, Maharashtra, India from 1982-83 to 1985-86. Infestation was observed every fortnight on trees that were unsprayed throughout the experimental period. The outbreak of *H. antonii* was observed on sporadic vegetative flush in June-July 1982- 83 and 1983-84. The major outbreak was observed in November, coinciding with the emergence of panicles, reaching the peak in December. The minimum temperature was negatively correlated with pest incidence. The build-up of pest population commenced with the emergence of new flush during October after the cessation of monsoon shower. The pest remained in the field until January. Thus, it was suggested that spraying should be scheduled during October- November, coinciding with the emergence of new flush, flowering and fruit set.

210. GODSE, SK. 2002 . **An annotated list of pests infesting cashew in Konkan region of Maharashtra.** *The Cashew* 16(3): 15-20

This paper listed the various pests infesting cashew in the Konkan region and its predators for natural control.

211. GODSE, SK., BHOLE, SR and MUNJ, AY. 2002. **Rational use of pesticides in management of cashew tea mosquito bug infesting cashew.** *The Cashew* 16(2): 43-45

Three spray schedule is essentially required for effective control of tea mosquito bug on cashew. Monocrotophos (0.5%) or Phosalone (0.7%) were observed as equally effective pesticides for controlling TMB. The flowering and fruit initiation stages of crop growth are most critical in tea mosquito management.

**212. GOGATE, SS and NADGAUDA, RS. 2003. Direct induction of somatic embryogenesis from immature zygotic embryo of cashew nut. *Scientia Horticulturae* 97(1): 75-82**

Direct somatic embryogenesis was induced in precociously germinated immature zygotic embryos (IZEs) of cashew nut. The IZEs were cultured on semisolid MS basal medium with 0.5% activated charcoal and incubated in dark. After 4-5 weeks, somatic embryos were induced directly from the radical tip of IZEs on medium with 2,4-dichlorophenoxyacetic acid (2,4-D) (5µM)+BAP (5µM)+ GA3 (3µM) with 10% frequency of embryogenic response, which was 9% when 2,4-D (5µM) was used alone or with Kinetin (5µM). The somatic embryos were transferred to medium with ABA (20µM) and maltose (3%) for further maturation and , studies are being carried out for conversion of somatic embryos in to plantlets. A histological study of somatic embryo development was carried out where it was seen that the somatic embryos arose from the outermost cell layer of radical tip.

**213. GOVINDAN, M; SALAM, MA and JAYAPRAKASH NAIK, B. 2002. Aerial microbial load in cashew garden and their role in inflorescence blight and fruit rot. *The Cashew* 16(4): 13-18**

Aerial fungal load in cashew plantation ranged from 22.5- 36.08 colonies per Petri plate during the flowering and fruit phase of cashew. The pathogenic fungi consistently observed in the cashew plantations of Kasaragod district are *Botryodiplodia*, *Colletorichum* and *Aspergillus*. Of these, *Botryodiplodia* was found to be dominant species. About 50% of the fungal flora of the cashew plantation are *Botryodiplodia*. Sample survey of diseased plantations revealed that about 84.6% of the samples affected with fruit rot and inflorescence blight is associated with the pathogen *Botryodiplodia*.

**214. GRUNDON, NJ. 1999. Cashew nuts in north Queensland respond to phosphorus and sulfur fertilizers. *Better Crops International* 13(2): 22-24**

In a 3 year field trial begun in 1996 on 4 year old grafted cashew trees, 5 rates each of P,K and S fertilizers were applied. All the P was applied in March, June and September. The rates were increased each year to accommodate tree growth. Applying P at upto 288g/tree annually and S up to 176g/tree annually increased the marketable yield of cashew nuts in shells. K application had no significant effect on yield. Applying P and S fertilizers at the recommended rates could lead to increased incomes of between \$260 and \$720/ha annually. The high P rates recommended increased P accumulation in the surface soil horizon.

**215. GUNJATE, RT. 1997. Cashew plantation management: problems, perspective and approach. *The Cashew* 11(2): 15-19 (Regional Fruit Research Station, Vengurla, India.).**

Present production and future productivity of cashew plantations in India are discussed under the following headings:

potential, constraints, cultivars, planting material, *in situ* grafting, age of grafts at planting, disturbance of root systems, time of planting, removal of rootstock suckers, gap filling, spacing, irrigation, manuring, training and pruning and plant protection.

**216. GUPTA, CR. 1999 . Intercropping in cashew orchard under rainfed condition - a model for Bastar plateau zone of Madhya Pradesh. *The Cashew* 13(2): 18-22**

An intercropping system (cashew orchard with vegetables, pulses and oil seed under rainfed conditions) is under long term evaluation at Jagdalpur to determine the most suitable intercrop for obtaining maximum returns per unit area in the Bastar plateau zone. Cowpeas, bush-type-French beans, cluster beans, rice beans, urd beans, moong beans, soyabeans and groundnuts were grown in a 3 year old cashew orchard. Gross and net returns per ha. worked out for different models for the years 1993-94 and 94-95 showed that all the intercrops recorded higher net returns than the sole crop of cashew.

**217. GUPTA, SP and PRASANT, DS. 2004. Marketing and processing of cashewnut in Goa state: an economic analysis. *Agricultural Marketing*. 47(1): 20-29 (Department of Agricultural & Natural Resource Economics, College of Agriculture, Indira Gandhi Agricultural University, Raipur - 492 005 (CG), India.)**

Based on data collected from 45 cashew growers, 39 traders, and 8 processing units in Goa, India, this paper (i) examines the month-wise and category-wise sales and prices of cashew nuts in the state; (ii) identifies the marketing channels, their market share, and the price spreads; (iii) determines the marketing

costs incurred by producers; (iv) works out the costs, returns and profitability of processing; and (v) identifies the constraints in production and marketing. Policy implications are then drawn up to improve the production, marketing and processing of cashew nuts in Goa.

**218. HALDANKAR, PM, CHAVAN, VG and SAPKAL, BB. 2004. Strategies and constraints for cashew production in Maharashtra. *The Cashew* 18(2): 13-15**

Cashew is an important commercial crop of the Konkan region of Maharashtra, India. This paper describes the Konkan region and the status of cashew development in Maharashtra. The achievements of research on cashew nuts in Maharashtra are briefly discussed, focusing on varietal improvement through selection and hybridization, propagation techniques, and plant protection from tea mosquito, flower thrips, and stem and root borer. A list of constraints in cashew production is given, as well as future prospects and developmental strategies.

**219. HALDANKAR, PM., DESHPANDE, SB and PATIL, BP. 2004. Association of heterostyly with fruitset and nut size in cashewnut. *The Cashew* 18(3): 13-18 (Regional Fruit Research Station Vengurle - 416 516, Sindhudurg Dist-(M.S.), India.)**

An experiment was conducted in Maharashtra, India, during the 2001/02 cropping season, to study the extent of heterostyly and its association with fruit set and nut size in 29 cashew cultivars. The dimensions of heterostyly varied from cultivar to cultivar. The difference between style and filament length of hermaphrodite flowers had strong negative associations with fruit set. The

heterostyly parameters play negligible roles for nut size in cashew. The regression equations confirmed the significant roles of differences in style and filament length with fruit set. The effect was more pronounced in bold nut types compared to small and medium nut types.

**220. HALDANKAR, PM., DESHPANDE, SB., CHAVAN, VG and RAO, EVVB . 2003. Weather associated yield variability in cashewnut. *Journal of Agrometeorology*. 5(2): 73-76 (Regional Fruit Research Station, Vengurle - 416 516, India.)**

The effect of weather components on year to year yield variation in cashew cv. Vebgurla-1 during 1991-2001 was studied in Sindhudurg, Maharashtra, India. The maximum temperature, humidity and rainfall jointly proved to be the major determinants of yield whereas, the relative humidity alone showed significant positive association with yield. The relative humidity during pre-flowering period was the key factor in explaining the yield variation in this cultivar.

**221. HARRIES, HC., KUSOIWA, PM., MILLANZI, KJ. and MASAWA, PAL. 1997. A cashew breeding programme for Tanzania. *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp. 128-133**

At Naliendele ARI, a breeding programme to generate new cashew clones started in 1996 and is expected to continue for the foreseeable future. Crosses are planted annually and made using standard seed parents in a crossing garden where 102 selected clones are available. The pollen parents are individual trees, from both Tanzanian and overseas accessions, selected from the trails planted at Naliendele. The first round of crossing,

appraisal and selection will take up to 9 years to complete. Thereafter, new material should become available for release every year.

**222. HARRIS, CV., PANDIAN, IRS and THANGAVELU, S. 1994. Pre treatment of cashew seeds to improve germination. *South Indian Horticulture*. 42(2): 121-122. (TNAU, RRS, Vridhachalam, Tamil Nadu.)**

Cashew seeds when kept in moist gunnies for 7 days or treated with Sodium hydroxide 10 or Gibberelic acid 100ppm recorded significantly high rate of germination and seedling growth. It is likely that these treatments removed the waxy layer of the pericarp thereby facilitating germination and seedling growth.

**223. HEGDE, M., MOHANDAS, SS and KUMAR, DP. 2000. Studies on shoot tip cultures of cashew. *Recent Advances in Plantation Crops Research* 13: 41-44 (Proceedings of PLACROSYM - XIII, 1998.)**

Exudation of phenolic substances from shoot tip explants was least (0.604mg Catechol/ 100 g medium) on MS medium supplemented with 20% (v/v) coconut water. The best growth and multiple shoot induction from shoot tips of seedling plants was achieved on MS medium supplemented with coconut water and BAP two to 4 mg / litre whereas direct rooting of shoot tip explants (64.7%) from *in vitro* derived shoots was obtained on B5 medium with NAA 5mg/litre.

**224. HEGDE, M and KULASEKARAN, M. 1994. Studies of elimination of phenolic exudation and callus culture in cashewnut. *Proceedings of the XI Symposium on Plantation Crops*. P. 569-576. IISR, Calicut, Kerala.**

The whole process of preparation of different explants and culturing under low temperature conditions reduced the incidence of media browning in cashew. Further, exudation and blackening of explants and media were considerably reduced by adding activated charcoal (50mg/l) + ascorbic acid (150mg/l) + calcium pantothenate (200mg/l) into the culture media. Optimum callusing was obtained in different explants on Lin and Staba medium in the presence of 3-4mg/l 2,4-D. None of the calli obtained from different tissues responded in regeneration medium.

**225. HEGDE, MV. 1999. Evaluation of cashew nut cultivars under rainfed conditions of Northern Karnataka. *Annals of Biology* (Ludhiana) 15(2): 263-265**

An investigation was carried out during 1995-97 at the ARS, Kanabargi to study the growth pattern, fruiting behaviour and yield of eight introduced cashew nut cultivars. Genotypes under study varied significantly with respect to canopy spread, tree volume and leaf area per shoot. The highest fruit set percentage was recorded in Ullal 2 (11.62%) and the minimum percentage was obtained in Vengurla 3. Vengurla 4 exhibited the highest percentage (47.81%), while Vengurla 1 showed the lowest percentage of fruit retention.

**226. HEGDE, MV. and HEGDE, RV. 2000. Flowering behaviour and sex ratio in cashew cultivars under transitional tract of Karnataka. *The Cashew* 14(1): 35-38**

Studies were carried out on duration of flowering, number and percentage of staminate and perfect flowers and sex ratio of eight cashew cultivars during 1996-97 at ARS, Kanabargi. The study indicated that the duration

of flowering varied from 96.93 to 142.75 days among different cultivars. Vengurla - 3 produced highest number and percentage of perfect flowers and the same cultivar recorded the lowest percentage of staminate flowers. The sex ratio ranged between 0.73 and 0.07, Vengurla - 3 recorded the maximum (0.73) and minimum was observed in Ullal-2 (0.07).

**227. HIDEELAGE, V. 1999. Quality defects in manually processed cashew: incidents, origins and recommendations. *Tropical Agricultural Research* 11: 61-73**

A high incidence of quality defects was observed in cashew kernels at the point of export in Sri Lanka. Cashew processing is done in 2 phases: cottage based initial processing involving shelling and peeling, and a second phase of drying and grading at collection centres. As processing proceeds from initial to final stages, kernels with brown patches increased from 6 to 8%, scratched or scraped kernels from 7 to 12% and the colour changed from pale ivory to yellow with score of hedonic scale rising from 6 to 8. Rejects at export stage were 40% with the balance showing 3% brown patches, 4% scraped kernels and colour score of 6. Such cashews do not meet specifications of grade 1 cashew kernels.

**228. HOLANDANETO, JP de., FREITAS, BM and BUENO, DM. 2002. Low seed/nut productivity in cashew : effects of self-incompatibility and honey bee foraging behaviour. *Journal of Horticultural Science & Biotechnology* 77 (2): 226-231**

The roles of self-versus cross pollination and honey bee foraging behaviour in low nut yield of cashew were studied in NE, Brazil in 1997 and 1998. It was shown that both self and

cross pollination can set fruits in cashew, but most of the fruits originating from self pollination are shed 9-15 days after pollination. Honey bees display foraging behaviour in cashew orchards conducive to cross pollination but in plantations originating from clonal material they failed to increase fruit yield despite cashew's dependence on insect pollination. It is concluded that cashew has a mechanism of selective abortion through which it discards self-pollinated fruits and that honey bees can contribute to increased fruit yield only when cashew trees of genetically diverse origin are found in the same orchard.

**229.** HORE, JK and SEN, SK. 1999. **Extension of storage life of cashew nut seeds.** *Advances in Horticulture & Forestry* 6: 45-48

After sun-curing, cashew seeds were stored in polyethylene bags for 1 month and then treated with GA<sub>3</sub> (200 or 400ppm) thiourea (5000 or 10000ppm), K<sub>2</sub>HPO<sub>4</sub> (2500 or 5000ppm), maleic hydrazide (500 or 1000ppm), Ethrel (500 or 1000ppm), NaH<sub>2</sub>PO<sub>4</sub> 2H<sub>2</sub>O (500 or 1000ppm) in darkness for 24 h in June 1984. Treated seeds were dried back to the original weight and stored in polyethylene bags at room temperature. A further set of seeds was stored in a closed polyethylene bag at 10°C. The highest germination per centages in the first (1 month after treatment) and second sowing (6 month after treatment) were observed in seeds treated with K<sub>2</sub>HPO<sub>4</sub> at 5000ppm (94.5%) and those stored at 10°C (69.8%), respectively. Control seeds showed germination per centages of 68.2 and 32.7% after 1 and 6 months, respectively. NaH<sub>2</sub>PO<sub>4</sub> 2H<sub>2</sub>O (1000ppm) and GA<sub>3</sub> (400ppm) were also effective for retention of seed viability. Seedling fresh weight, height, root length and leaf number were highest with

GA<sub>3</sub> at 400, NaH<sub>2</sub>PO<sub>4</sub> 2H<sub>2</sub>O at 500 or 1000ppm, or K<sub>2</sub>H<sub>2</sub>O<sub>4</sub> at 5000ppm.

**230.** HUBALI, K. 2004. **Status of cashew in India in relation to North Eastern States.** In: *Horticulture for sustainable income and environmental protection*, Vol. II. 2006. Edited by VB. Singh., YY. Kikon and CS. Maiti. p. 591- 598.

Govt. of India has provided revolving fund assistance to establish Regional Nurseries of Cashew for the generation of planting materials in the States of Assam, Tripura, Meghalaya, Nagaland and Manipur during the Ninth Plan period which have become source of generating planting materials. Comprehensive package for the application of nutrition, pest management and other horticultural management practices are available. Therefore, there is a need for their transfer to the field by the way of development programmes, which is being done by the traditional States.

**231.** HUBBALLI, VN. 1999. **Whither the Indian cashew? Indian cashew production to cross half a million mark.** *The Cashew* 13(4): 2-5

A brief overview of cashew production in India is presented. The expected production in 2000 is 570,000 tonnes of raw nuts. India is expected to reduce the import of raw nuts for re-export, from 50% to 30% in the year 2000. The biggest obstacle to increasing production is the large area of old unproductive orchards. Some 34% of old orchards contributed only 14% of the total production. Poor management of state-owned orchards and their slow replacement with young orchards is also delaying the increase in home production.

232. HUONG, NL., NIEU, NH. and TAN,TTM. 1996. **Cardanol-phenol-formaldehyde resins: Thermal analysis and characterization.** *Angewandte Makromolekulare Chemie* 243: 77-85

Phenolic resins based on phenol and cardanol, a natural alkyl phenol from CNSL were synthesized, and their thermal and chemical resistances as well as their mechanical properties were determined. The results show that the addition of certain amounts of cardanol to phenol distinctly improves the chemical resistance and some mechanical properties such as tensile, flexural and Izod impact strengths of the resins. At the same time, the high thermal stability of pure phenol-formaldehyde resins still remains in the temperature range of high relevance.

✓233. INGLE, ST., MORE, MR and NARVANKAR, DS. 2005. **Management of irrigation to cashew plantation through drip irrigation.** *Drainage and irrigation water management*. 165-169 (College of Agril. Engineering and Technology, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth Dapoli - 415 712, Dist Ratnagiri (Maharashtra), India. )

A field experiment was conducted at the College of Agriculture Engineering and Technology, Dapoli, Maharashtra, India, to study effect of different depths of irrigation through drip irrigation on growth parameters of cashew. The experiment was laid in random block design with five treatments and four replications, viz., T1=80% of total water requirement, T2=90% of total water requirement, T3=100% of total water requirement, T4=110% of total water requirement, T5=control (by check basin

irrigation). Estimated value of EU [emission uniformity coefficient] was 89.49% for the entire system. The study revealed that plant height was superior in treatment T2 (40.77 cm) followed by other treatments T3 (38.72 cm), T4 (38.64 cm), T1 (38.07 cm), T5 (35.73 cm). The other growth parameters such as girth of plant, number of leaves, N-S spread of the plant, E-W spread of the plants showed superiority for the treatment T2 over the rest of the treatments.

234. JACOB, B. 1999. **Organic production of cashew.** *Cashew Bulletin* 37(5): 3-5 (Managing Director, SYNERGY SYSTEMS, GCDA Complex, Maraine Drive, Cochin-682 003.)

The Organic Industry is now growing at an impressive rate of 25% annually. It can offer solutions to the most pressing problems of agriculture in the world. Organic production of cashew offers immense potential. Countries in Asia and Africa would be able to derive considerable benefit by moving over to organic production of cashew in view of the growing global demand for organic products.

235. JACOB, TK., VEENAKUMARI, K and BHUMANNAVAR, BS. 2004. **Insect pests of cashew in the Andaman Islands.** *The Cashew* 18(4): 25-28 (Central Agricultural Research Institute, Port Blair, Andaman, India.)

Thirty-seven insects were recorded as pests of cashew in Sipighat, Andaman and Nicobar Islands, India, during a survey conducted from November 1987 to December 1992. Twenty-six are reported for the first time on cashew, and 13 were pests of other host plants in the area. *Aulonogria* sp., *Citripestis eutrapphera*, *Drymophoetus multicostatus*, *Egropa* sp., *Hyperaxis quadraticollis* and *Neculla* sp. were recorded as major pests.

236. JAYALEKSHMY, VG. and SALAM, MA. 2002. **Cost of establishment of a cashew apple processing unit and production cost of cashew apple syrup.** *The Cashew* 16(2): 29-33 (Cashew Research Station, KAU, Madakkathara, Kerala.).

Information required for establishing a cashew apple processing unit with a processing capacity of half a tone per day is presented in this paper. The infrastructure requirement of a cashew apple processing unit and the technology for the production of cashew apple syrup are presented. The economics of the production of cashew apple syrup are also discussed. The data presented in this paper is based on the experience gained in the pilot plant established at CRS, Madakkathara.

237. JAYALEKSHMY, VG and JOHN, PS. 2005 . **Pollination studies in cashew.** *The Cashew* 19(1): 20-27

The effects of pollen parent and parent compatibility on fruit set and retention were studied in Madakkathara, Kerala, India, during 2002-03. Hundred pollinations each in 15 selected female parents with 4 pollen parents with a total of 60 cross combinations revealed no incompatibility in any of the cross combinations attempted. Sulabha x Vengurla - 5 and Dhana x Anakkayam - 1 recorded 89 and 68% initial fruit set, respectively. Hand pollination resulted in an overall average of 20.9% initial fruit set against 4-6% in natural pollination under humid tropical conditions of Kerala. The cultivars were mutually compatible. Superior combining ability as either male or female parent was indicated in some cultivars.

238. JAYAPRAKASH NAIK, B., MURALEEDHARAN, P and LATHA, P. 1997.

**Growth and quality analysis of different genotypes of cashew in Northern Kerala.** *The Cashew* 11(4): 31-36

An experiment was conducted to study the growth performance and physio-chemical qualities of apple of 14 genotypes of cashew. The genotypes significantly differed for various biometrical characters. The hybrid H-1600 recorded the highest nut yield followed by MDK-1. The juice recovery of apple was maximum in the hybrid H 3-17, while the juice yield per tree was maximum in the hybrid H-1600. However, the apples of MDK-1 were found to be superior in quality for the preparation of juice products. The spread of branches, height and collar girth were found to be significantly correlated with nut yield. The superiority of the vegetative growth characters has not always resulted in high yield.

239. JISHA, KG., REKHIA RAVINDRAN and PADMA NAMBISAN . 1998. **Changes in protein, carbohydrate and lipid content of cashew kernels during storage under 2 humidity conditions** *Indian Cashew Journal* 25(2): 11-13

Cashew kernels were stored at 20 or 80% RH for up to 40 days, and changes in organoleptic characteristics, and protein, lipid, carbohydrate and oil contents were determined. Changes in protein, lipid, carbohydrate and oil contents were significantly affected by RH during storage, with all parameters measured decreasing faster during storage at the higher RH. Oxidation of fats was thought to contribute to the deterioration of kernels (induction of browning and rancidity).

240. JOIN, KC. 2002. **Cashew: cashing in on exports.** *Economic and Political Weekly* 37(32): 3324-3325



This paper presents an overview of cashew cultivation on India, as well as the country's exports of cashew kernels, and imports of raw cashews. India is the world's largest producer of cashews, but it does not produce sufficient quantities of raw cashews required for export and has to resort to imports. It is suggested that India has to fully utilize and expand its cashew production potential if it is to keep pace with growing global demand and stay ahead of the rapidly emerging competition in this commodity.

**241. JOSHI, MS . 2005 . Leaf blight of cashew incited by *Pestalotia heterocornis* Guba. *Indian Phytopathology*. 58(2): 252 (Department of Plant Pathology, Dr. B.S.Konkan Krishi Vidyapeeth, Dapoli 415 712, India. )**

Cashews were observed to exhibit minute irregular necrotic patches of brick red colour at the leaf margins which enlarged, turned grey-silver in colour and covered the major portion of the leaf lamina during the rainy season (August to September 2000) in Dapoli, Maharashtra, India. *Pestalotia heterocornis* was isolated in pure form on potato dextrose agar. Upon conducting pathogenicity tests, the fungus was reisolated from the inoculated leaves. The identity of the pathogen was confirmed from ITCC (No. 4948.01). This is thought to be the first report of *Pestalotia heterocornis* on cashew from India.

**242. JOY, M., JACOB, J and SMITHA, KP. 2002. Preliminary investigations on the antifungal properties of cashew. *PLACROSYM* - XV: 547-550**

A preliminary study was undertaken to assess the influence of cashew leaf, fruit and shell extracts on the growth of certain

polypathogenic fungi commonly found to infect crops in the homesteads of Kerala. The extracts at 5,15,25 and 50% (w/v) were tested on various polypathogenic fungi like *Phytophthora palmiovora*, *Alternaria solani*, *Fusarium oxysporum* etc. Cashew shell extract was found to have a tremendous effect in suppressing the growth of all the fungi especially *Phytophthora palmiovora* in which an inhibition to the extent of 70% was observed. The results highlight the immense possibility of using cashew shell extract as potential antifungal botanical which could form a vital component in eco-friendly and sustainable disease management practices.

**243. KABONGE, PMD., SHOO, J A E and KIKOKA, LP. 1997. The cashew nut industry in Tanzania- status report. *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp. 7-9**

The cashewnut is the chief cash crop of the Coastal belt of Tanzania except Tanga and Morogoro regions. It is grown in mixed stands with coconuts and a variety of food crops by mainly smallholders, estimated at 300,000 farmer families, on some 400,000 ha. with about 40 million trees. Large scale cashewnut plantations total to about 4000 ha. some of which have been abandoned. The cashewnut industry is hampered by poor processing facilities, narrow market channels, agro-ecological conditions, pests and diseases.

**244. KADAM, SG., NAWALE, RN and KHANDEKAR, RG. 1995. Effects of scion storage media and duration on success of *in-situ* softwood grafting in cashew. *The Cashew* 9(1): 21-25**

The studies regarding storage of scion budsticks in different media and for different

storage periods and their effects on success of *in-situ* softwood grafting in cashew with Vengurla-4 variety were carried out during the first fortnight of September 1990 under warm and humid climatic conditions of the Konkan region. Among 4 storage media and control treatments tried, polythene bag and moist sphagnum moss media recorded higher percentage of grafting success than the moist newspaper, wax coating and control treatments. The scion budsticks stored in polythene bag recorded 65 to 80 percent success followed by moist sphagnum moss treatment which recorded 65 to 75% grafting success for 1 to 7 days period of storage and these media were found to be suitable for storing the scion budsticks of cashew for longer periods.

245. KADAM, SG., NAWALE, R N and NADKARNI, HR. 1996. *In-situ* softwood grafting in cashew: effect of size and maturity of scion sticks, var. Vengurla-4. *The Cashew* 10(1): 18-21

The studies revealed that the *in-situ* softwood grafting is a successful method of clonal propagation in cashew and could be used for achieving large scale multiplication of high yielding plantations of improved cashew varieties. The percentage of graft success was maximum with the budsticks of 120 days age which was at par with the budsticks of 150 days age. The age of budsticks as well as size influenced the graft success significantly. Highest percentage of grafting success was obtained with the scion sticks of 12.5 cm length followed by scion sticks of 10.0 cm length. The growth of the successful *in-situ* grafts was also vigorous and encouraging.

246. KADAM, SG and NAWALE, RN. 1995 **Studies on *in-situ* softwood grafting in cashew.** *The Cashew* 9(2): 8-11

The studies revealed that the *in-situ* softwood grafting is a successful method of clonal propagation of cashew and could be used for achieving large scale multiplication of high yielding plantations of improved varieties in cashew growing regions. *In-situ* softwood grafting is an easy, rapid and simple method. The higher grafting success of 73.33 to 83.33 percent and also survival of the grafts were obtained between the period from 15th July to 15th September; the month of rainy season.

247. KADAM, SG., NAWALE, RN and NADKARNI, HR. 1996. **Effects of prior defoliation of budsticks and leaf retention on rootstocks of *in-situ* softwood graft.** *The Cashew* 10(4): 29-33 (Dept of Horticulture, KKV, Dapoli (M.S), India.)

The effect of complete defoliation of budsticks and partial defoliation of rootstocks on the successful grafting of 4 to 5 month old shoots of cashew cv. Vengurla 4 on Vengurla-1 rootstocks were investigated at Dapoli during 1990-91. Defoliation of budsticks promoted successful grafting; the best grafting success (61.25) was obtained from budsticks defoliated 8 days before grafting. Defoliation of rootstocks did not significantly influence percentage grafting success, but did promote scion growth particularly when 3 or 4 pairs of leaves were left on the rootstock.

248. KANNAN, S and SUSHEELA, T. 2002. **Increasing the storage life of cashew apple.** *Cashew Bulletin* 40(3): 3-6 (Home Science college, TNAU, Madurai, Tamil Nadu.).

Cashew apple variety VRI-2 was procured and treatments were given to the fruits with mustard oil, neem oil, bavistin, BHT, KMS+Sodium benzoate + Citric acid at 1%

level and compared with control. The treated samples were packed in polyethylene bag and were kept in low temperature (20°C) to observe the storage behaviour of cashew apple. Once in 2 days the samples were noted for PLW, TSS, acidity and ascorbic acid. Among the above treatments, mustard oil treated sample was found to be the best (12 days) than the other treatments.

**249.** KARANDE, MG., RAUT, SP and GAWANDE, AD . 2007. **Efficacy of fungicides, bio-organics and plant extracts against *Colletotrichum gloeosporioides* and *Fusarium oxysporum*.** *Annals of Plant Protection Sciences*. 15(1): 267-268 (Department of Plant Pathology, Dr. B.S.K.K.V., Dapoli - 415 712, India. ).

Experiments were conducted to identify the pathogen from dieback- and inflorescence blight pathogen-affected cashew trees and to screen fungicides, bio-organics and plant extracts against *Colletotrichum gloeosporioides* [*Glomerella cingulata*] and *Fusarium oxysporum*. The treatments comprised Bavistin [carbendazim], Copper oxychloride, Mancozeb, Tilt [propiconazole], Bordeaux mixture, Purna, Prabal, Reviver, Amogh, Gliricidia, Garlic, Sadafuli, Bougainvillea, Tulsi, Onion and Neem [*Azadirachta indica*]. Pathogenic symptoms appeared 10 days after inoculation. The branches and shoot showed white to pinkish growth of the fungus on the bark. Shoots started drying from the tip downwards. The symptoms of *Fusarium oxysporum* were minute water-soaked lesions, blighted spots enlarged in size and turned to black. Bavistin and Tilt inhibited 100% fungal growth of *Fusarium oxysporum*. The mycelial growth of *Colletotrichum gloeosporioides* was completely inhibited by Bavistin, Copper oxychloride and Tilt.

**250.** KASUGA, LJ., MARTIN, PJ., BOMA, F., TOPPER, CP. and WAAL, D.de. 1997. The concept of integrated cashew management (ICM) as a sustainable approach to increase the production. *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp. 71-73

ICM is a multidisciplinary approach that presents to cashew farmers a range of options geared to reduce the number of farmers obtaining very low cashew nut yields and to increase the average yields of cashewnuts/tree. Technologies and skills offered to farmers include better farmer knowledge about the Powdery Mildew disease, its epidemiology and range of control measures; the teaching of upgrading skills; wider distribution of improved planting materials. Results from ICM villages have shown a surprising readiness to "and adapt the various options".

**251.** KASUGA, L.J.F and MARTIN, PJ. 1997. **Comparison of the performance of seed and grafts of improved and local cashew trees under on-farm trials.** *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania.. pp. 53-63

The on-farm testing of some of the improved cashew materials selected and released by breeders from Naliendele started in 1992. The testing involved planting seed and grafts of improved and local materials in different agro-ecological zones in southern Tanzania. Preliminary farmer preference survey of the different cashew materials after the fifth year from establishment has indicated that most farmers are in favour of grafts of both improved and local material than local seed material.

**252.** KATINILA , N., KERVEN, C and GONGWE, A. 1997. **Cashew marketing in**

**relation to input utilisation in Southern Tanzania.** *Proceedings of the international cashew and coconut conference: trees for life - the key to development*, Dar es Salaam, Tanzania, 17-21 February. pp.200-205 (Cashew Research Project, Agricultural Research Institute Naliendele, P.O Box 509, Mtwara, Tanzania.)

Recently the Tanzanian economy has been subjected to various changes in all sectors including market liberalization which has affected both the input supply sector and the commodity marketing of the cashew nut industry in the Southern zone. The Farming Systems Research (FSR) unit in collaboration with the Cashew Improvement Programme organised and conducted a survey to investigate the relationship between buyers and sellers, input use, nature of buyers and sellers, types of preferred inputs and transaction details. Three hundred farmers from 16 villages were interviewed using a questionnaire during March 1995. The results indicated a number of variations in the prices between districts with Newala having the highest price. In many districts, higher prices were paid by buyers from outside the district, while the cooperatives gave the lowest price. Only in Tunduru were all the nuts sold of standard grade. Many buyers did not buy in cash and the delay in payment varied between districts and among buyers.

**253. KESHAVACHANDRAN, R., SIELJA, PB and JACOB, DAISY.** 2000. *In vitro* micrografting of cashew. *Recent Advances in Plantation Crops Research* 13: 52-54 (Proceedings of PLACROSYM - XIII, 1998.)

A successful micrografting technique was developed for cashew. High levels of graft union were obtained when shoots from stage II. Cultures were grafted on to three week old

*in vitro* raised rootstocks. The micrografts after a process of culture in liquid MS medium for a month and then hardening for two weeks could be successfully transplanted to soil.

**254. KESHAVACHANDRAN, R.** 1996. **Morphogenic potential of shoot buds in cashew.** *Proceedings of PLACROSYM -XII :* 34-39 (Kerala Agricultural University, Vellanikkara, Thrissur-680 654.).

Shoot tips, nodal segments and cotyledonary nodes from greenhouse grown seedlings showed varying levels of morphogenetic potential when cultured on media with cytokinins and auxins. Nodal segments and cotyledonary nodes formed multiple shoots in SH medium supplemented with BAP and NAA. Subculture in to media with decreased BAP level and increased sucrose induced elongation of the shoots. The shoots could be successfully rooted on solid medium supplemented with auxins.

**255. KIKOKA, L.** 1997. **Cashewnut processing in Tanzania: challenges and options.** *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp.211-216

The cashewnut industry in Tanzania provides livelihood to over 180,000 families and is the third foreign exchange earner from agricultural commodities. Estimated production now is about 100,000 tons. The installed processing capacity is 112,000 tons/year by 12 factories. This paper analyses the problems and proposes options to remedy the ailing industry. The options proposed include the adoption of alternative technology including small to medium scale processing; improvement of marketing structure and international co-operation in promotion of cashewnut consumption as a health diet.

256. KOBENAN, K., GNONHOURI, GP., KEHE, M and AKE, S. 1997. **Pests of fruit crops in Cote d'Ivoire.** In: *Quatrieme Conference Intl. Sur Les Ravageurs En Agriculture, Paris, France* (ANPP) PP.623-632. ISBN 2-905550-72-4. (DFA/IDEFOR 01 B.P.1740 Abidjan 01, Cote d'Ivoire.).

Parasitic fungi and nematodes attacking pineapple, banana, citrus, pawpaw, mango, cashew, avocado, guava, melon and strawberry in the environment of intercropping and intensive cultivation practised by fruit growers on Cote d'Ivoire are reviewed. Control measures are considered.

257. KONAN, NA., BACCHI, EM and LINCOPAN, N. 2007. Acute, subacute toxicity and genotoxic effect of a hydroethanolic extract of the cashew (*Anacardium occidentale L.*). *Journal of Ethnopharmacology*. 110 (1): 30-38 (Departamento de Farmacia, Universidade de Sao Paulo, C.P. 66083, Av. Prof. Lineu, Prestes 580, B-15 Sao Paulo 05508-900, SP, Brazil.)

*Anacardium occidentale L.* (Anacardiaceae), popularly known as cajueiro is a native plant to Brazil, and largely used in popular medicine to treat ulcers, hypertension and diarrhoea. In the present study, acute, 30-day subacute toxicity and genotoxicity assays were carried out. The crude extract did not produce toxic symptoms in rats in doses up to 2000 mg/kg. Based on biochemical analyses of renal and hepato-biliary functions, such as the level of urea, creatinine, transaminases and alkaline phosphatase, we determined that the extract is generally tolerated by rats. This was also confirmed by hematological and histopathological exams. Genotoxicity was accessed by the Ames test in *Salmonella typhimurium* strains TA97, TA98, TA100, TA102 and by the bone marrow micronucleus

test in mice. The extract was shown to induce frameshift, base pair substitution and damage to the chromosomes. However, this effect was less deleterious than the clastogenic effect of cyclophosphamide.

258. KUBO, I., KINST-HORI, I and YOKOKAWA, Y. 1994. **Tyrosinase inhibitors from *Anacardium occidentale* fruits.** *Journal of Natural Products*. 57 (4): 545-551 (Department of Environmental Science, Policy and Management, University of California, Berkeley, California 94720, USA.)

Anacardic acids, 2-methylcardols, and cardols, isolated from various parts of cashew fruits, were found to exhibit tyrosinase [monophenol monooxygenase] inhibitory activity. Kinetic studies with the two principal active compounds indicated that both of these phenolic compounds exhibited characteristic competitive inhibition of the oxidation of L-3,4-dihydroxyphenylalanine (L-DOPA) by mushroom tyrosinase.

259. KUBO, J., LEE-JAERAN and KUBO, I. 1999. **Anti-*Helicobacter pylori* agents from the cashew apple.** *Journal of Agricultural and Food Chemistry*. 47(2) 533-537 (Department of Environmental Science, Policy and Management, University of California, Berkeley, California 94720-3112, USA.)

Anacardic acids and (E)-2-hexenal characterized from *A. occidentale* fruits (from Brazil) exhibited antibacterial activity against the Gram-negative bacterium *Helicobacter pylori*, a causal organism of acute gastritis. The same antibacterial compounds inhibited the activity of urease.

260. KUMAR, DP. 1999. **Quality cashew grafts production under poly house.** *The Cashew* 13(1): 18-22

In an experiment in 1996-97, freshly harvested nuts of cashew cv. Ullal-1 were sown to produce rootstocks under field and polytunnel conditions at Ullal, Karnataka. Seed germination and the number of rootstocks suitable for grafting were higher under polytunnel conditions, a greater proportion of the graft were successful and more grafted plants were salable at 6 months after grafting. The cost of production per graft was almost halved when polytunnels were used for rootstock production.

**261.** KUMAR, DP and UDUPA, KS. 1996. **The association between nut yield and yield attributing characters in cashew.** *The Cashew* 10(1): 11-17

Among the 26 characters studied for their association with the nut yield per tree in cashew, the total number of nuts produced per tree was found to be most important character positively and highly significantly correlated with nut yield as compared to all the other yield attributing characters. 99.9 to 100 per cent variability in nut yield was found to be governed by the 26 characters studied during both the years. However, 99.7 to 99.9 per cent of the total variability in nut yield was found to be controlled by only important five characters viz. the number of reproductive shoots, number of bisexual flowers per panicle, fruit set, fruit retention and the total number of nuts produced per tree.

**262.** KUMAR, DP., KHAN, MM and VENKATARAMU, MN. 1995. **Effect of NPK and growth regulators on harvesting, nut yield, shelling percentage and kernel grade of cashew.** *Journal of Plantation Crops* 23(2): 96-104

The effects of applying NPK at 0+0+0, 250+ 125+ 125, 500+125+125 or 500+ 250+ 250g/plant annually and plant growth regulators (2,4-D at 5 or 10 ppm, NAA at 10 or 15 ppm. and Ethrel at 25 or 50 ppm) on harvesting, nut yield, shelling percentage and kernel grade in cashew clone Ullal 1. The duration of harvesting and total percentage of nuts harvested increased significantly and harvesting season became earlier as NPK rate increased. Similarly, nut yield and number of nuts per tree, shelling percentage and weight per kernel significantly increased as NPK rate increased. However, foliar application of growth regulators had no marked and consistent effect on many of the characteristics studied, except for number of nuts and nut yield per tree. The percentage of export grade kernels (210 and 240 counts) were increased by applying high NPK rates and growth regulators.

**263.** KUMAR, DP., KHAN, MM and MELANTA, KR. 1996. **Effect of nutrition and growth regulators on apple characters and yield in cashew.** *The Cashew* 10(2): 17-24

Application of different levels of nutrients and growth regulators did not have any significant positive influence on the weight of apple and the juice content. However, the total soluble solids of the juice and apple yield per tree increased significantly due to levels of nutrients and growth regulators. Among the levels of nutrients and growth regulators, application of 500:250: 250g NPK/plant / year and spraying with ethrel at 50ppm were found to be most effective. The effect of different levels of growth regulators were found to be more pronounced under increased levels of nutrients.

**264.** KUMAR, DP and HEGDE, M. 1997. **“Ullal-4” and “UN-50” promising cashew varieties for coastal Karnataka.** *The Cashew* 11(3): 8-12 (Agricultural Research Station, UAS, Ullal, D.K.Dist, Karnataka.).

Developing high yielding cashew varieties possessing export grade kernels is essential to retain India's supremacy in the present global trade. Among 111 indigenous clonal collections evaluated for their nut size at Ullal, genotypes 2/77 and 2/27 were found to be promising over all the other types. The important characteristics of these selections are bigger nut size (7.14 and 9.0g respectively), higher shelling percentage (30.85 and 32.75) and quality of kernels. The selections were released as Ullal-4 and UN-50 and recommended for cultivation in coastal Karnataka during 1994 and 1995 respectively.

**265.** KUMAR, DP., KHAN, MM and MELANTA, KR. 1994. **Effect of growth regulators on sex expression, fruit set, fruit retention and yield of cashew.** *Proceedings of the XI Symposium on Plantation Crops.* p. 610-627. (ARS, Ullal-574 179.)

The effects of levels of nutrients, growth regulators and their interactions on various characters in cashew were studied at Ullal, Karnataka during 1989-90 to 1991-92. Foliar applications of ethrel, NAA and 2,4-D significantly improved sex ratio, fruit set retention and yield during both years of study. Among the growth regulators, ethrel 50ppm, NAA 25ppm and 2, 4-D 5ppm were most effective. The influence of growth regulators was more pronounced on plants provided with higher levels of nutrients (500:250:250 and 500:125:125g NPK/plant) as compared to lower levels (250:125:125g NPK/plant).

**266.** KUMAR, DP., KHAN, MM. and SRIDHARA HERIE, P. 1997. **Effect of NPK nutrients of vegetative growth and floral characters of cashew.** *Cashew Bulletin* 34 (4): 3-9 (Agricultural Research Station, Ullal, Karnataka.).

Application of different levels of nutrients were found to significantly increase various vegetative growth characters, besides increasing the number of bisexual flowers per panicle and duration of mixed phase and flowering in a tree as compared to control. The sex ratio (male: bisexual flower) was found to be inversely proportional to the increased levels of nutrients, application of 500:125:125g NPK/plant/year seem to be the optimum from the economic point of view.

**267.** KUMAR, DP., HEGDE, M and GURUPRASAD, TR. 1998. **Fertigation for higher nut production in cashew (*Anacardium occidentale* L.)** *Cashew Bulletin* 35(4): 2-4 (Agricultural Research Station, UAS, Ullal -574 159, D.K., Karnataka.).

Fertigation studies in cashew taken up at ARS, Ullal indicated the superiority of fertigation treatments in increasing the nut yield /plant. Among the fertigation treatments, split application of water soluble NPK fertilizers at 100 and 80 level record maximum nut yield /plant during 2nd year of crop itself (3.72 and 3.82Kg respectively) followed by normal NPK fertilizers (3.09 and 3.03 Kg respectively as against nut yield of 2.44 and 1.77 Kg /plant in conventional method of application of fertilizers with and without drip system of irrigation respectively.

**268.** KUMAR, DP., HEGDE, M., KHAN, MM. and SHIVASHANKAR, K. 1996. **Fertigation for higher scion production in cashew.** *PLACROSYM - XII* : 160-162 (Agricultural Research Station, UAS, Ullal-574 159, Karnataka.).

The results have clearly indicated the superiority of different fertigation levels in increasing the scion production per plant

significantly over conventional method of application of fertilizers with or without drip system of irrigation. Among the fertigation treatments, water soluble NPK fertilizers recorded maximum number of scions per plant was registered in plants fertilized through soil application without drip system of irrigation. The percentage grafting success was higher in scions collected from the plants treated with different fertigation levels as compared to soil application.

**269.** KUMAR, DP., HEGDE, M., BAGYARAJ, DJ and MADHAVA RAO, AR. 1998. **Influence of biofertilizers on the growth of cashew root stocks.** *The Cashew* 12(4): 3-9 (Agricultural Research Station, (UAS), Ullal - 574 159, Karnataka.).

The effect of various biofertilizers (*Azospirillum*, *Azotobacter* and *VA-Mycorrhiza*) at different levels (each at 5, 10, 15 and 20g/poly bag) on the germination of nuts and growth of the cashew root stocks was studied for 3 seasons. Different biofertilizer treatments significantly improved the percentage of nuts over untreated nuts, during all the 3 seasons studied. The growth characters such as seedling height and stem girth varied significantly due to different biofertilizer treatments during 2nd and 3rd season of study. The incidence of fungal diseases in the nursery was also significantly less.

**270.** KUMAR, DP and HEGDE, M. 1998. **Influence of NPK and growth substances on nut size in cashew.** *Cashew Bulletin* 35(8): 3-7 (Associate Professor, Agricultural Research Station, Ullal - 574 159, Karnataka).

Studies on the influence of nutrition and growth substances on nut size in cashew were carried out at ARS, Ullal. The results have indicated that, application of different levels of

NPK nutrients significantly increased the nut weight, length, breadth and thickness of nuts over control. Whereas, foliar applications of different growth substances had no significant influence on the nut weight, length and breadth of nuts over control. The nut characters seem to be governed by the genetical character of a variety.

**271.** KUMAR, DP and HEGDE, M. 1998. **Technologies for cashew cultivation in different agro climatic tracts of Karnataka.** *The Cashew* 12(3): 75-88 (Agricultural Research Station, (UAS), Ullal - 574 159, Karnataka.).

The different agroclimatic regions in which cashew can be grown in Karnataka are: 1. Coastal Region, 2. Southern Dry Region, 3. Hilly Region and 4. Transitional Region. In this paper the author listed the soil types, nutritive requirements, the recommended varieties, soil and water conservation measures and pest management to be followed in all the four regions.

**272.** KUMAR, DP. and HEGDE, M. 1997. **Ullal-4- a promising cashew variety for Karnataka.** *Cashew Bulletin* 34(2): 15-18 (Agricultural Research Station, Ullal-574 159, Karnataka.)

Among the 111 indigenous clonal collections evaluated for nut size at ARS, Ullal, the genotype 2/77 was found to be promising over all the other types including the released varieties of the Research Station. The important characteristics of the selection are early flowering, short harvest period, bigger sized nuts (7.14g), higher shelling percentage (30.85) and quality of kernels (210 counts) with an average nut yield of 9.55 kg/tree. Considering



its promising characters, this selection was released as Ullal-4 and recommended for cultivation in Karnataka.

**273. KUMAR, TNJ . 2005. Leaf nutrient status-yield interaction in different cashew varieties. *The Cashew*. 19(1): 28-32 (University Live Stock Farm Kerala Agricultural University, Mannathy - 680 651, India.)**

This study was conducted during 1997 and 1998, in Madakkathara, Kerala, India, on graft raised progeny of 18 cashew cultivars planted during 1987 at a spacing of 7.5x7.5 m. The trees were maintained with uniform dose of fertilizers, plant protection measures and other recommended practices. Leaf samples were collected at pre-flushing (bud breaking) during October-November and at pre-flowering stage (at the onset of panicle emergence) during November-December, and analysed for nutrient concentration. Observations on growth and yield characters were also recorded. Nut yield and leaf nutrient concentrations were recorded during the 10th and 11th year after planting and averaged for the 2 years. Of the 18 cultivars, only 3 were really poor yielders, i.e. V-2, VTL-59/2 and H-1610. In contrast, M-44/3, II-1598 and H-1608 were fairly high stable yielders. The high yields observed in these cultivars were associated with the higher absorption and utilization of N, P and K and their ability to counteract the adverse effects of Fe, Mn and Cu.

**274. LAKSHMIPATHY, R. 2000. Symbiotic response of cashew root stocks to different VAM fungi. *The Cashew* 14(3): 20-24**

Nine different VAM fungi viz. *Acaulospora laevis*, *Gigaspora margarita*, *Glomus caledinium*, *G.leptotichum*, *G.fasciculatum*,

*G.intraradices*, *G. acrocarpum*, *G.mosseae* and *Scutellospora calospora* were screened for their ability to enhance the growth and P uptake in cashew root stock under glass house condition. Among the fungi studied *A.laevis* and *G.mosseae* significantly increased plant height, stem girth and total biomass of cashew root stock as compared to uninoculated plants. Similarly, the percent root colonization and P uptake were also significantly higher in *A.laevis* and *G. mosseae* inoculated plants as compared to uninoculated plants. These results suggest, that the above 2 VAM are better symbionts for inoculating cashew.

**275. LAKSHMIRAJU, D., THIMMARAJU, KR and MURTHY, N. 1998. Pollination biology in cashew (*Anacardium occidentale* L.) *The Cashew* 12(2): 10-14 (Division of Horticulture, G.K.V.K., UAS, Bangalore-560 089).**

Inadequate pollination, poor fruit set and high rate of fruit drop are problems in cashew. The present study was undertaken to identify the role of pollinators in fruit set, to compare the rate of fruit set under open, self and cross pollination and to test for the presence of self incompatibility. The study revealed that limited insect activity and self incompatibility of the flowers are the major causes for poor fruit set in cashew.

**276. LATHA, A., JOHN, PS and GEORGE, M. 1994. Productivity of cashew as influenced by chlorophyll and leaf nitrogen content. *Journal of Tropical Agriculture* 32(1): 86-88**

In a long-term fertilizer trial on cashew at Vellanikkara, cv. BLA-39/4 was given N at 0, 250, 500 or 1000g/tree, P at 0, 125, 250 or

500g/tree and K at 0, 250, 500 or 1000g/tree annually. The chlorophyll composition, leaf N and yield/tree were determined. Significant increases in chlorophyll b, total chlorophyll, leaf N and yield/ tree were obtained with each of the 3 nutrients. Significant increases in chlorophyll b were obtained with each increase in N rate; total chlorophyll and yield/tree also increased with increasing N rate, but the increases were not significant for every increment. Increasing rates of P and K did not significantly increase any of the measured parameters.

277. LATHA, A and SALAM, MA. 2003. **Response of cashew seedlings to soil moisture regims.** *The Cashew* 17(3): 17-20

An experiment was conducted at CRS, Madakkathara to study the response of cashew seedlings in different levels of soil moisture regims. The cashew seedlings of six month old were subjected to six soil moisture regims (irrigation at 20% depletion of available water (DAW), 40% DAW, 60% DAW, 80% DAW, 90% DAW and life saving irrigation). Observations on morphological and physiological characters of cashews were recorded. It was noticed, that there was a gradual decline in morphological characters with increase in soil moisture stress. However, root shoot ratio was unaffected up to 90% DAW indicating the capacity of roots to withstand soil moisture stress. There was no significant variation in RWC at moderate stress. The result indicate that cashew can tolerate mild to moderate levels of moisture stress without affecting the growth in seedlings.

278. LATHA, A and SALAM, MA. 2001. **Cashew varieties tolerant to K-deficient soils.** *Journal of Plantation Crops* 29(1): 16-21

A green house experiment was conducted at KAU, CRS, Madakkathara to identify cashew varieties tolerant to K- deficient soils. The growth characters, content and uptake of nutrients, response of ten varieties to K and K use efficiency were recorded. Ten varieties evolved by KAU, TNAU and KKV were screened for their tolerance to K- deficient soils. The results indicated that the varieties II-1591, M 26-2 and H-1598 were suitable for K-deficient soils. The K-use efficiency of cashew was 12.37%.

279. LATHA, A. 2000. **Cashew varieties tolerant to N deficient soils.** *The Cashew* 14(2): 29-39

A green house experiment was conducted at KAU, CRS Madakkathara to identify cashew varieties tolerant to N deficient soils. Ten varieties evolved by KAU, TNAU and KKV were screened for their tolerance to N deficient soils. The growth characters, content and uptake of nutrients, response to applied N and N use efficiency were estimated. The results indicated that the varieties H-1591 and M-26/2 are tolerant to N deficient soils. The N use efficiency of cashew was 24.7%.

280. LATHA, A and SALAM, MA. 2001. **Effect of N at different levels of drip irrigation in cashew.** *The Cashew* 15(3): 18-26 (Kerala Agricultural University, Vellanikkara, Thrissur.)

A field experiment was conducted at KAU, CRS, Madakkathara to study the differential response of graft raised cashew to applied N at different levels of drip irrigation. The treatment involved 3 levels of drip irrigation (0.40 and 80 litres of water/tree/day and three levels of N (0.750 and 1500 g/tree/

year) in a 3 year old cashew plantation for a period of 2 years. In rainfed trees, application of N 1500g/tree/year resulted in an yield of 0.77 kg/tree while trees applied with no N gave no yield. In irrigated trees 40 litres/tree/day, N application 1500g/tree/year resulted in an yield increase of 54% compared to rainfed trees. But when the irrigation level was increased to 80 lit.yield increase was 124%.

**281. LATHA, A and SALAM, MA. 2001. Screening of cashew varieties for drought tolerance. *Journal of Plantation Crops* 29(2): 27-30**

An experiment was conducted at CRS, Madakkathara to identify drought tolerant cashew varieties on physiological basis. Seedlings of 21 cashew varieties were screened to assess their ability to tolerance test, 4 varieties H-1591, M-26/2, M-44/3 and V-5 showed high net photosynthesis, high leaf water potential, more leaf area, high total chlorophyll content, high chlorophyll stability index and low relative injury, which are characters to tolerate drought and the 2 varieties (K-22- 1 and H-3-13) showed opposite character. The study suggest that the characters such as high net photosynthesis, high leaf water potential, more leaf area, high total chlorophyll content forms the physiological basis of drought tolerance.

**282. LATHA, A. and SALAM, MA. 2001. Varietal variation in fertiliser response in cashew seedlings. *The Cashew* 15(2): 36-40**

An experiment was conducted at CRS, Madakkathara to study the varietal variation in the response of fertiliser and nutrient absorption pattern of cashew seedlings in 10 varieties. Cashew varieties H-1591 and M-26/2 showed high response to applied N and K (1.2 to 2.0g

dry matter per mg of N and above 0.67g per mg of K respectively).The N,P and K use efficiencies of cashew seedlings were 24.7, 8.02 and 12.17 per cent respectively.

**283. LATHA, A., JOHN, PS. and MERCY GEORGE. 1996. Effect of fertiliser management on the quality of nuts in cashew. *The Cashew* 10(4): 26-28 (College of Horticulture, Vellanikkara, Kerala.).**

The quality of nuts produced by cashews in a long term fertilizer trial was assessed. Trees received annual applications of N (250,500 or 1000g/tree), P(125,250 or 500g P<sub>2</sub>O<sub>5</sub>/tree) and K(250,500 or 1000gK<sub>2</sub>O/tree). N, P and K application increased the protein content of nuts compared with untreated controls.Increasing rates of N increased the protein content of nuts,increasing rates of P and K had no significant effect on protein content of nuts.

**284. LATHA, A., JOHN, PS and MERCY GEORGE. 1996. Effect of NPK fertilisation on the growth of cashew. *The Cashew* 10(3): 8-10 (College of Horticulture, Vellanikkara, Thrissur,Kerala.).**

The effects of N (250,500 or 1000g/tree), P (250 or 500g/tree and K (250,500 or 1000g/tree) on the growth of cashews (cv.BLA-39/4) in a long term fertilizer trial established in 1979 were investigated at Vellanikkara. Fertilizer application significantly affected height, number of flushes/m<sup>2</sup> and chlorophyll b content of leaves. The chlorophyll content of leaves was unaffected by N, P and K application.

**285. LAURENS, A., FOURNEAU, C and IIOCQUEMILLER, R. 1997. Antivectorial activities of cashew nut shell extracts from *Anacardium occidentale* L. *Phytotherapy***

*Research*. 11: (2): 145-146 (Laboratoire de Pharmacognosie, URA 1843 CNRS, Faculté de Pharmacie, 92296 Chatenay-Malabry, France.)

Sodium salts of cashew nut shell extracts and anacardic acids isolated from *A. occidentale* (collected from Senegal in 1993) demonstrated potent activity against *Aedes aegypti* larvae and *Biomphalaria glabrata* snails. Structure-activity relationships are discussed with particular reference to the importance of double bonds on the side chains of anacardic acids.

286. LAUTIE, E., DORNIER, M and SOUZA, FM de. 2001. **The cashew tree and its products: main characteristics and possible uses.** *Fruits* 56(4): 235-248

This work is a summary of the economic interests and the different uses of the cashew tree, a widespread tree indigenous to Brazil. The tree is a species resistant especially to dry periods, making it well-adapted to many tropical areas. In spite of its tolerance to parasitic attack, it can be susceptible to several insects and some fungi attacks. The average yields obtained for nuts are approximately 600kg ha<sup>-1</sup> year<sup>-1</sup>. The cashew nut has a high lipid content, and approximately 20% proteins. It is suggested that the cashew apple requires better development in many places, because it is presently an underutilized by product of the cashew nut with a strong potential.

287. LEKBERG, Y. 1996. **Cashew in Guinea-Bissau.** The small producer's perspective. A minor field study. *Working Paper Intl. Rural Devp. Centre, Swedish University Of Agril Sciences*, NO.316, 35pp. (Swedish Uty of Agril Sciences, Intl. Rural Devp. Centre, Box 7005, S-75007Uppsala, Sweden.)

A survey was carried out of the importance of cashews for small producers in Guinea-Bissau, where production increased at

an average yearly rate of 20 from 1984- 94. Currently Guinea-Bissau accounts for 6 of world cashew production. The main reason for planting cashews was to obtain rice. Many farmers run out of rice at the same time as the cashew harvest begins and therefore the cashew crops increases food security. Information on intercropping, planting risks, processing possibilities and training is included.

288. LENKA, PC and MOHAPATRA, KC. 2006. **Agro-ecological regions of north eastern India and varieties of cashew & its management.** *The Cashew* 20(3): 30-35

The North Eastern region lies in the agro-eco region No. 16 and 18. The optimum temperature is 15 to 35°C. It is very sensitive to frost. The mean annual temperature should not be higher than 20°C. Cashew is grown in areas receiving annual rainfall of 500 to 4000 mm. Cashew is very much resistant to drought because its roots penetrate deep in to the soil. Light rain during flowering is helpful but heavy rain reduces yield. So the climatic condition is suitable for cashew in North Eastern region.

289. LENKA, PC. 1999. **Genetic divergence in cashewnut.** *Journal of Plantation Crops* 27(3): 193-195

Genetic divergence was assessed in 13 cultivars of cashewnut evaluated for vegetative, flowering and fruit characters at Ranasinghpur during 1992. Varieties were grouped in to five clusters using Mahalanobis' D<sub>2</sub> statistic and Tocher's method. Apple and nut weight contributed for more than 36 and 17%, respectively, in genetic divergence.

290. LENKA, PC. 1999. **Hybrid 2/16 (BPP-8)-a promising cashew variety for Orissa.** *The Cashew* 13(1): 42

Released in 1993, this new variety showed nut yields on 23 kg per single tree with mean yields of 8.7 kg in Bhubaneswar. It has bold nuts (8.2g) with a shelling percentage of 28%. BPP-8 has an upright compact habit with intensive branching and 9 year old plants reach 4.95m. Panicle shape is pyramidal and there are 6.2 nuts per panicle. It is an early variety with a flowering duration of 60-70 days from second week of December to third week of February. The apple is yellow when ripened and nuts are ready for harvest during March-April.

**291. LENKA, PC. 1999. Studies on floral characters and sex ratio in various cashew types. *The Cashew* 13(1): 23-30**

In studies of 13 cashew clones at Bhubaneswar in 1995-96, flowering continued up to week 14 in 2 clones (BPP 30/1 and H-303). Staminate flower production peaked in weeks 3- 6 and perfect flower production in weeks 5-6. The sex ratio was high in the first 3 weeks of flowering and then declined after week 6.

**292. LENKA, PC., MOHAPATRA , KC., DASH, S and MISHRA, NK . 2001. Genetic variability and character association in cashew. *Horticultural Journal*. 14 ( 2): 105-110 (All India Co-ordinated Cashewnut Improvement Project, Department of Horticulture, Orissa University of Agriculture & Technology, Bhubaneswar - 751 003, Orissa, India.)**

The nature and magnitude of genetic variability and their inter-relationship was studied for nut yield and its ten component traits in 13 types of cashew. High estimates of genotypic coefficients of variation, heritability and genetic advance were observed for nut yield

per plant, number of staminate flowers/panicle- and number of perfect flowers/panicle and number of nuts/panicle indicating their reliability for effecting selections for high nut yield. Number of flower per panicles, nut weight and number of nuts per panicle were the best contributors to nut yield and further number of staminate flowers and perfect flowers showed high positive association with nut yield both at genotypic and phenotypic levels. Hence, the study revealed the importance of number of staminate and perfect flowers, number of nuts per panicle, nut weight and nut yield per plant as selection criteria for improvement of nut yield in the cashew types.

**293. LENKA, PC., MOHAPATRA, KC., MISHRA, NK and DASH, S. 1998. Studies on apple characterisation of cashew types and their physico-chemical characters. *Orissa Journal of Horticulture* 26(1): 20-24 (Cashew Research Station, Dept of Horticulture, OUAT, Bhubaneswar-751 003, Orissa.)**

Thirteen cashew genotypes were evaluated for fruit traits at Bhubaneswar during 1996-1997. The highest apple weight was recorded in H-367 (76.8g) and the lowest in M44/3 (32.55g). Maximum apple length was recorded in NRCC-1 (6.85cm) followed by H-367 (6.65cm). Apple width ranged from 3.40 to 4.55cm. Content of total soluble solids was highest in H-303(14.35%) followed by M 15/4(14.05%). Titratable acid content ranged from 0.34 in H-68 to 0.50 in BPP3/13 and H-367. Apple and nut ratio was lowest in M44/3 (5.3) and highest in BPP 10/19 (7.9) and H-367 (7.7).

**294. LENKA, PC., MAHARANA, T and MISHRA, NK. 1997. Studies on performance of different cashew types under agroclimatic conditions of Orissa, India. *Proceedings of***

*International Cashew and Coconut Conference, Dar Es Salaam, Tanzania. (Dept of Horticulture, OUAT, Bhubaneswar, Orissa, India.).*

Studies on floral and yield attributing characters of 16 cashew types were carried out in RBD with 2 replications. Number of flowering panicles / sq.mt. was highest in H-1608 and lowest in T-129. The flowering duration varied from 53.26 days to 90.0 days. The variation in sex ratio ranged from 0.093 to 1.038. The yield of nuts varied significantly and maximum (15.675 kg/plant) yield was obtained in cashew type H2/16, followed by H-1608 (8.700). The cashew type H2/16 was found to be promising yielder with an average nut weight of 7.5g, sex ratio of 0.130 and number of nut 6.2 per panicle.

**295.** LENKA, PC. 1998. **Technologies and strategies to enhance cashewnut production in Orissa.** *The Cashew* 12(3): 109-114 (AICRP (Cashew), OUAT, Bhubaneswar - 751 003, Orissa.)

Considering the prevailing soil, climate, topography and the cropping patterns, the state of Orissa has been divided in to 10 agroclimatic zones. Vegetatively propagated high yielding varieties coupled with suitable package of practices can enhance the productivity of cashew. If the farmers are aware of management of young grafted cashew plants, nutrient management, soil water conservation practices and plant protection measures the scope for enhancing the production of cashewnut in Orissa will be more.

**296.** LIMA, AC., GARCIA, NHP and LIMA, JR. 2004. **Obtention and characterization of the main cashew products.** *Boletim Do Centro De Pesquisa e Processamento De Alimentos* 22(1): 133-144

Cashew nuts and peduncles from the clone CCP 76 were processed and subjected to physical and chemical analysis. By pressing the cashew nut it was observed that a partially defatted meal (36.41% protein, 26.57% lipid and 7.86% total dietary fibre) and the oil (82.74% of unsaturated fatty acids, predominantly oleic acid - 60.30% and linoleic - 21.53%). From cashew fruit it was obtained a clarified and concentrated juice. It was concluded that the products originated from cashew showed high potential for the elaboration of different food products by virtue of the diversity and richness of the cashew nut and fruit chemical composition.

**297.** LIMA, AC., SANTOS, RA and ALMEIDA, FAG. 2000. **Methodological evaluation for an improved extraction of cashew tree (*Anacardium occidentale*, L.) gum.** *Revista-Brasileira-de-Fruticultura*. 22 (3): 391-396

In a trial carried out in Pacajus, Ceara State, Brazil, different stem wounding techniques with or without treatment with 5% dimethyl sulfoxide (DMSO), were compared for gum extraction from cashew trees (all trees were also treated with 20% ethephon). The best method was superficial stem stripping plus puncturing on both sides of the stem combined with DMSO treatment, which yielded an average of 1.966 g gum/plant.

**298.** LIMA, AC and PASTORE, GM. 2000. **Study of the antibacterial activity of anacardic acids from oil of cashew nut shells (CNSL) of the clones of cashew-midget-precocce CCP-76 and CCP-09 in five stages of maturation on oral microorganisms.** *Ciencia-e-Tecnologia-de-Alimentos*. 20 (3): 358-362 (Laboratorio de Tecnologia de Alimentos-DSER-CCA-UFPB, Brazil. )

The antimicrobial activity of cashew (*Anacardium occidentale*) shell oil was studied with the oral microorganisms *Streptococcus mutans* ATCC 25175, *Staphylococcus aureus* 12598, *Candida albicans* ATCC 10231 and *Candida utilis*. Anacardic acids from the ethyl extract of shell oil were active against these bacteria, with the greatest activity against *Streptococcus mutans*.

299. LIMA, JR and BORGES, M de F. 2004. **Cashew nut kernel storage: influence of packaging and salting.** *Revista Ciencia Agronomica* 35(1): 104-109

The effect of packaging and salting on cashew nut kernel stability during storage was investigated. The treatments were: packaging in flexible plastic bags laminated with aluminium foil, polypropylene (PP) vessels and low density polyethylene bags (LDPE); and application or no application of salt. Kernel were stored at room temperature (28°C) and evaluated every 50 days, for 250 days. Peroxide and acid values were evaluated on the lipid fraction, while water activity, sensory acceptance and microbiological quality were evaluated on the kernels. Peroxide showed high values at 150 days. Microorganism count was lower than 10<sup>5</sup> for all treatments. *Salmonella* Sp., 45°C coliforms and *Staphylococcus aureus* were not detected. Sensory changes were observed under PP vessel packaging at 100 days and under LDPE packaging at 200 days. Kernels packed in plastic/ aluminium foil laminate did not show sensory changes up to 250 days of storage, indicating higher stability. Salting did not affect the kernel quality during storage.

300. LIMA, JR. and CAMPOS, SONIA DS. 2000. **Relationship between water activity and texture of roasted and salted cashew kernel.** *Journal of Food Science & Technology* 37(5): 512-513

Textural tests were carried out in roasted and salted cashew kernel to determine the relationship between water activity and texture. Moisture absorption isotherm was obtained. Textural tests suggested that as water activity increased, more energy was absorbed during tests, until a maximum point. From this maximum point to higher water activities, the energy decreased.

301. LIMA, R de LS de and OLIVEIRA, VH de. 2003. **Accumulation of N,K,Ca,Mg and S in dry material of aerial parts of dwarf cashew seedlings influenced by increasing levels of organic matter.** *Revista Brasileira De Fruticultura* 25(1): 148-151

The effects of increasing amounts of organic matter on macro-nutrient uptake by seedlings of dwarf cashew clone CCP-76 were evaluated in Brazil during April-June 1995. Medium texture acid red-yellow soil was collected from the top layer (0-30cm) in Ceara. The following treatments were used : 0, 100, 200, 300 and 400 cm<sup>3</sup> coprolite/2.5kg soil with 4 evaluation periods (15,30,45 and 65 days after germination). Increasing organic matter had a positive linear effect on sodium and potassium, reaching a maximum value with 400 cm<sup>3</sup> coprolite/2.5kg soil. A negative linear effect on these nutrients was observed for the evaluation periods. Ca, Mg and S remained stable between evaluation periods.

302. LIMA, R De LS de., FERNANDES, VLB and OLIVEIRA, VH de. 2001. **Growth of seedling dwarf-precocious cashew influenced by organic and mineral fertilizations.** *Revista Brasileira De Fruticultura* 23 (2): 391-395

The effects of organic and mineral fertilizers on the vegetative growth of cashew

(cv. CCP 76) seedlings grown from April to June 1995 were studied in Ceara, Brazil. The soil in the study area was acid red-yellow podzolic with medium texture, from which soil samples were collected at a soil depth of 0-30 cm. Treatments consisted of 4 levels of organic matter (0, 100, 200 and 300 cm<sup>3</sup> coprolite/ 2.5kg of soil) and 4 levels of mineral mixture (0, 1.92, 3.34 and 6.18kg/ 2.5kg of soil) containing urea, triple superphosphate, KCl, gypsum, lime and fruits of the MIB-3 type. Measurements were obtained 75 days after plant germination. The addition of mineral nutrients and organic fertilizers on cashew seedlings significantly affected the height, dry matter weight of aerial parts and the number of leaves.

**303.** LINGAIAH, HB., KRISHNAPPA, KS and GOWDA, TNV. 1997. **Chintamani - 1, a promising cashew variety for maidan parts of Karnataka.** *The Cashew* 11(1): 33-35

An attempt was made to collect different cashew types from cashew research stations and planted in ARS, Chintamani, to evaluate them under 'maidan' parts of Karnataka. Of the 72 accessions subjected for evaluation, only 7 were found to be promising for nut yield and these 7 accessions were raised by using air layers. The data on yield, nut weight and shelling percentage were recorded and was considered for the selection of the variety Chintamani - 1 (ARSC 5/10) for cultivation under 'maidan' parts of Karnataka.

**304.** LINGAIAH, HB. 2000. **Influence of growing conditions on the production of root stocks and grafting success in cashew.** *The Cashew* 14 (3): 9-13

The influence of growing conditions on growth of root stocks and graft success in cashew was carried out during 1997 at ARS

Chintamani. The studies showed that the growing condition had definite positive influence on germination of seeds, recovery of graftable stocks and grafts. Among the structures tried, the low cost Poly-cum- shade net Tunnel was found to be the best as it recorded highest recovery of graftable root stocks (95.02%) and grafts (90.87%) besides reducing the period of growth.

**305.** LINGAIAH, HB., REDDY, S and KULKARNI, RNS. 1996. **Genetic divergence in cashew genotypes.** PLACROSYM - XII. pp. 28-33 (University of Agricultural Sciences, Bangalore.)

A study was carried out at the ARS, Chintamani during 1994 -95 using 25 entries of 8 year old trees to estimate the genetic divergence. In canonical variate analysis, canopy spread, plant height, stem girth, panicle length, nuts/panicle, total number of shoots per m<sup>2</sup>, flowering shoots per m<sup>2</sup> and percent flowering shoots per m<sup>2</sup> contributed more towards genetic divergence. The entries were grouped in to 4 clusters using Dendrogram technique. Among the genotypes, Vengurla-3 and M44/3, Vengurla-5 and Hyb.2/16 were most divergent between themselves whereas Vengurla-1 and Bapatla-3 showed the least dissimilarity.

**306.** LOPEZ, AMQ and LUCAS, JA . 2002. **Effects of plant defence activators on anthracnose disease of cashew.** *European Journal of Plant Pathology* 108(5): 409-420

The plant defence activators acibenzolar-S- methyl, (Benzo (1,2,3)thiadiazole-7-carbothioic acid - S- methylester, ASM), 2,6-dichloro-isonicotinic acid (DCINA), salicylic acid (SA), and dibasic potassium phosphate were tested for their ability to protect cashew seeds



and leaves from anthracnose disease caused by *Colletotrichum gloeosporioides*. No inhibition of the early stages of pathogen development was caused by concentrations equal to or lower than 1.1 mM a.i. ASM, 1.2 mM a.i. DCINA, 5mM SA and 50 mM K<sub>2</sub>HPO<sub>4</sub>. In field experiment conducted in Ceara, Brazil during late July and August 1997, plant protection was conferred by a soil drench of concentrations as low as 12.6mM a.i. ASM and DCINA and 2.6mM SA. These concentrations were not phytotoxic suggesting that plant defence activators have potential for control of anthracnose disease in the field.

**307. LU PING. 1997. A direct method of estimating the average sap flux density using a modified Granier measuring system. Australian Journal of Plant Physiology 24(5): 701-705 (CSIRO-TERC, Division of Horticulture, PMB 44, Winnellie, NT 0821, Australia.).**

The Granier sap flow measuring system that normally uses one analogue input channel of a data logger for each sensor was modified to enable one channel to measure the average value of signals from 2 or more sensors. The sap flux density (of mangos and cashews) calculated from this average value of signals was very close (difference <6) to the arithmetic mean of the sap flux densities measured separately by means of individual sensors. By using the modified Granier system, the error in sap flow measurement with limited sampling can be reduced without the need for extra data loggers.

**308. LYANNAZ, JP. 2006. Towards a revival of cashew crops in Mozambique. Fruits 61(2): 125-133**

In Mozambique, the cashew tree is found all along the coast, but it is especially localized

in the provinces of the North. Recently, the 'Project of revival of cashew crops' was launched. It aimed at the improvement of the cashew nut productivity and the production of quality nuts through operating systems ready to preserve the fertility of the soils. In this context, accompanying research were focused on the disease and pest control of cashew nuts and on the selection of the best vegetable material. The result obtained for *Oidium* control with organic fungicides and for the possibility of an alternation of products are presented. In the same way, the use of organic fungicides for anthracnose control is approached. Obtaining new varieties was approached by a behaviour control test, the selection of common local types and by hybridizations.

**309. MADDISON, A., SHOMARI, S., SIJAONA, M and TOPPER, CP. 1997. Disease dynamics in the cashew powdery mildew pathosystem in Tanzania: a review. Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania. pp. 266-269**

This paper aims to bring together relevant parts of studies to provide an overview of PMD dynamics and how they relate to disease management. To analyse disease dynamics, it is necessary to have quantitative information on the development of both pathogen and host. There are interactions of the host and pathogen and their dependence on the weather and the microclimate, and on any human intervention such as the application of fungicide and phytosanitary measures. The development of disease scales with diagrams, designed to permit estimates of disease severity on leafy shoots, inflorescences and nuts.

**310.** MADDISON, A., BOMA, F., TOPPER, CP and SHOMARI, S. 1997. **Sanitation in the management of cashew powdery mildew disease in Tanzania.** *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp. 236- 240

There is an enormous loss of cashewnut harvest because of damage to flower buds caused by the powdery mildew fungus, *Oidium anacardii*. The epidemic reaches its peak in the dry season at a time when flowering is abundant on most trees. Sanitation is most likely to help in places with relatively low risk to PMD, where large areas can be sanitised in a thorough and timely way. It is not likely to be successful if applied piecemeal in very tall, densely canopied trees in high risk areas. It must be stressed that sanitation pruning has to go alongside formation and maintenance pruning as essential practice.

**311.** MADHUKESHWARA, SS., RAJU, CG and BABU, HNR . 2005. **Studies on caulicolous and ramicolous fungi of Karnataka -II - on cashew.** *Journal of Mycopathological Research*. 43(2): 181-187 (AICRP on Small Millets, University of Agricultural Sciences, GKVK, Bangalore 560 065, India.)

This paper describes and illustrates the morphological characters of five caulicolous and ramicolous fungi (*Chaetomium globosum*, *Diatrypella indica*, *Cytospora* sp., *Phoma* sp., and *Pestalotiopsis* sp.) found infesting cashews (*Anacardium occidentale*) based on a survey conducted in Karnataka, India during 1987-88. Some are new host records from India while others are new geographic records from either South India or Karnataka.

**312.** MADHULETY, TY., SUBBARAO, IV and NEERAJA, PV. 2002. **Differential histolocalisation of certain phenolics and related enzymes in cashew var. BPP-6.** *Indian Journal of Plant Physiology* 7(3): 270-276

A study was conducted on the histolocalisation of certain phenolics and their enzymes in the intact explants ; i.e. shoot bud (SB), sub-apical meristem (SAM), mature leaf (ML) and young leaf (YL) of cashew cv. BPP-6. SAM, which contained the lowest phenols and highest tannins, was found associated with high *in vivo* activities of phenylalanine ammonia-lyase (PAL), tyrosine ammonia-lyase (TAL) and nitrate reductase (NR) but with the lowest activity of polyphenol oxidase (PPO). Phenols accumulated densely in endodermis and arch-shaped fibre cells (AFC) of SAM but found absent in resin canals and xylem cells. Xylem and resin canals of both SAM and SB did not stain for phenolics, enzymes, proteins and reducing sugars.

**313.** MAHANTHESH, B and MELANTA, KR. 1994. **Effect of nitrogen, phosphorus and potassium on the yield of cashew apple.** *The Cashew* 8(4): 14-18

The effect of N (0, 250 or 500g/tree), P (0, 100 or 200g/tree), and K (0, 125 or 250g/tree) on the growth and yield of cashews (cv. Ullal-1) at the Horticultural Research Station, Bangalore, was investigated. Fertilizers were applied once per year (during Sep.) between 1987 and 1991. The highest yield was obtained from trees treated with N, P and K at 500, 100 and 250 g/tree, respectively.

**314.** MAHANTHESH, B, MELANTA, KR, and JANARDHAN, G. 2006 . **Studies on the impact of NPK on flowering duration, kernel yield and shelling percentage of cashew in eastern dry zone of Karnataka.** *Journal of Plantation Crops* 34 (3): 281-285

A field investigation with three levels of NPK was carried out at the HRS, Bangalore on cashew plants cv. Ullal-1. The treatments were imposed when the age of the plants were 4 years and the application of fertilizers every year was continued up to 9 years. The number of and total weight of cashew kernel per plant increased significantly with the combined application of 500g of nitrogen and 100g of phosphorus and 250g of potassium per plant per year. Among two factor interaction effects NP,NK and PK interactions significantly increased the yield of cashew kernel. The highest yield of cashew kernel was recorded from the plant treated with 500g of N, 100g of P and 250 g of K.

**315.** MAHESII, MS and NAGARAJA, KV. 2002. **Coating of cashew kernel baby bits for value addition.** *Journal of Food Science & Technology* 39(2): 124-128 (National Research Centre for Cashew, Puttur-574202, D. K.)

Value addition of Cashew Kernel baby bits has been attempted by coating with cane sugar, honey and salt. Optimum coating occurs at 100.C for 5 min. at 70% concentration for cane sugar and honey and 5% for salt. Sweetened (70%)and vanillian (0.1%)flavoured CKBB are the most preferred. Defatting of CKBB enhances the per cent coating.Coating of cashew kernels of different grades with cane sugar at 70% is dependent on the surface area. Cashew apple juice could be coated on the CKBB. Acceptability of cashew apple juice coated baby bits improves with the addition of cane sugar at 70% concentration. Permitted colours and cane sugar compete with each other during coating.

**316.** MAIA, GA., SOUSA FILHO, M de SM de and FIGUEIREDO, RW de. 2004. **Chemical characteristics of cashew apples of different clones of early dwarf cashew tree.** *Revista Ciencia Agronomica* 35: 272-278

The physico-chemical properties of the fruits of cashew clones CCP-06, CCP - 1001 and CCP-76, randomly harvested in a 15-day interval for 75 days, as well as their suitability as feeds were determined. The peduncles of the different cashew clones recorded low acidity and high moisture and tannin content. The fruits were a poor source of iron, fibre and protein; a regular source of calcium and phosphorus; a good source of sugar and excellent source of vitamin C.

**317.** MAIA, JGS. 2000. **Volatile constituents of the leaves, fruits and flowers of cashew.** *Journal of Food Composition and Analysis* 13(3): 227-232

**318.** MAIA, SMF., OLIVEIRA, TS de and OLIVEIRA, FNS. 2004. **Spontaneous plants in the soil covering and accumulate of nutrients in areas cultivated with cashew.** *Revista Ceres* 51(293): 83-97

The potential of weeds as soil cover in fields planted with cashew was evaluated in a field experiment conducted in Pacajus, Ceara, Brazil from 1999 to 2001. Weed persistence during drought and dry matter yield were determined, and nutrient accumulation was quantified. The weeds provided soil cover throughout the year, and accumulated K, Ca, Mg and C mainly during the initial growth stage of cashew.

**319.** MAJULE, AE., TOPPER, CP and NORTCLIFF, S. 1997. **The environmental effects of dusting cashew trees with sulphur in Southern Tanzania.** *Tropical Agriculture* 74(1): 25-33 (Agriculture Research Institute, Box 509, Mtwara, Tanzania.)

The effect of dusting S as a fungicide for controlling PMD in cashew on soil fertility was

studied in 2 agro- ecological zones, termed C2 and E5 in Tanzania. S application decreased the pH of the top soil by upto 0.7 units over a period of 4years, reducing pH values to less than the critical 5.5 level in some areas. At most sites a decrease in pH was associated with the loss of major soil macronutrient elements from the top soil due to leaching. An increase in Al saturation to toxic levels also occurred, particularly in C2. The crop yield was also negatively affected by the increased soil acidity.

**320. MAJULE,AE., TOPPER, CP and NORTCLIFF,S. 1997. The environmental effects of sulphur dusting cashew trees in southern Tanzania. *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp.84-93**

To control PMD the application of elemental sulphur dust has been recommended, initially at the rate of 7 applications of 0.25kg S at 2 weekly intervals and from 1994 five applications of 0.25kg at 3 weekly intervals. Following application, sulphur deposits on the tree declined by up to 80 within a period of 3 weeks. Other work has shown that sulphur addition to the soil can result in acidification beyond the tolerance of some crops and negatively affect the levels of other soil nutrients, and increases the saturation of aluminium in soils to toxic level.

**321. MALKUP, M., MAJUMDER, K and MAZUMDAR, BC . 1997. Important constituents in apple and kernel of three types of cashew grown in southern part of West Bengal. *South Indian Horticulture.* 45: (5-6): 299-300 (College of Agriculture, Calcutta University, 35 Ballygunge circular road, Calcutta 700 019, India.)**

The composition of red, yellow and mixed colour cashew apples were determined and results are tabulated. Vitamin C and sugar contents were highest in red fruits.

**322. MAMATHA, TG and GUMMAGOLMATH, KC. 2002. Trends analysis in production and export of cashew in India. *The Cashew* 16(1): 13-17 (RA, Dept. of Agricultural Economics, UAS, Dharwad)**

The study is based on the secondary data collected from various reports of DES and FAO year book for 1990-2000 on area, production and productivity and export and import of cashew in India. The result of the study revealed that the growth rate in area, production and productivity of cashew were positive and shows increasing trend in the states of Karnataka, Tamil Nadu, West Bengal and AP. Where as other states like Goa, Kerala, Orissa production were decreased over the years. Import of raw nut increased over the years due to the requirement of raw material for processing in to cashew kernel. Hence, cashew kernel export was also increased.

**323. MANJANAİK, C., RAMASWAMY,GR and SHIVANNA, BK. 2006. Performance of different formulations of insecticides against tea mosquito bug, *Helopeltis antonii* Sig. (Miridae: Heteroptera) on cashew. *Environment and Ecology.* 24 S(Special 4): 1209-1210 (Zonal Agricultural Research Station, College of Agriculture, UAS, Brahmavar, Udipi 576 213, India.)**

The efficacy of solid and EC formulations of insecticides for the control of *H. antonii* on cashew (cv. Ullal-1) was evaluated. Among the formulations evaluated, carbaryl 50 WP(0.10%) was the most effective,

as it recorded the lowest average percent damage (6.20) and highest nut yield (7.40 quintal/ha), followed by the spray formulation of endosulfan 35 EC (0.05%). The other solid formulations were also effective in the reduction of the population of *H. antonii*. [1.0 quintal=100.0 kg].

**324. MANJUNATHA, D. Effect of nutrients (NPK) supplied through irrigation water on growth of rootstocks and grafts of cashew.** *The Cashew* 2001 15(1): 13-18

The influence of nutrients (NPK) supplied through irrigation water on growth of cashew root stocks and grafts was studied. The root stocks when observed 45 days after planting, recorded highest plant height (23.22 cm) and maximum stem girth (1.66 cm) in T5 treatment. When observed 120 days after grafting, highest graft height, maximum number of leaves and highest graft union success (62.87%) was recorded in treatment T5. In this treatment the plants were supplied with 150, 20 and 100ppm of N, P and K at the rate of 100ml/plant/week.

**325. MANOJ, PS., GEORGE, TE and KRISHNAN, S. 1994. Correlation studies and path co-efficient analysis in cashew hybrids.** *The Cashew*. 8(2): 10-14 (KAU, Vellanikkara, Kerala-680654.)

An experiment was carried out with 56 ten year old F1 hybrids of cashew belonging to twelve parental combinations. The correlation studies and path co-efficient analysis identified the important biometric characters which contribute towards nut yield/tree in cashew as weight of kernel, mean canopy spread, number of nuts/panicle, girth of the tree, leaf area, duration of flowering and height of the tree in that order of priority.

**326. MANOJ, PS., GEORGE, TE and KRISHNAN, S. 1994. Variability in cashew as influenced by hybridization.** *The Cashew* 8(4): 10-13 (KAU, Vellanikkara-680 654, Trichur.)

A study of 56 cashew hybrids and their parents revealed the presence of a high degree of variability with respect to growth parameters, floral traits, yield attributes and apple characters. It was also perceived that hybridization has resulted in the broadening of the spectrum of variability in cashew in the case of ten of the 22 biometric characters studied.

**327. MANTELL, SH., BOGGETTI, B., BESSA, AMS., LEMOS, EP., ABDELHADI, A. and MNENEY, EE. 1997. Micropropagation and micrografting methods suitable for international transfers of cashew.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp. 95-107

Collaborators based in the UK, Portugal, Brazil, Morocco and Tanzania improved existing cashew micropropagation systems to the point that this technique in combination with micrografting might be used to transfer valuable germplasm safely between Brazil and Africa. Micrografting shoot tips excised from glasshouse raised seedlings and field-grown plants by a modified side grafting procedure on *in vitro*-raised seedling rootstocks gave micrografting success rates in the range 40-80. The implications of the obtained results are discussed to safe international cashew germplasm transfers in the future.

**328. MARCO, JAM and KISHIMBA, MA. 2006. Pesticides and metabolites in cassava, eucalyptus, plum and cashew leaves and roots in relation to a point source in Kibaha.** *Chemosphere* 64(4): 542-548

Leaves of Eucalyptus, plum and cashew as well as roots and leaves of cassava were used to study the local distribution of pesticides and metabolites from a point source, an old storage site at Vikuge farm in Tanzania. The GPC - cleaned extracts were analysed by GC-ECD and GC/MS. Eleven organochlorine pesticide residues were detected in the samples. The concentrations of total DDT were 818ng/g fw in Eucalyptus, 16 ng/g fw in cashew and 4ng/g fw in *P. domestica*. There are very positive correlation in the concentration of the detected compounds, suggesting that they have a common source. The low DDE/DDT ratios (0.02-0.07) in all samples indicate input of non-degraded DDT from the source.

**329. MAREEN ABRAHAM., MAHAPATRO and MATHIEW, JOSE. 2007. Canopy structure in various cashew types and their yield performance . *Journal of plantation Crops* 35(2): 116-118**

Based on the canopy spread, cashew accessions can be grouped in to low (< 3 m), intermediate (3-6 m) and high (> 6 m). High canopy is associated with high yield. The result of the study thus indicated that maximum canopy spread with optimum girth is to be achieved for high yield. This can be ensured by the selection of superior genotypes/ varieties. It may also be remembered that the canopy developing ability of a variety is a function of soil, climate and management practices including crop geometry that ought to be worked out on location specific mode.

**330. MARIAPPAN, S., PRABAKARAN, J and SAMBANDAMOORTHY, S. 1995. Effect of growth regulators on sex expression and fruit set in cashew. *The Cashew* 9(1): 11-13**

The present investigation was undertaken to assess the effect of certain growth regulator

on fruit set and alteration of sex ratio in cashew under acid lateric soils. Among the plant growth regulator tested on the productivity of hermaphrodite flower, nut count, and nut weight on cashew , planofix given at 200 ppm had registered its significance followed by ethrel given at 100 ppm concentration over other levels of ethrel (250 & 500 ppm) as well as water control.

**331. MARTIN, KP. 2003. Plant regeneration through direct somatic embryogenesis on seed coat explants of cashew. *Scientia Horticulturae* 98(3): 299-304**

A protocol of plant regeneration through direct somatic embryogenesis was established for the first time on cashew using seed coat explants. Frequency of embryogenesis was significantly influenced by type and age of the explant and growth regulators supplemented to the medium. Seed coats isolated from the immature nut between 15 and 40 days after pollination were superior in the induction of somatic embryos. Only 35% of seed coat halves induces somatic embryos. Somatic embryos developed best on MS medium fortified with 13.3  $\mu$ M benzyladenine (BA), 271.5  $\mu$ M adenine sulphate (Ads) and 2.7 $\mu$ M naphthaleneacetic acid (NAA). On this medium, an average of 3.3 embryos were developed per half seed coat. Embryos originated from the inner layer of the seed coat. Transfer of the embryos to fresh induction medium facilitated development of secondary somatic embryogenesis. Embryos exhibited all stages of development, i.e, from globular to cotyledonary. Fifty per cent of embryos underwent conversion upon transfer to MS medium containing 4.65 $\mu$ M kinetin and plantlets were successfully transferred to field conditions. Ninety percent survived in field conditions.

**332. MARTIN, PJ and KASUGA, LJ. 1995. Variation in cashew tree yields in south-east Tanzania and the implication for management of cashew smallholdings. *Tropical Agriculture* 72(4): 261-268**

In 2 - ha plots of mature cashew trees in farmers' fields, cashew production showed large variation in relation to local tree density and canopy ground cover ratio (CGCR). Maximum cashew production usually occurred between tree densities equivalent to 40-80 trees/ha but at one site where trees were small it occurred at 120 trees/ha. Below a CGCR of 0.4, cashew production was low and was usually at a maximum between 0.5 and 0.6. Individual tree yields were highly variable and were poorly correlated with density, canopy ground cover area, trunk cross-section area and yields of surrounding trees. In both on-farm and on-station blocks of trees, individual tree yields were highly correlated with their yields in previous years showing that, at the same site, tree yields relative to each other were consistent from year to year. All on-farm sites contained an appreciable proportion of very low - yielding trees. The productivity of smallholder cashew farms may be improved by a combination of selective thinning of poor-yielding trees and planting available spaces with improved material.

**333. MARTIN, PJ., KASUGA, LJ and BASHIRU, RA. 1998. Cashew farm upgrading: agronomic options for increasing cashew production by smallholder farmers. *Experimental Agriculture* 34(2): 137-152 . (Tea Research Foundation, PO Box 51, Mulanje, Malawi.)**

The main production constraint in Tanzania is powdery mildew disease which

causes large reductions in tree yields. Although fungicides can control this disease, the majority of farmers are unable to afford them. Recently, cashew material with some tolerance to this disease has been released to growers and use of this material will be one of the main ways for farmers to cope with the disease. The most important initial step is to fell non-productive trees. Where there is sufficient space these can be replaced by improved material established either as grafted plants, polyclonal seed or by top- working.

**334. MASAWA, PAL. 1999. Observations on progenies in a crossing scheme between cashew clones establishment characters. *Tanzania Journal of Agricultural Sciences* 2(1): 1-6**

Six cashew clones held in the Tanzanian cashew germplasm collection, but of diverse origin, were selfed and crossed. The crossing programme resulted in progenies of 13 hybrid combinations and 5 selfs. These were planted in 4 replications of 12 tree plots in the field at Naliendele Agril Research Insti., Mtwara, Tanzania along with vegetative propagules of the parent clones. Tree heights and canopy diameters were recorded 3 years after planting. The results showed that the growth of the seedlings was more vigorous than the clonal propagules of the parental clones. Plant height was more highly heritable than canopy diameter at this stage in the establishment and hence would be more readily manipulated by selection.

**335. MASAWA, PAL. 1999. Studies on genotype-environment interaction in half-sib progenies of cashew in Tanzania. *Tanzania Journal of Agricultural Sciences* 2(1): 53-62**

The aim of the work was to provide information on the variability in performance of cashew over different geographic growing sites and on the potential to carry out effective selection. Half-sib progenies, of 16 selected cashew clones were used to establish progeny test trials at Kibiti and Chikomo. There were differences in performance of the progenies in the 2 sites indicating the existence of genotype-environment interaction. The data were used to calculate the heritability and response to selection for yield, canopy diameter, trunk cross sectional area and height. Heritabilities of yield were low (3-40%), whereas height (47-72%) was amenable to selection.

**336.** MASAWA, PAL., CUNDALL, EP and CALIGARI, PDS. 1996. **Distribution of cashew flower sex-types between clones and sides of tree canopies in Tanzania.** *Annals of Botany* 78(5): 553-558 (Cashew Research Project, Agril Research Institute, Naliendele, PO Box 509, Mtwara, Tanzania.)

In a study conducted from July to Dec. 1992, production of male, hermaphrodite and abnormal flowers on different sides of the canopy was studied in the cashew clones AC4, AC22, AC28 and AZA2. There were differences in the numbers of flower types between clones and between different sides of the canopy, although there were consistently more male flowers than other types. There were no significant differences in yield between the clones; however, AC22 was relatively late-yielding compared with the others.

**337.** MASAWA, PAL and CALIGARI, PDS. 1997. **Investigation of cashew apple colour and out-crossing in cashew.** *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp. 134-137

The data on cashew apple colour was collected at 4 sites for progenies of 12 selected cashew clones with a range of apple colours. The segregation of the apple colours could only be scored on mature trees and was recorded for each individual tree within each progeny. The results indicated that there was consistency in the segregation of the cashew apple colours between sites in the progenies of most clones. This indicated a consistency in scoring of the colours and the paucity of differences over sites indicated a lack of effect of environmental sensitivity in expression of apple colour.

**338.** MASAWA, PAL., CUNDALL, EP and CALIGARI, PDS. 1997. **Performance of local cashew germplasm and selected clones in south-eastern Tanzania.** *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp. 146-150

Collecting missions of cashew germplasm, potentially tolerant to PMD were carried out in selected villages of southern Tanzania in 1987 and 1988. After field evaluation for a period of 3 years, using disease score and yield as the selection criteria, only 41 trees showed acceptable levels of yield and tolerance to PMD. These 41 clones were selected for further evaluation. The trial was inoculated with powdery mildew spores to ensure a high potential level of infection before vegetative and yield characters were recorded.

**339.** MATHEW, SALLY K., SALAM, M.A., VILASINI, T.N. and KURIEN, SUSANNAMMA. 1999. **Anthracnose disease- an emerging threat to cashew.** *Cashew Bulletin* 37(8): 3-5 (Kerala Agricultural University, CRS, Madakkathara- 680 654, Kerala.).

Anthracnose disease is caused by the fungus *Colletotrichum gleosporioides*. Reddish



brown shiny lesions appear on the affected shoots followed by gum exudation. At an advanced stage, the branches may be dried leading to die-back. The pathogen spreads through rainwater and wind. To control the disease adopt a combined spray involving fungicide and insecticide such as Quinalphos and Copper oxychloride, Endosulfan and Mancozeb with water may be sprayed during flushing and flowering periods.

**340. MATHEW, AG. 1995. Improved shelling machine.** *Cashew Bulletin* 32(4): 9-11 (Technical Director, M/s.Plant Lipids Private Ltd, Kadayiruppu, Kolenchery-682 311, Kerala).

This shelling gadget consists of 2 sets of blades arranged horizontally. By means of a leg operated lever the two blades are brought together. The blades ,when brought together, describe a cavity which is kidney shaped like a cashew nut. When a roasted raw nut is placed between the blades, horizontally flat, appropriate edges, concave and convex, facing the correspondingly shaped blades, it will cut. However the nut inside will not be damaged,since the blades are so arranged that it will stop moving further. In fact the gap can be adjusted according the size of the nut.

**341. MAI'OS, NN., TEXEIRA JR, AC and SILVEIRA, JAG da. 2003. Influence of rootstock on physiological behaviour of grafted cashew under stress.** *Revista Brasileira De Fruticultura* 25(1): 27-31

The resistance levels were compared of dwarf cashew rootstocks CCP 06 and CCP 09 and grafted plants CCP 76/06 and CCP 76/09 to water and saline stress, using biochemical and biophysical characteristics. Significant

differences were observed between the grafted plants. Grafted CCP 76/06 reproduced the behaviour of stomatal opening of rootstock CP06, which was more resistant to water and saline stress than CCP 09. The role of the rootstock in the regulation of ion absorption and gas exchange is also discussed.

**342. MBULANYA, GGN. 1997. Wear-pattern characteristics of cashewnut shell liquid.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp. 206-210

The present work exploits the fact that the aromatic ring of CNSL is prone to of electrophilic attack by methanol in alkaline medium and fast curing thermosetting resins result. These are then step-polymerised with hexamine and the resulting material ground to a powder which is later graded by sieve analysis to an approximately 60 meue mol sized particles. By incorporating inorganic fillers, asbestos fibres and a CNSL binder emulsion the powdered resin can be subjected to high pressures and temp. to obtain a fractional element.

**343. MCBRATNEY, ME and SUBRAMANYA, S. 2000. Microwave eradication of *Tribolium castaneum* in stored cashew.** *The Cashew* 14(3): 31-34

The effectiveness of microwave treatment on adult *T.castaneum* infesting cashew was studied. The cashew kernels containing insects were exposed at 60, 70 and 80°C and exposure periods of 0, 90 and 180 min.using a kitchen model microwave unit. Treatment of adults with microwaves showed that the temperature had a significant influence on the adult mortality in *T.castaneum* with over

90% mortality being achieved when exposed at 180 min. at 60°C. However, the exposure time did not affect the mortality significantly as over 70% of the insects were killed by mere heating of the kernels with insects to a temperature of 60°C. The usefulness of the technology is discussed.

**344. MCBRATNEY, ME. and SUBRAMANYA, S. 2000. Microwave drying of cashew kernels. *The Cashew* 14(3): 25-30**

The effectiveness of microwave and oven drying of cashew as a means to improve the conventional process of tray drying in hot chambers was taken up. An utilitarian microwave unit and 2 kernel sizes W240 and W400 were used. It was observed that when the kernels of the size W400 were subjected to heating at 70 and 80°C, they lost 4.85% and 5.12% moisture in four hours, while in W240 kernels, the values for similar time and exposure were 4.42 and 4.61, respectively. Thus, about 4-5% moisture content in the kernels was effectively removed by oven drying in about 4 hrs. On the other hand, up to 5.09% moisture could be lost in W400 kernels by heating in a microwave oven at 80°C for just 2 hrs.

**345. MELO-FILHO, OM., COSTA, JTA., CAVALCANTE-JUNIOR, AT and BEZERRA, MA. 2006. Biometric traits and growth of seedlings of new rootstocks of precocious dwarfed cashew. *Revista Ciencia Agronomica*. 37(3): 333-339 (Dep. de Fitotecnia, CCA/UFC, Caixa Postal: 12.168, CEP: 60.455-970, Fortaleza, CE, Brazil.)**

The performance of 9 rootstocks (P3BI-1, P3BIII, P4B-1, P6BII-2, P3BI-2, P6-BIII-1, P5BIII, P3BII-2 and clone CCP 06) of dwarfed cashew was evaluated in Fortaleza, Ceara,

Brazil, from November 2003 to September 2004. The heaviest nuts were obtained with P3BI-1, P6BIII-1, P5BIII, P3BIII and P6BII-2. The average values for the biometric traits of P3BIII and P6BII-2 were similar to those recorded for CCP 06, the genotype commercially used as rootstock. In general, the evaluated rootstocks resulted in substantial seedling growth and development. CCP 06 was superior with regard to the index of graft handling.

**346. MENDEZ-NATERA, JR. 2003. Determination of correlation and path coefficients among vegetative and productive characteristics of cashewnut (*Anacardium occidentale* L.) cultivars at Madakkathara, Kerala, India. *Revista-de-la-Facultad-de-Agronomia, Universidad-del-Zulia.*; 20(4): 401-416 (Departamento de Agronomia, Escuela de Ingenieria Agronomica, Nucleo de Monagas, Universidad de Oriente, Av. Universidad, Campus Los Guaritos, Maturin, 6201, Monagas, Venezuela.)**

An experiment was conducted on 18 cashew cultivars in Kerala, India, to determine the associations among nut yield per tree (NYT); the mean canopy (MC), shaft circumference (SC) and tree height (TH); nut weight (NW), apple weight (AW) and AW/NW ratio; and to determine the direct and indirect effects of these characters on NYT. The NYT was negatively correlated with AW and the AW/NW ratio. NW was positively correlated with AW, while AW was positively associated with AW/NW. The MC was related positively with SC and TH. SC was positively correlated with TH. The other correlation coefficients were not significant. Path coefficient analysis showed that the characteristics that more directly

affected NYT were AW and NW, while the other 4 characteristics had lower direct effects than the residual effect. The increments of NYT can be obtained by selecting heavier nuts and lighter apples, however, the 3 vegetative characters of the tree showed very low direct effects on the NYT but did not show any significant association.

347. MENESTRINA, JM., LACOMINI, M., JONES, C. and GORIN, PAJ. 1998. **Similarity of monosaccharide, oligosaccharide and polysaccharide structures in gum exudate of cashew.** *Phytochemistry* 47(5): 715-721 (Departamento de Bioquímica, Universidade Federal do Paraná, Caixa Postal 19046, 81531-990, PR, Brazil.).

The gum exudate from the Brazilian cashews contained traces of the reducing sugars: rhamnose (0.005), arabinose(0.03), mannose (0.007), galactose(0.03), glucose(0.02) etc. Rhamnose, arabinose, glucose and the 3 oligosaccharides were components of the side-chains of the gum polysaccharide, which had a main chain of (1->3)- linked B-D-Galp units. The structure of this polysaccharide was determined and found to differ from that previously reported for the gum of a tree growing in India, lacking units of 4-O-methylglucuronic acid.

348. MENON, ARR and PILLAI, CKS. 1995. **Phosphorylated cardanol prepolymer as a multi-functional additive for natural rubber-compounding a comparison with coumarone - indene resin.** *The Cashew* 9(2): 18-22

The effect of phosphorylated Cardanol Prepolymer (PCP) and Coumarone Indene Resin (CIR) on the vulcanization characteristics and tack strength of NR compounds containing 0 to 40 phr of HAF black and on the tensile

properties and thermo - oxidative decomposition characteristics of their vulcanizates have been studied. The cure rate index of the PCP- modified formulations decreased from 0.70 to 0.515-1 with filler loading, whereas the decrease for the corresponding CIR modified samples was from 0.70 to 0.635-1.

349. MENON, ARR and PILLAI, CKS. 1998. **Modification of NR with phosphoric plasticizers: a comparison of PCNSL with 2-ethyl hexyl dephenyl.** *European Polymer Journal* 34(7): 923-929

The vulcanization characteristics, tensile properties, thermal decomposition and flame retardancy of natural rubber (NR) modified with PCNSL prepolymer has been studied and compared with 2-ethyl hexyl dephenyl phosphate at concentrations ranging from 10 to 20 phr. The PCNSL modified NR vulcanizates showed higher tensile properties and resistances to thermo- oxidative decomposition and flame compared to that containing similar dosages of Santicizer.

350. MENON, ARR and PILLAI, CKS. 1998. **Physicomechanical properties of NR vulcanizates modified with phosphorylated CNSL.** *Journal of Applied Polymer Science* 68(8): 1303-1311

Effect of fillers like carbon black, silica, and china clay on the cure characteristics and physicomechanical properties of natural rubber (NR) modified with PCNSL in various proportions has been studied. Prominent cure retardation has been observed with progressive increase in concentration of PCNSL from 0 to 20 phr. The softening effect of PCNSL on the vulcanizate has been displayed by the linear decrease in hardness and tensile modulus and

the increase in elongation at break with the increase in concentration of PCNSL.

**351. MENON, ARR. 1997. Stress-Relaxation characteristics of Natural Rubber modified with Phosphorylated CNSL prepolymer. *Journal of Applied Polymer Science* 65(11): 2183-2189**

The tensile stress-relaxation characteristics at room temp. of gum NR vulcanizates containing 10-20 phr of phosphorylated CNSL prepolymer were studied at various strain rates and strain levels, in comparison with that containing the same dosage of 2-ethyl hexyl diphenyl phosphate and the unmodified sample. Modification of NR with 10-15 phr of PCNSL resulted in improvements in tensile properties along with a lower degree of stress relaxation at the higher strain rates and strain levels.

**352. MENON, ARR and PILLAI, CKS. 1998. Vulcanization of natural rubber modified with CNSL and its phosphorylated derivative. *Polymer - London*. 39(17): 4033-4036**

The vulcanization characteristics of unfilled natural rubber compounds was studied in presence and absence of CNSL and its phosphorylated derivative (PCNSL) by using an oscillating disc rheometer at various temp. The case of crosslinking in the presence of PCNSL and the active role of PCNSL in the crosslinking reaction was shown by the comparatively higher values of the cure rate index and lower values of the activation energy of vulcanization.

**353. MESQUITA, ALM., BECKER, VO and SOBRINHO, R.B. 1998. Taxonomic identification of lepidopterous species of cashew plant in Brazil. *Anais Da Sociedade Entomologica Do Brasil* 27(4): 655-656**

(EMBRAPA/CNPAP, Rua Dra, Sara Mesquita, 2270, Pici, 60511 110, Fortaleza, CE, Brazil.).

In this paper, three pepidopteran cashew pest species are identified. The species attacking cashew in Brazil are *Thagona postropaea*, *Stenomoma cathosiota* and *Anacampsis phytomiella*. Notes are given on the damage caused and localities where the pests are found.

**354. MESQUITA, PC., MAIA, GA and NASSU, RT. 2003. Microbiological, physico-chemical and sensorial stability of cashew apples (*Anacardium occidentale* L.) processed by combined methods. *Ciencia-e-Tecnologia-de-Alimentos*. 23(3): 366-369 (Universidade Federal do Ceara, Av. Mister Hull 2977 Bloco 857 Alagadico, CEP 60356 000 Fortaleza, CE, Brazil.)**

Cashew processed using combined methods were stored at room temperature and evaluated for chemical, microbiological and sensorial changes during storage at 120 days. Microbiological stability was affected by the treatments: reduced water activity, mild heat, pH reduction, ascorbic acid, sodium benzoate at 1000 ppm, SO<sub>2</sub> at 600 and 900 ppm.

**355. MESQUITA, RCM., PARENTE, JIG and MONTENEGRO, AAT. 2004. Influence of irrigation levels on the growth phenology of common and dwarf cashew progenies during their first twenty months. *Revista-Ciencia-Agronomica*. 35(1): 96-103 (Embrapa Agroindustria Tropical, Fortaleza, CE, Brazil.)**

An experiment was conducted in Ceara, Brazil to investigate the effects of irrigation levels on the growth phenology of common (C-CP 12 and C-CP 07) and dwarf (CCP 76 and CCP 09) cashews, and their progenies (P-09 and P-07) during the first 20 months of cultivation.

The treatments included no irrigation, irrigation all year and supplemental irrigation during the rainy season. Plant vertical and lateral growths were continuous for all genotypes, with high performance by the common clones and progenies. Lateral growth was higher than vertical growth during the first 11 months. Stem diameter was not a suitable parameter for estimating plant height and canopy diameter until the twelfth month after planting. Irrigation did not affect plant height, canopy diameter and flowering. Stem diameter and fruiting were positively affected by the interaction of irrigation level and genotype. Fruiting occurred mainly during the second half of the year for clones and progenies under all irrigation levels..

**356. MILLANZI, KJK. 1997. Effect of powdery mildew and storage practice on quality and viability in cashew. *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania..* pp. 151-153**

During 1994 nuts were harvested from randomly selected of 12 air-layered clones growing at the ARI, Naliendele. Twenty panicles were treated with Bayfidan to obtain healthy nuts while another 20 panicles were untreated and these produced mildew diseased nuts. Nut yield and apple quality differences from the treated and untreated panicles were highly significant. A known mildew susceptible clone, AM6, yielded 4 times as much when mildew was controlled, thus showing the impact of disease. Visual quality differences between healthy and the diseased nuts were variably significant.

**357. MILLANZI, KJK. 1997. *In situ* bud vigour method: a field technique for screening cashew for resistance to powdery mildew. *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania..* pp. 138-140**

The *in situ* bud vigour method effectively screens cashew clones for resistance/tolerance to PMD, a causative agent for collapse of buds. It involves identifying single conical buds on panicle laterals and taking size measurements before and after inoculation, allowing 14 days for inoculation. The size change attributable to the effect of powdery mildew is calculated after comparing with size changes of non-inoculated buds. Clonal differences become apparent with significant differences between the susceptible and resistant clones.

**358. MILLANZI, KJK. 1997. Screening of cashew clones for reaction to *Helopeltis*. *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania..* pp. 117-120**

Sucking insect known as *Helopeltis* damage tender shoots and panicles of cashew and contribute to poor canopy structure and to yield reduction. When 3 screening methods were used they all identified significantly different tolerant and susceptible clones. The damage is relative to the flushing patterns so that in field the early types suffer more damage than the late one. Caging *Helopeltis* in the laboratory or confining *Helopeltis* in a large polydome with a field like environment did not produce consistent results. A knowledge of flushing habit is important when doing clonal assessments.

**359. MINI ABRAHAM and SALAM, MA. 1995. Canopy analysis in cashew. *The Cashew* 9(4): 26-28**

A study was conducted at the College of Horticulture, KAU to quantify the leaf area of cashew and to apportion the leaf area in relation to leaf age. A six year old yielding cashew tree (Anakkayam - 1) during preharvest flushing

phase had a total leaf area of 54.15m<sup>2</sup> with leaf area index less than one. The preharvest flushes that occur during November accounted for 79.2 per cent of the total leaf area in the crown. Leaf area contributed by flushes of age more than one year was very less.

**360.** MINI ABRAHAM., SALAM, MA and KAMALAM, NV. 1995. **Foliar absorption of 32P by cashew.** *Journal of Plantation Crops* 23(2): 70-77

A method was developed during 1993-94 to study the extent of foliar absorption of 32P and to identify the factors affecting foliar absorption in cashew. A leaf washing technique was developed to quantify foliar P absorption. Plant factors such as leaf surface, leaf age, cuticle thickness and stomatal index and other factors such as time of application, duration allowed for absorption and presence of surfactant in the spray solution were found to influence the absorption of foliar applied P. It is recommended that spraying should be carried out around 11.00 h to the lower surface of younger leaves and allowing a minimum absorption time of 6 days to achieve maximum benefit from foliar applied P.

**361.** MINI ABRAHAM and SALAM, M.A. 1997. **Absorption pattern of 32P by cashew.** *Cashew Bulletin* 34(12): 2-4 (Dept of Agronomy, College of Horticulture, Vellanikara, Trichur, Kerala.).

A green house cum laboratory experiment was conducted at the College of Horticulture, KAU, Vellanikara to study the absorption patterns of 32P through the roots of cashew seedlings. Absorption was rapid initially, attained its peak at 8 hours. Within 8 hours of feeding 59.15 of the 32P present in the feeding solution was absorbed.

**362.** MINI ABRAHAM., SALAM, MA., WAHID, PA. and KAMALAM, NV. 1997. **Foliar absorption of 14 C-urea by cashew.** *Journal of Nuclear Agriculture and Biology* 26(2): 93-104 (College of Horticulture, KAU, Vellanikara, Thrissur-680 654, Kerala.).

A method was developed to study the foliar absorption of 14C-urea and the factors affecting foliar absorption in 3 month-old cashew cv. Anakkayam-1 seedlings. A sequential leaf washing technique involving 4 washings each with 50ml of 2 teepol was used to quantify the foliar absorption of urea. It was recommended that for better absorption of foliar-applied urea in cashew leaves which have stomata only on the lower surface, urea solution in 0.05 teepol should be sprayed between 11 and 14 h, directing the spray particles to the lower surface of younger leaves, giving an absorption time of 7 days.

**363.** MIRANDA, JRP., CARVALHO, JG., FREIRE, ALO and FERNANDES, AR. 2004. **Silicon and sodium chloride effects in leaf content of macronutrients, Na, Cl and SiO<sub>2</sub> of dwarf-early cashew clones (*Anacardium occidentale* L.).** *Revista-de-Ciencias-Agrarias*. 41: 203-213 (Universidade Federal de Campina Grande/Centro de Saude e Tecnologia Rural, Departamento de Engenharia Florestal, Paraiba, Brazil.)

An experiment was conducted to evaluate the NaCl-induced alterations on leaf content of macronutrients, sodium, chloride and silicon in CCP-09 and CCP-1001 dwarf-early cashew plants and the SiO<sub>2</sub> amelioration effect on plant growth under salt stress. The cashew plants were grown in a half-strength complete Hoagland e Arnon (1950) nutrient solution with different levels of NaCl (0; 30; 60; 90 and 120 mol/m<sup>3</sup>) and SiO<sub>2</sub> (0.0; 0.5; 1.0 and 1.5 mol/

m3). The nutrient solutions were fully changed every 10 days. The experiment was harvested 60 days after plant acclimatization period. Sodium chloride reduced nitrogen and silicon content, and silicon increased N, P and K levels in leaves of CCP-1001 clone plants. N levels were also favoured by silicon in CCP-09 plants. Silicon increased Ca and Mg uptake in plants of the CCP-09 and CCP-1001 clones, respectively. Sodium chloride increased Na and Cl uptake in both clones and silicon kept Na levels lower in salt tolerant than in salt sensitive plants.

**364.** MISHRA, NK and LENKA, PC. 1997. **Physico-chemical characters of cashew apples of selected types.** *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania.

An investigation on physio-chemical properties of cashew apples was carried out at AICRP on Cashew,OUAT,Bhubaneswar-751 003, India during 1995- 96. Statistical analysis revealed significant variation with respect to various characters i.e. weight ,length, breadth and specific gravity of cashew apple. Maximum apple weight was recorded in H367 (66.42g) followed by NRCC-1 (59.47g). Maximum apple length (7.01cm) and breadth (4.78cm) was observed in NRCC-1. Highest specific gravity was obtained in H320 (1.0003). The juice recovery varied from 47.04 to 82.22 in different cashew types.

**365.** MNENEY, EE and MANTELL, SH. 2002. **Clonal propagation of cashew by tissue culture.** *Journal of Horticultural Science & Biotechnology* 77 (6): 649-657

A study was conducted to develop *in vitro* culture techniques relevant to the clonal multiplication of cashew using the Tanzanian elite clone AC4. Cultural factors affecting shoot

proliferation, shoot elongation, and node development were assessed using glasshouse-raised plants of various ages. MS salts medium containing full-strength macrolelements was found to be the best for shoot proliferation and shoot elongation. Increasing ages of resulted in drastic decreases in the abilities of axillary buds on nodal explants to sprout and elongate and best performances were obtained from juvenile explants of 1-6 month-old explants. Out of 6 cytokinins compared , 6-benzylaminopurine applied at 30 $\mu$ M and zeatin at 5 $\mu$ M were found to be optimal for axillary shoot proliferation and shoot elongation, respectively.

**366.** MNENEY, EE. 2001. ***In vitro* micrografting of cashew.** *Plant Cell, Tissue and Organ Culture* 66(1): 49-58

Shoot tips excised from glasshouse-raised seedlings and field grown plants of cashew were micrografted by a modified side grafting procedure using *in vitro* raised seedling rootstocks. Factors affecting graft-take were optimized. The micro-scions was obtained with hypocotyls rather than with epicotyls as stock tissue. Rooting of micrografted shoots of mature tree origin was poor (13.3%) because the shoots were only partially rejuvenated.

**367.** MNENEY, EE. 2001. **Use of random amplified polymorphic DNA (RAPD) markers to reveal genetic diversity within and between populations of cashew.** *Journal of Horticultural Science and Biotechnology* 76(4): 375-383

RAPD markers were used to determine the genetic diversity within and between populations of cashew. Efficient and novel procedure for extracting polymerase chain reaction (PCR)- amplifiable, high molecular

weight DNA from young cashew leaves were developed and the PCR conditions for RAPD analysis of cashew DNA using random 10 bp primers were defined. Optimized PCR reaction conditions were then used to analyse differences in RAPD profiles within and between the selection of cashew varieties obtained from diverse geographical locations around the world and within a pool of 20 elite Tanzanian cashew lines.

**368.** MNENEY, EE., MANTELL, SH and TSOKTOURIDIS, G. 1997. **RAPD profiling of Tanzanian cashew.** *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp. 108-115

This study presents the results of experiments which were done to explore the possibility of developing DNA-based techniques to assess genetic diversity within and between cashew populations and for detecting markers linked to important traits like nut size. Initially the conditions for extracting PCR-amplifiable, high molecular weight DNA from young cashew leaves and the PCR conditions for RAPD analysis of cashew DNA using random 10-mer primers and anchored microsatellite primers were defined.

**369.** MOHAN, E and RAO, MM. 1995. **Effect of growth regulators and pruning on the growth and yield of cashew.** *Environment & Ecology* 13(3): 675-679

In a trial carried out at the CPCRI (RS) in Karnataka, 8-year-old cashew cv. M.76/2 Virdhachalam (VTII 539) trees were sprayed during the bud activation period with Ethrel, CCC or TIBA in 2% KNO<sub>3</sub>. In addition, some trees were pruned and sprayed with 2% KNO<sub>3</sub> or sprayed with 2% KNO<sub>3</sub> only. Most treatment

increased the numbers of laterals/ leader compared with untreated controls and all treatments increased the percentage of perfect flowers/ panicle and the numbers of fruits set and carried to maturity/panicle. The number of fruits carried to maturity/panicle was increased least by the pruning + KNO<sub>3</sub> treatment, which also gave the lowest nut yield (5.66Kg/tree, compared with 6.7Kg/tree in controls). Ethrel at 50ppm resulted in the highest nut yield (13.4kg/tree) followed by 1000ppm CCC (10.7 kg/tree). The growth regulator and pruning treatments did not affect the durations of flowering and harvesting.

**370.** MOHAPATRA, LN and MOHAPATRA, RN. 2004. **Distribution, intensity and damage of cashew stem and root borer in Orissa.** *Indian Journal of Entomology* 66(1): 4-7

Major cashew growing districts of Orissa were surveyed for incidence of stem and root borer *Plocoedetus ferrugineus* L. during 1993-97. Highest tree infestation of *P. ferrugineus* was observed in the coastal district Ganjam (20.8%) and lowest infestation of 2.8% in interior district of Koraput. Maximum trees were in early to medium stage of infestation. Tree trunk height of up to 50cm was the most preferred site of borer attack. Studies on seasonal incidence revealed that the pest was active during warmer part of the year (March - May) and completed two generations in a year. Amongst several weather parameters viz, maximum temperature and average temperature showed significant positive influence on the activity of the pest.

**371.** MOHAPATRA, LN. 2004. **Management of cashew stem and root borer *Plocaederus ferrugineus* L.** *Indian Journal of Plant Protection* 32(1): 149-150



Experiment were conducted on 18-year-old cashew trees in Orissa, India, during 1995/97 to determine the efficacy of ecofriendly prophylactic measures against stem and root borer. The treatments comprised: mud slurry + carbaryl 0.25% swabbing (T1); Sevidol (carbaryl + indane) (75g / tree basin) and carbaryl swabbing (T2); Sevidol and swabbing tree trunk with 5% neem oil (T3); neem oil swabbing; neem seed kernel extract swabbing (T4) coal tar + kerosene (1:2) swabbing (T5); and untreated control (T6). T1 gave the lowest mean cumulative percentage of infested trees (6.0) and highest recovery of infested trees after 4 treatments (38.4).

372. MOHAPATRA, LN. 2001. **Bioefficacy of some synthetic insecticides and neem products against cashew leaf folder.** *Annals of Plant Protection Sciences* 9(1): 121-123

Field trials were conducted in 7 year old cashew plantations at Bhubaneswar during 1996-97 to determine insecticides suitable for controlling *C.tiselaia* under the agroclimatic conditions prevailing in coastal Orissa. The synthetic insecticides and neem products were sprayed during the peak flushing period of the crop in December. All of the tested insecticides and neem products significantly reduced the leaf infestation by the pest at 7 and 14 days of spraying. At 14 days after spraying, the highest reduction in leaf infestation over the control was 76.6% with 0.1% triazophos followed by 76.2% with 0.05% monocrotophos.

373. MOHAPATRA, LN. 2001. **Efficacy of some synthetic insecticides and neem products against cashew leaf beetle.** *Indian Journal of Entomology* 63(1): 11-13

The efficacy of 7 synthetic insecticides and 2 neem products against cashew leaf beetle,

*Monolepta longitarsus* was evaluated during 1996 and 1997. It was observed that two rounds of spraying either with triazophos (0.05%) or monocrotophos (0.05%) at 15 days interval was found effective in reducing the beetle damage.

374. MOHAPATRA, LN. 1997. **Seasonal dynamics of cashew leaf miner and its parasite *Sympiesis* sp. at Bhubaneswar.** *The Cashew* 11(1): 36-38

The seasonal dynamics of the cashew leaf miner *Acrocercops syngramma* and its larval parasite *Sympiesis* sp. was studied at Bhubaneswar, Orissa during 1992-94. Maximum activity of the parasite was recorded during the second fortnight of October which synchronized with the peak incidence of leaf miner. The extent of parasitisation declined along with host density during December.

375. MOHAPATRA, LN., BEHIERA, AK and SATAPATHY, CR. 1998. **Influence of environmental factors on the incidence of cashewnut shoot tip caterpillar.** *Cashew Bulletin* 35(7): 17-18 (Dept of Entomology, College of Agriculture, OUAT, Bhubaneswar-751 003, Orissa.)

The shoot tip caterpillar, *Hyatima haligramma* is a major pest of cashew in Orissa. It is revealed from the study that activity of the caterpillar commenced from end of August and increased its maximum with 30.5 shoot infestation during 4th week of October synchronizing with peak vegetative growth stage of the crop. The peak pest population occurred in the preceeding week i.e., 3rd week of October. The effect of abiotic factors on population and extent of shoot infestation indicated that increase in temperature and sunshine hour favoured the population built up.

376. MOHAPATRA, LN and LENKA, PC. 1997. **Response of different cashew types to shoot tip borer, *Hypatima haligramma* in Orissa, India.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.*

Sixteen cashew types were evaluated for resistance/tolerance to shoot tip borer, a major foliage feeding pest of cashew in Orissa for 3 years during 1993- 95. The minute yellowish to greenish caterpillars of the pest inflicted severe damage to young shoots by boring the shoot tips and the leaves. Infestation of shoot tip borer started from August and was continued up to November. Cashew types H-1600, VTH 30/4, H-1608, H-1598, VTH 44/3 and H-1610 showed some degree of tolerance to the pest. These cashew types also exhibited prolonged larval and pupal periods of the pest under artificial infestation.

377. MOHAPATRA, R., JENA, BC and PANDA, D. 2004. **Effect of insecticides and phytosanitation in management of cashew stem and root borer.** *Journal of Plantation Crops* 32((supl)): 349-350 (PLACROSYM - XVI.)

A field trial was conducted in Khurda district, Orissa during 2000-03 to evaluate the efficacy of insecticides and phytosanitary measures for management of cashew stem and root borer, *Plocaederus ferrugineus* L. The study revealed that chlorpyrifos (0.2%) was the most effective in protecting about 88.13% of infested plants from further reinfestation in the subsequent period. Phytosanitary measures i.e; removal of grubs by mechanical method decreased further infestation satisfactorily.

378. MOHAPATRA, R. 2000. **Evaluation of some new chemicals against insect pests of cashew in Orissa.** *The Cashew* 14(2): 26-28

Field experiments conducted during 1998 to 1999 to evaluate the efficacy of certain new and conventional insecticides on certain insect pests of cashew at CRS, Bhubaneswar revealed that shoot tip caterpillar, yellow thrips, black thrips appeared in both the years while TMB only made its appearance in 1998. All the insecticides controlled effectively shoot tip caterpillar in both the years up to a month. Moderate efficacy of insecticides was noticed in controlling yellow and black thrips, whereas the insecticides exhibited poor efficacy against TMB. The performance of the new products was evaluated to be more or less equal to those of conventional pesticides.

379. MOHAPATRA, RN., JENA, BC and LENKA, PC. 2006. **Studies on the level of cashew stem and root borer infestation on different cashew cultivars.** *Journal of Plantation Crops* 34(3): 417-419

The level of cashew stem and root borer (CSRB) was recorded on 13 promising cashew cultivars at CRS, Bhubaneswar, Orissa. The study revealed that the cultivar BPP 3/28 exhibited lowest (2.8%) CSRB infestation. On the contrary II-320 recorded the highest infestation (33.3%). Further it was observed in the bark of relatively tolerant cultivars had smoother surface than the susceptible cultivars. When the nut yield was taken in to consideration, it was observed that even more susceptible cultivars gave good nut yield if proper plant protection measures are taken.

380. MONTEALEGRE, JC., CHILDERS, NF., SARGENT, SA., BARROS, L. de M and ALVES, RE. 1999. **Cashew nut and apple: a review of current production and handling recommendations.** *Fruit Varieties Journal* 53 (1): 2-9 (Hort. Science Dept., PO Box 110 690, University of Florida, Gainesville, FL 32611-0690, USA.).

The history of cultivation, climatic and soil requirements, cultivars, propagation, seed germination and culture, fertilizer and irrigation requirements, pest and disease problems, harvesting and handling and storage of cashew nuts and apples are discussed.

**381.** MOURA, CFH., FIGUEIREDO, RW de and ALVES, RE. 2005. **Appearance and colour of the peel of early dwarf cashew clones, for consumption in natura, stored under different layers of PVC.** *Revista Ciencia Agronomica* 36(3): 371-375

A study was conducted to evaluate the effects of modified atmosphere on the postharvest life of early dwarf cashew apple clones CCP 76, BRS 189, END 183 and END 189 harvested from Beberibe, Brazil, and wrapped in various layers of PVC film and refrigerated at 5°C. Cashew apples were laid three at a time in foamy trays which were individually wrapped in 2, 4, 6 or 8 layers of PVC film to simulate different film permeability. Appearance was assessed using a hedonic scale from zero to 4, while peel colour was assessed based on luminosity, chromaticity and hue angle. Clone CCP 76 had a postharvest life of 16 days, regardless of film permeability. However, film permeability affected the postharvest life of clones BRS 189 and END 183, which were kept for 16-19 and 17-20 days, respectively. Clone END 189 had a postharvest life of 14 days, which was unaffected by film permeability. Cashew apples yellowed throughout storage, as indicated by the rise in hue angle.

**382.** MOURA, CFH. 2000. **Internal quality of the new dwarf cashew apple clones cultivated under irrigation and destined for fresh consumption.** *Interamerican Society of Tropical Horticulture* 42: 119-123

The cashew apples of 9 early dwarf cashew clones from an irrigation experiment

set up in Mossoro, Brazil in 1994 were evaluated. Clone CCP76 was used as a control. Cashew apples were harvested in August 1997 and evaluated for total soluble solids, soluble sugars, pH, total titratable acidity, Vitamin C, tannins and total carotenoids. Clone END 157 showed the best characteristics for fresh consumption, even when compared to the control, especially for high TSS, Vitamin C contents. Clones END 183 and END 189 were similar to the control.

**383.** MOURA, CFH. and ALVES, RE. 2001. **Physical characteristics of cashew apples for fresh fruit market.** *Revista Brasileira De Fruticultura* 23(3): 537-540

Nine clones of early dwarf cashew were evaluated in Rondonia, Brazil. Cashew were harvested in August 1997 and assessed for firmness; size; shape; colour; and weight. Of the clones evaluated, only CCP09 had poorer colouring than the control CCP76, while in apples from clones CAP6(500), END157, END 189 and END 329, colour was more intense than in the control. Clones END157, END183 and END189 produced apples which could be classified as type 4 (highest commercial value, while clones CAP6(500), END157 and END183 produced pear-shaped apples. Clone END 157 had the best characteristics for the fresh fruit market.

**384.** MOURA,CFH., FIGUEIREDO, RW., ALVES, RE and ARAUJO, PGL. 2004. **Evaluation of the respiratory activity of early dwarf cashew (*Anacardium occidentale* L.) clones stored with different layers of PVC.** *Proceedings of the Interamerican Society for Tropical Horticulture.* 47: 143-145 (Universidade Federal do Ceara, C.P. 12168, 60.316-000, Fortaleza, CE, Brazil. )

Cashew apples of 4 clones were cold stored (5+or-1 degrees C) under modified atmosphere with different layers (2, 4, 6 and 8) of PVC [poly vinyl chloride] film (15 micro )

for 21 days. Weight loss was analysed on a semi-analytic scale and CO<sub>2</sub> production was measured daily up to the 7th day and then on the 14th and 21st day of storage. In general, cashew apples wrapped with 2 layers of PVC lost more weight, with 'END 189' giving the greatest weight loss of 1.40%. CO<sub>2</sub> accumulation was highest (15.35%) in 'CCP 76'.

**385.** MULIN, M. 1995. **Callus formation from thin cell layers of *Anacardium occidentale* L. *Silva Lusitana* 3(2): 205-211** (Centro de Investigacao das Ferrugens do Cafeeiro, I.I.C.T. Quinta do Marques, 2780 Oeiras, Portugal.).

Thin layers of cells were isolated from internodes of vegetative or floral shoots of 1 to 4 year old cashew trees. These layers produced globular embryogenic-type callus when cultured in MS medium supplemented with 2,4-D + kinetin or with 2,4-D + 2iP. All media were supplemented with an antioxidant. Use of ascorbic acid (49.32mg/litre) as an antioxidant retarded the browning of explants and globular callus but all explants necrosed when activated charcoal (1g/lt) was used as an antioxidant. The frequency of globular callus production was higher in explants isolated from flowering shoots.

**386.** MUNIU, FK and WEKESA, E. 1997. **Diagnostic study on cashewnut production and marketing in Kilifi and Kwale districts in Kenya. *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp. 155-158**

In this paper the current cashew production and marketing practices in the two districts are described. The main causes of low yields are diseases affecting inflorescences (PMD and anthracnosis). Other contributory factors are low prices, poor orchard management, fire and wildlife. Suggested interventions are: Screening of fungicides for

control of PMD and anthracnosis, introduction of disease resistant clones, introduction of orchard upgrading techniques, liberalization of the market and encouragement of small scale processing industries.

**387.** MUNIZ, F., LEMOS, EEP., VARZEA, VMP., RODRIGUES JR, CJ and BESSA, AMS. 1997. **Characterisation of *Colletotrichum gloeosporioides* isolates and resistance of cashew to the pathogen. *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp. 249-253**

Eleven isolates of *Colletotrichum gloeosporioides* were collected from cashew trees in several places in North-East of Brazil. They were characterized according to their colony, appearance, mycelial growth at 15-35°C and sporulation ability in 3 culture media viz; PDA, WYA, WDA. The medium for fungus growth was Potato-Dextrose-Agar (PDA). The highest growth took place at 25°C. The pathogenicity of the isolates on cashew leaves varied according to the clone. The isolates BCAI-16L, BCAI-7L, BCAI-9L and BCAI-18L of *C. gloeosporioides* induced the largest lesions in cashew leaves.

**388.** MUSALLAR, SH. 1998. **Value addition in cashew kernels for export and internal market-problems and prospects. *The Cashew* 12(3): 129-132** (Chairman, Cashew Export Promotion Council of India, Chittor Road, Cochin-16.).

It is noted that while India's cashew exports total an annual average of around 78 000 t, the export of value added cashews is less than 0.02%. The need for better packaging to meet international standards, and the marketing problems involved are outlined together with the need for government assistance for promotional activities. With regard to the domestic market (60 000 t), it is considered that a good potential exists for value added cashew products, but that a large scale promotional effort is required.

389. MWASHA, A., ELLIS, R and TRAN HON. 1997. **The effect of desiccation on the subsequent survival of seeds of cashew.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp. 309-312

The effect of storage environment on seed deterioration was investigated in 5 clones of cashew. The seed survived desiccation to 6 moisture content and short term (70 days) storage at cool temperatures. In addition, one sample was stored hermetically at 4.3 moisture content and -20°C for 2 years and showed 100 normal germination. Deterioration was detected when seeds were stored at 40°C. There was a negative logarithmic relation ( $P < 0.005$ ) between seed moisture content and longevity at 40°C.

390. MWASHA, AJ., ELLIS, RH and HONG, TD. 1997. **The effect of desiccation on the subsequent survival of seeds of cashew.** *Seed Science and Technology* 25(1): 115-122 (Dept of Agriculture, University of Reading, Earley Gate, PO Box 236, Reading RG6 6AT, UK.).

The effect of storage environment on seed deterioration was investigated in 5 clones of cashew. The seeds survived desiccation to 6 moisture content and short term (up to 70 days) storage at cool temp. (0°C and -20°C). One sample was stored hermetically at 4.3 moisture content and -20°C for 2 years and showed 100 germination. The duration of hermetic storage influenced seed germination ( $P < 0.01$ ). There was a negative logarithmic relation ( $P < 0.005$ ) between seed moisture content and longevity at 40°C. Thus cashew shows orthodox seed storage behaviour.

391. NAGARAJA, KV. 2007. **Biochemistry of cashew: a review.** *Journal of Food Science & Technology* 44(1): 1-9 (National Research Centre for Cashew, Puttur - 574 202, DK., Karnataka.)

Biochemical changes in cashew kernel and apple during development, storage and insect interaction, nutritional studies and

product development have been reviewed. Cashew kernel, testa, and shell and cashew apple and its pomace have been analysed for biochemical constituents during development of cashew nut and apple and during storage of these have been documented. Few reports are available on the presence of trypsin inhibitors, allergens and aflatoxins in cashew kernel. Presence of antimicrobial agents in cashew apple flavour have been reported. Possibilities of product development from cashew kernel rejects, cashew kernel baby bits, cashew testa, and cashew shell and cashew apple pomace have been documented. Biochemical changes during infestation of cashew by tea mosquito bug and cashew stem and root borers have been studied to a limited extent.

392. NAGARAJA, KV. 1998. **Quality of cashew kernels in relation to export.** *The Cashew* 12(3): 143-148

Processing of cashew results in kernels of all grades like wholes, splits, bits etc. and the price is depend on the size of the kernels. Large white wholes fetch maximum price while bits and splits fetch less. The economic effectiveness of a processing plant is judged by the capacity to produce white wholes. Quality guidelines have been laid by the importing countries and CEPC at Cochin ensures that these quality standards are maintained before the kernels are exported.

393. NAGARAJA, KV., GOWDA, BHAVANISHANKARA PS and KURUP, VVK. 1994. **Biochemical changes in cashew in relation to infestation by tea mosquito bug.** *Plant Physiology & Biochemistry* 21(2): 91-97

Biochemical changes in tender shoots and leaves of cashew during infestation by tea mosquito bug have been studied. Infestation of cashew for 24 h by TMB results in decreased sugar, Chl a and carotenoid contents. Total phenols, orthodihydroxy phenols and leaching

of electrolytes tend to increase after 24 h of infestation by TMB. Activity of superoxide dismutase decreased while activity of nitrate reductase increased after 24 h of infestation of TMB. Studies during shorter period of infestation have revealed that the biochemical changes are manifested as early as 6 h after infestation by TMB.

**394.** NAGARAJA, KV. 2000. **Biochemical composition of cashew kernel testa.** *Journal of Food Science & Technology* 37(5): 554-556

Testa from high yielding varieties of cashew and those procured from commercial processors of cashew have been analysed for tannins, proteins, starch, sugars and phenols. Significant variations in the testa composition have been observed among different high yielding varieties and commercial samples of testa. Composition of almond testa compared well with that of cashew with regard to proteins, starch, sugars and phenols. Tannin content in almond testa was low compared to cashew. Cashew kernel testa, besides being a rich source of tannins, could be a good source for developing food or feed additives, as it contain considerable quantities of protein and starch.

**395.** NAGARAJA, KV. 2006. **Composition of cashew processing by-products.** *Journal of Food Science & Technology* 43(3): 267-271

By-products of cashew processing (cashew apple pomace, testa, kernel rejects and cashewnut shell cake) and crude fibre extracted from these have been analysed for chemical composition and mineral content. Extensive washing of CNSL removed cashew shell cake washed with water helps in improving the *in vitro* digestibility of protein and water absorption capacity. Crude fibre exhibited higher WAC compared to their respective by-products. Proteins from cashew processing by-products could be extracted better with NaOH (0.05M) and NaCl (0.25M). Extent of *in vitro*

digestibility of the extracted proteins is higher compared to the respective by-products. Cashew processing by-products after suitable treatment could be a good source of protein, crude fibre and minerals.

**396.** NAGARAJA, KV. 2001. **Functional properties of defatted cashew kernel flour.** *Journal of Food Science & Technology* 38(4): 319-323

Functional properties of defatted cashew flour were compared with those of Almond and Soybean. Defatted cashew kernel flour had lower water absorption capacity, higher oil absorption capacity and emulsification capacity compared to defatted soybean flour. Foaming capacity of defatted cashew kernel flour was comparable with that of soybean. Defatted kernel flour of Almond exhibited lower water absorption, oil absorption, foaming capacity compared to cashew and soybean. Blending of cashew and soybean in the ratio of 1:1 improved the water absorption and emulsification capacity of cashew. Both almond and soybean exhibited similar behaviour with respect to stability of the foam at pHs, ranging between 3 and 10.

**397.** NAGARAJA, KV. 2002. **Harvest and post harvest handling of cashew.** *Indian Cashew Industry* 2002: 118-123 (Edited by Singh, HP and Balasubramanian, PP. DCCD, Cochin.).

This article summarise the work done on maturity of cashew, harvesting of nuts, post harvest storage and value addition. The review has indicated that fully mature nuts are to be harvested to reduce kernel rejects during processing. Peeling out turn and shelling percentage tend to increase with maturity. Whereas, per cent kernel reject tend to decrease with maturity. Cashew kernel baby bits could be used for the preparation of organoleptically acceptable milk sweetened and cocoa flavoured spread.

398. NAGARAJA, KV. 2003. **Preparation of spread from cashew kernel baby bits.** *Journal of Food Science & Technology* 2003 40(3): 337-339

Sweetened and flavoured spread has been prepared from cashew kernel baby bits (CKBB). Among the Sweetened spreads prepared with different flavours, cardamom flavoured spread was the most preferred. Defatting of CKBB did not affect the organoleptic acceptability of the spread. Mixing of CKBB with groundnut kernels in equal proportion did not affect the organoleptic acceptability of the spread. Almond spread was preferred over spread from CKBB.

399. NAGARAJA, KV. 1998. **Quality and processing aspects of cashew.** *Harvest & Post Harvest Technology of Plantation Crops*: 111-113 (Edited by Bosco, SJD. et al. CPCRI, Kasaragod.).

This paper listed the vitamin content and mineral content of the cashew kernel. It also explained about the use of cashew apple viz; preparation of cashew apple juice, syrup, canned fruit, jam etc.

400. NAGARAJA, KV., BHUVANESHWARI, S and SWAMY, KRM. 2007. **Biochemical characterization of cashew (*Anacardium occidentale L.*) apple juice and pomace in India.** *Plant Genetic Resources Newsletter*, No. 149: 9-13

Released varieties (33) and germplasm accessions (79) were characterized for biochemical composition of cashew apple juice (tannin, flavonoids, sugars, ascorbic acid and organoleptic acceptability) and pomace (protein, carbohydrate, sugar, tannin and crude

fibre). Based on the variability noted, quality indices have been developed, and varieties and accessions with desirable qualities identified. Among the varieties and accessions analysed, variety Jhargram 1 and germplasm accession NRC 190 were best for cashew apple juice, while varieties NRC Sel. 1, BLA 139/1 and Bhubaneswar - 1 and germplasm accessions NRC 247 and NRC 160 were found to have the best cashew apple pomace characteristics.

401. NAGARAJA, KV AND PADMA, S. 2005. **Studies on coated cashew kernel baby bits.** *Journal of Food Science & Technology* 42(1): 89-92

Cashew kernel baby bits (CKBB) coated with sugar and flavours such as vanilla, cardamom and ginger could be stored at ambient temperature in sealed LDPE pouches for 12 months without any quality deterioration. CKBB coated with honey and combination of cardamom flavour and apple green colour were preferred organoleptically over other combinations of flavour and colour. Deep frying of CKBB in vegetable oils did not affect organoleptic acceptability after coating with sugar. Deep fried defatted CKBB coated with sugar and combination of cardamom flavour and saffron colour were organoleptically preferred over other combinations. During coating colours bind to protein depending on the concentration of protein and colours.

402. NAGARAJA, KV., SHOBHA, D and YOGESH, A. 2007. **Extraction of tannin from cashew kernel testa at acidic pH.** *Journal of Food Science & Technology* 44(6), 636-638

Refluxing with distilled water (1:4 w/v) at pH 1 was efficient for the extraction of tannin from cashew kernel testa (CKT). The acidic

extract after precipitation of pectin and concentration, is a rich source of tannin with potential antioxidant activity. The antioxidant activity of CKT compared well with that of tea. Antioxidant activity per mg tannin was less in CKT due to higher tannin content compared to tea, which is having lower tannin content.

**403. NAGARAJA, KV and BALASUBRAMANIAN, D. 2007. Processing and value addition in cashew. National Seminar on Research, Development and Marketing of Cashew, 20-21st Nov. 2007, Goa. Souvenir and Extended Summaries. p. 89-91 (National Research Centre for Cashew, Puttur-574 202., D.K., Karnataka)**

This lead paper dealt with various aspects of cashew nut processing, value addition and future strategies to improve the value addition and processing aspects of cashew kernel and cashew apple.

**404. NAIDU, TCM., SREEKANTH, B and NARAYANAN, A. 1999. Biochemical and nutrient changes in different components during cashewnut fruit growth. Journal of Plantation Crops 27(2): 145-148. (Dept of Plant Physiology, Agricultural College (ANGRAU), Bapatla-522 101, AP.)**

This study was undertaken to estimate the changes in sugars, proteins and macronutrients in 3 different parts of cashew fruit, pseudofruit, pericarp and kernel during fruit growth. In pseudofruit there was a continuous increase in TSS. TS increased from 125.0mg g<sup>-1</sup>dw at 0 weeks after peanut stage (WPS) to 653.7mg g<sup>-1</sup>dw at 5 WPS. In pericarp there was a continuous decrease in the TS during fruit growth. In kernel TS increased till 3 WPS and decreased thereafter. Oil content in

the pericarp increased between successive stages from 10.1 at 1 WPS to 41.4 at 5 WPS and then decreased.

**405. NAIDU, TCM. 1999. Utilization of seed reserves for seedling growth of cashew-I: effect of seed size on depletion of nutrient and biochemical constituents. Seed Research 27(2): 149-153**

The total content of seed reserves were higher in cashew cv.BPP-8 than BPP-4 owing to the larger size of its cotyledons. The total contents depleted from cotyledons during seedling growth were also higher in BPP-8 than in BPP-4. The percentage depletion of all the reserves except for Mg was almost the same in both cultivars.

**406. NAIDU, TCM., SREEKANTH, B and NARAYANAN, A. 1998. Growth and development of cashew fruit: I. Drymatter accumulation in different components of fruit. Journal of Plantation Crops 26(1): 89-92 (Dept of Plant Physiology, Agricultural College, APAU, Bapatla-522 101, A.P.)**

The development of individual fruit components in cashew were independent of each other. The results show that, while one component is in its fully accelerated growth, the others were at suppressed growth. That is, the maximum development of apple occurred during first 3 weeks, while that of kernel occurred during 3rd and 4th weeks, where as maximum development of apple occurred during 5th week. It shows that during 3rd week there was a close competition between pericarp and kernel for development which may determine the final true fruit /nut composition.

**407. NAIR, MK and ANITHA KARUN. 1994. Vistas of biotechnology for palms, cocoa and**



cashew. *Indian Horticulture* 39(3): 36-39 (Central Plantation Crops Research Institute, Kasaragod-671 124, Kerala).

Tissue culture of woody perennials including palms, cocoa and cashew are not commercially successful so far. Research programmes of different laboratories around the world, however provide some hope for a breakthrough in these crops.

**408. NALINI, PV. Canopy characteristics in cashew.** *The Cashew* 1999 13(1): 31-36

In a trial at Anakkayam, Kerala, seedlings, grafted plants and those produced from layers of cashew cultivars Anakkayam-1 and Madakkathara-1 were planted at a spacing of 7.5x7.5 m. Canopy surface area was smallest in grafted plants of both cultivars. These plants produced a highest nut yields (11.30 and 10.56 kg/tree).

**409. NALINI, PV., PUSHPALATHA, PB and CHANDY, KC. 1994. A special type of cashew nut sans shell liquid.** *The Cashew*. 8 (1): 15-16. (CRS, Anakkayam, Kerala.)

The *Anacardium occidentale* variety Pattannur-1-1, collected from Pattannur in the Kannur district of Kerala, India was evaluated for yield and agronomic and quality traits at the CRS, Anakkayam, Kerala over 26 years from 1967. It is noted for the absence of cashew nut shell liquid, which, although a highly valuable commercial byproduct, prevents raw consumption of the nuts. Thus, Pattannur-1-1 is recommended for use as a fancy type, especially in homestead gardens. Nuts should ideally be collected just before they turn grey (40-45 days after setting).

**410. NALINI, PV., CHANDY, KC and PUSHPALATHA, PB. 1998. Sulabha and**

**Dhanashree - new cashew varieties of Kerala.** *The Cashew* 12(1): 5-6 (Cashew Research Station, KAU, Anakkayam, Malapuram Dist., Kerala.).

Sulabha is a selection from the germplasm bank of CRS, Anakkayam and Dhanashree is a hybrid progeny of Tree no.30 of Kottarakkara and Brazil 18. Both the varieties have bold nut size, high yield and superior kernel characters suited for export purposes. Moreover the apple characters of these varieties are of extraordinary worth. These varieties are suitable for cultivation in the laterite and red loam soils as rainfed crop. The export grade of both the varieties are W.210 and W.240 respectively. The mean nut weight is 7.8g, shelling percentage 30.5.

**411. NANDAKUMAR, S., BALAKRISHNAN, K and PAPPYIAH, CM. 1998 Effect of foliar sprays of urea and endosulphan on the incidence of tea mosquito bug and yield of cashew.** *The Cashew* 12(1): 7-9

The experiment conducted in six years old cashew plantations Cv- VRI-1 grown under rainfed conditions during 1991-93 at RRS, Vriddachalam revealed that the soil application of 500:200:250 g N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O per tree along with three foliar spray of 4.0 percent urea combined with 0.05 percent endosulfan at the time of formation of new flush, flowering and fruit development stage significantly recorded higher nut yield. However, this treatment has not reduced the incidence of Tea mosquito bug.

**412. NATHANIELS, NQR., SIJAONA, MER and SHOO, JAE. 2003. IPM for control of cashew powdery mildew in Tanzania I. Farmers' crop protection practices,**

**perceptions and sources of information.**  
*International Journal of Pest Management*  
49(1): 25-36

A survey of 218 cashew farmers conducted in three Tanzanian cashew-growing districts recorded farmers' knowledge of cashew powdery mildew disease caused by *Oidium anacardii* and its control. The survey complemented a wider study of cashew powdery mildew disease management knowledge and information systems. The overall objective was to identify difficulties in, and solutions to, implementing integrated pest management (IPM) to minimize costly and environmentally harmful use of sulfur fungicides. Over 90% of farmers in Newala and Nachingwea dist., and 70% of respondents in Mkuranga Dist., used sulfur dust. Most farmers believed that sulfur was essential for protecting cashew flowers from damage by mist - 'mist disease' and for increased production, and knew no ways of reducing use of sulfur. A minority of farmers' had some knowledge of the life cycle of *O. anacardii* and of the possibility of linking cultural practices to remove infection sources with reduced need for sulfur later.

**413. NATHANIELS, NQR., SIJAONA, MER and SHOO, JAE. 2003. IPM for control of cashew powdery mildew in Tanzania II: Networks of knowledge and influence.**  
*International Journal of Pest Management*  
49(1): 37-48

A standardized sulfur-based strategy for control of powdery mildew disease was strongly favoured by the progressive farmers' of Tanzania, and by a coalition of organizational and financial resources of influential farmers'. Major efforts to promote alternative knowledge and understanding about powdery mildew

disease and its integrated control have, to a disturbing extent, not reached either the majority of producers. Important factors limiting access to this knowledge were : poor integration of the knowlegde and other resource networks of farmers and key nonfarming stakeholders with official sources of alternative cashew crop protection and IPM information; ambiguity amongst researchers and development practitioners concerning the potential of IPM in cashew, deficient communication methods, and limited ideas on how to promote the active learning required for IPM. Researchers' understanding of the potential for IPM in cashew can be enriched through study of those farmers who have begun to practice their own local forms of IPM.

**414. NATHANIELS, NQR and KENNEDY, R. 1996. Variation in severity of cashew powdery mildew disease in Tanzania: implications for research.**  
*International Journal of Pest Management* 42(3): 171-182  
(ARI, Naliendele, PO Box 509, Mtwara, Tanzania..)

In 1993, cashew trees in farmers fields in 2 areas of southern Tanzania were surveyed for growth, powdery mildew development, amounts and application of sulfur, pest damage and nut yield. It is suggested that final yields resulted from an interaction of factors, one of which was powdery mildew disease. There was a highly significant (<0.01) association between the number of sulfur rounds and disease severity in Newala but no significant association between number of rounds of sulfur and yield in October. Pest damage estimates showed no consistent pattern in either region.

**415. NAYAK, MG., SWAMY, KRM and PALANISAMY, K. 1995. Studies on**

**screening of cashew types for dwarfing character.** *The Cashew* 9(4): 18-24

Evolving dwarf cashew types suitable for high density planting is the need of the day to exploit maximum yield from unit area. The eight month old seedlings raised from the Brazilian origin and of the identified semi dwarf trees exhibited differences with respect to height of seedling and internodal length. The height of seedling and internodal length in the case of semi dwarf types were about half that of tall types. These seedlings have been planted in the field and the preliminary observations made on seedlings have indicated the possibility of identifying the semi dwarf types in cashew.

416. NAYAK, MG., SWAMY, KRM and YADUKUMAR, N. 2007. **Effect of Pruning on growth and yield of Cashew (*Anacardium occidentale.L.*)** National Seminar on Research, Development and Marketing of Cashew, 20-21st Nov. 2007, Goa. *Souvenir and Extended Summaries*. p. 56 (National Research Centre for Cashew, Puttur - 574 202, DK, Karnataka)

Pruning, an essential horticultural technique for the improvement of crop yield in several horticultural crops (Mika, 1986) is not well understood in cashew. Khan et al. (1987) reported that pruning of the deadwood alone helps in improvement of 30-40% nut yield in cashew while, Mohan and Singh (1989) reported that the nut yield can be doubled by leader shoot pruning. In other tree crops like apple pruning helps in inducing dwarfing and thereby better size and shape to the canopy and same has been recommended in high density planting to restrict the tree size and to improve the quality of the produce. (Mika, 1986). Pruning also helped in changing the pattern of

branching and flushing in several other crops like grapes, apple, pear and several ornamental crops. Most of the older cashew plantations available in the country are of seedling origin and have become senile. These need rejuvenation to improve the yield performance so as to achieve self sufficiency in nut requirements. Therefore, to understand the effect of pruning on growth and yield on different cashew varieties a more comprehensive study was initiated and reported.

417. NAYAK, MG. 1996. **Training and pruning practices for cashew.** *The Cashew* 10(2): 5-9

To establish an ideal plantation the young grafts are to be trained from the first year of planting itself which helps in facilitating for easy and effective intercultural operations like base cleaning, trench making, fertilizer application, pesticidal spray against TMB, swabbing against CSRB, and harvesting of nuts. In old and unthrifty plants, the development of deadwood, water shoots, criss-cross branches should be pruned to enhance nut yield. The leader shoot pruning should also be attended atleast once in 2-3 years which will be of help in boosting the nut yield.

418. NAYAK, MG and BHAT, MG. 2004. **Biodiversity in cashew, its conservation and utilization in crop improvement.** In: *Horticulture for sustainable income and environmental protection*, Vol. II. 2006. Edited by VB. Singh., YY. Kikon and CS. Maiti. p. 615- 624.

Several species of *Anacardium* exists in Brazil and wide variability in cashew is reported from Brazil, being the centre of origin of cashew. A large number of new germplasm

having diverse characters have been collected and conserved in NCGB at Puttur, Karnataka. Twenty four cashew varieties were released by selecting from the germplasm after evaluating the accessions. Twelve hybrids have been evolved using germplasm as donor parents for desirable traits. The breeding strategies for cashew improvement is mainly for enhancement of yield with better nut size and other nut and apple characters.

**419.** NAYAK, MG., BHAT, MG and YADUKUMAR, N. 2004. **Status and need for mechanization of production and post-production operations in cashew.** In: *Proceedings of the National Working Group Meeting on Mechanization needs of Horticulture and Hill agriculture for production and post production operations and Value addition.* 16-17 April 2004. CIAE, Bhopal. p. 82-85

The status and scope of mechanization in Cashew cultivation and post production operations were discussed. The utility of mechanization in propagation, pruning, irrigation, fertigation, harvesting and processing and its cost effectiveness were listed.

**420.** NAYAR, KG. 1995. **Cashew: a crop with unlimited potential.** *The Cashew* 9(1): 3-10

This paper deals with the export potential of cashew kernel and the problems faced by the Indian exporters and farmers and the world scenario.

**421.** NETO, SPS., MARUTA, I and TAKAIWA, F. 1995. **Identification of cashew (*Anacardium occidentale* L.) seedlings with RAPD markers.** International symposium on tropical fruits. Improving the quality of tropical fruits, Vitoria, Brazil, 7-12 November, 1993.

*Acta-Horticulturae.*, No. 370, 21-26 (Department of Biotechnology, CAMPO-Cia. de Promocao Agricola, SEPN 516 B1 'A' 4 Andar, 70770-515 Brasilia-DF, Brazil.)

RAPD amplification products were obtained in genomic DNA extracted from seedlings of 4 dwarf cashew clones (CP06, CP09, CP76 and CP1001) amplified with six 10-mer arbitrary primers. The profiles obtained for each seedling were compared with each other for identification of clone specific amplified products. The size of the DNA fragments ranged from 240 to 1780 base pairs. The number of bands in the profiles varied from 0 to 4, depending on the primer and seedling tested. A total of 27 amplification products suitable for DNA fingerprinting were disclosed. Only the bands generated by 1 of the 6 primers tested were sufficient to distinguish each of the 4 clone seedlings investigated. Two primers were selected for the further identification of RAPD genomic markers in cashew.

**422.** NETO, V and CALIGARI, PDS. 1997. **The effect of variability on cashew yield trials.** *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp. 74-75

Several socioeconomic and environmental factors have contributed to the decline and a number of measures have recently been implemented to attempt to restore previous production levels in Tanzania. However, cashew research to support these efforts is facing very high yield variability in the data from field experimentation, which makes breeding assessment difficult and hinders the identification of improved cultivation practices. Trails showing coefficients of variation above 40 are not uncommon.

423. NGATUNGA, EL., DONDEYNE, S and DECKERS, JA. 2003. **Is sulphur acidifying cashew soils of South Eastern Tanzania?.** *Agriculture, Ecosystems and Environment*. 95(1): 179-184 (Naliendele Agricultural Research Institute, P.O. Box 509, Mtwara, Tanzania.)

Cashew nut, a major cash crop of Tanzania, is mainly produced in the South Eastern part of the country. Sulphur dust is widely used for controlling powdery mildew disease caused by *Oidium anacardii* Noack. This can cause acidification of soils and thus, may threaten the productivity of cashew and its intercrops. To assess the extent and magnitude of the current acidification, pH of topsoil (0-20 cm) and subsoil (20-40 cm) of 70 farmers' cashew groves where sulphur had been applied for up to 12 years, was compared to 70 similar undusted groves. On average topsoil pH of sulphur dusted groves on the Makonde plateau was 0.2 U lower than of undusted groves; subsoil pH was 0.1 U lower. However, in 29% of the groves the difference in topsoil pH between dusted and undusted groves was between 0.5 and 0.9 U. For groves of the inland plains, no effect could be established. Soil pH on the Makonde plateau decreased with increasing number of years of sulphur use while it remained stable in the inland plains. Soils of the Makonde plateau have a high risk for acidifying to pH levels between 4.5 and 4.0 which could affect the cashew nut production and would be detrimental to intercrops such as sorghum, finger millet, and maize. This is due to the soils' inherently low pH and low buffering capacity which is linked to their high sand content. Lime could be used to mitigate the effect of sulphur and can be obtained locally

from fossil coral limestone, not exploited yet. Alternatively, the incidence of powdery mildew could be reduced by crop husbandry techniques or by using organic fungicides; the first alternative has the disadvantage of requiring farmers to understand aspects of the epidemiology, the second of being more costly and more toxic than sulphur and of requiring water for its application which is scarce on the Makonde plateau.

424. NIRBAN, AJ and SAWANT, PA. 2000. **Constraint analysis of cashewnut growers.** *The Cashew* 14 (1): 45-49

This paper assess the extent of knowledge and adoption of the recommended practices of cashewnut cultivation by the cashewnut growers.

425. NIVAS, SHASHIKIRAN and D' SOUZA, L. 2004. **Somatic variation in tissue culture derived mature cashew trees.** *Journal of Plantation Crops* 32((supl)): 144-146 (Proceedings of PLACROSYM - XVI.)

Trees produced *in vitro* from cotyledonary nodes of cashew were planted in the field at various locations. Somaclonal variations were noted as compared to seed grown trees of the same age. The girth of the *in vitro* produced trees was slightly more and the height was lower than that of the seed grown trees. The flowers set in earlier in the tissue cultured trees. There was a strong tendency towards apical dominance in the initial growth of tissue cultured trees. The immune system is also not stable, resulting in a lot of infestation from pests.

426. OELRICHS, PB., MACLEOD, JK and SEAWRIGHT, AA. 1997. **Isolation and characterisation of urushiol components**

from the Australian native cashew (*Semecarpus australiensis*). *Natural Toxins*. 5(3): 96-98 (National Research Centre for Environmental Toxicology, Brisbane, Australia.)

Native cashew (*S. australiensis*) is a well-known food source for aboriginal people of northeastern Queensland and the Northern Territory (Australia). It is also well known that contact with the seeds at a certain stage of growth can cause severe dermatitis in susceptible individuals. To prepare the fruits for eating, they are commonly treated by leaching for 2-7 days with water followed by heating in bark, and this treatment apparently produces an edible cashew nut. Recently, attempts have been made to use this valuable source of food by a commercial company. It was necessary to identify the active principle(s) in the seeds to determine the most effective way of rendering the seed suitable for human consumption without altering the flavour. By using solvent extraction and silica-gel chromatography, a fraction containing 1 major urushiol was obtained. Its structure was confirmed by comparison of its NMR and mass spectral (MS) data with that previously reported. This compound, which is found in high yield, is also found in poison ivy (*Toxicodendron radicans*) and is responsible for dermatitis in susceptible individuals. Soaking the seeds in light petroleum ether for 1 week followed by roasting to evaporate the solvent is suggested as the most effective way of removing the toxin.

427. OGHOME, P and KEHINDE, AJ. 2004. Separation of cashew nut shell liquid by column chromatography. *African Journal of Science and Technology*. 5(2): 92-95 (Department of Chemical Engineering,

University of Lagos, Akoka, Lagos, Nigeria.)

Cashew nut shell liquid (CNSL) a natural product that consists of a mixture of phenolic compounds was separated into cardanol, cardol, and 2-methylcardol using column chromatography. The separation was aimed at recovering cardanol that can be used in the synthesis of cation-exchange resin. The separation was effected using a mixture of equal portions of benzene and chloroform as the mobile phase in a column packed with silica gel adsorbent of particle size 60-120 mesh as the stationary phase. The mean RF-values determined from the study were cardanol (0.516), cardol (0.173) and 2-methylcardol (0.148). The corresponding RM-values calculated were cardanol (-0.040), cardol (0.673), 2-methylcardol (0.753). The RF-value is a measure of the affinity of the component for the mobile phase. The results show that the component that eluted first from the column which was cardanol had the highest affinity for the mobile phase, followed by cardol while the 2-methylcardol had the least affinity. The RM-value is a measure of the polarity of the component and its affinity for the stationary phase. The results of this study show that the component that eluted last from the column which was 2-methylcardol was the most polar. The molecular structures of these three components also show that 2-methylcardol is the most polar followed by cardol and the least polar was cardanol. The RF-value of cardanol obtained in this study could be used in the design of an industrial chromatographic column for its separation from CNSL.

428. OGUNTUNDE, PG and GIESEN, N VAN de. 2005. Water flux measurement and prediction in young cashew tree using sap

**flow data.** *Hydrological Processes* 19(16): 3235-3248

Measurements of sap flow, meteorological parameters, soil water content and tension were made for 4 months in a young cashew plantation during the 2002 rainy season in Ejura, Ghana. This experiment was part of a sustainable water management project in West Africa. The Granier system was used to measure half-hourly whole-tree sap flow. Weather variables were observed with an automatic weather station, whereas soil moisture and tension were measured with a Delta-T profile probe and tensiometers respectively. Clearness index (CI) a measure of the sky condition, was significantly correlated with tree transpiration ( $r^2 = 0.73$ ) and potential evaporation ( $r^2 = 0.86$ ). Both diurnal and daily stomata conductance were poorly correlated with the climatic variables. Estimated daily canopy conductance ranged from 4.0 to 21.2 mm s<sup>-1</sup>, with a mean value of 8.0+3.3 mm s<sup>-1</sup>. Water flux variation was related to a range of environmental variables: soil water content, air temperature, solar radiation, relative humidity and vapour pressure deficit. Linear and non-linear regression models, as well as a modified Priestley-Taylor formula were fitted with transpiration, and the well-correlated variables, using half-hourly measurements. Measured and predicted transpiration using this regression models were in good agreement, with  $r^2$  ranging from 0.71 to 0.84. Solar radiation, CI, clouds and rain were found to influence tree water flux.

**429. OGUNWOLU, SO. 2000. Effects of hot water dip, chemical treatment and polyethylene film packaging on storage life of cashew apple.** *Nigerian Journal of Tree Crop Research* 4(2): 85-93.

The effects of hot water dip, chemical treatment and polyethylene film packaging, applied alone or in combination, on storage life of cashew apple were investigated. Fresh cashew apple were treated with hot water and benomyl solution and packed in polyethylene bags, while untreated fruits served as control. The treated and control samples were stored at tropical ambient conditions of 27-30°C and were assessed daily for appearance, firmness and loss in fresh weight. Samples sealed in polyethylene bags stored best, and the film packaging reduced fresh weight loss. There was no incidence of decay in benomyl-treated fruits. Benomyl treatment combined with storage in sealed polyethylene bags increased the storage life of cashew apples at ambient conditions from 4 to 12 days.

**430. OJELADE, KTM. 1998. Review of twenty years of cashew (*Anacardium occidentale*) entomology in Nigeria.** *Nigerian Journal of Tree Crop Research*. 2: (2): 80-91 (Entomology Division, Cocoa Research Institute of Nigeria, P.M.B. 5244, Ibadan, Nigeria.)

This article reviews the progress on cashew entomology made in the last 2 decades. Over 286 species of pests have so far been reported, but only *Analeptes trifasciata*, *Selenothrips rubrocinctus* and *Pachnoda cordata* have been comprehensively reported. The role of various ant species, *Dysdercus* and *Leptoglossus membranaceus* as vectors of diseases of cashew are highlighted. Suggestions for the improved quality of cashew production are presented.

**431. OLATUNJI, LA., OKWUSIDI, JI and SOLADOYE, AO. 2005. Antidiabetic effect of *Anacardium occidentale* stem-bark in**

**fructose-diabetic rats.** *Pharmaceutical Biology*. 43(7): 589-593 (Department of Physiology and Biochemistry, University of Ilorin, P. M. B. 1515, Ilorin, Kwara State, Nigeria.)

The antidiabetic activity of the cashew plant (*Anacardium occidentale* Linn. [Anacardiaceae]) stem-bark methanol extract was investigated in fructose-fed (diabetic) and normal rats. Animals were randomly divided into group A (control), group B (treated with 200.0 mg/kg body weight of the extract; orally), group C (fed with enriched fructose diet only, 25%; w/w) and group D (fed with enriched fructose diet along with 200.0 mg/kg body weight of the extract; orally). Animals were treated with extract and/or enriched fructose diet for 21 days. The enriched fructose diet resulted in significant increases in plasma glucose, total cholesterol, triglyceride, total cholesterol/HDL-cholesterol ratio, malonyldialdehyde, total protein, urea, and creatinine. Administration of the extract significantly prevented changes in plasma glucose, triglyceride, total cholesterol/HDL-cholesterol ratio, malonyldialdehyde, urea, and creatinine induced by enriched fructose diet. On the other hand, treatment with enriched fructose diet and/or extract did not have any significant effect on plasma alkaline phosphatase level. These results show that chronic oral administration of methanol extract of *Anacardium occidental* stem-bark at a dose of 200.0 mg/kg body weight may be a safe alternative antihyperglycemic agent that has beneficial effect by improving plasma glucose and lipids in fructose-induced diabetic rats, which is associated with a reduced lipid peroxidation.

**432.** OLIVEIRA-FREIRE, F-das-C and CHAGAS-OLIVEIRA-FREIRE-F-das. 1997. **Angular leaf spot of cashew (*Anacardium occidentale* L.) caused by *Septoria anacardii* sp. nov.** *Agrotropica*. 9 (1): 19-22 (Empresa Brasileira de Pesquisa Agropecuaria/Centro Nacional de Pesquisa de Agroindústria Tropical (EMBRAPA/CNPAT), Rua Dra. Sara Mesquita 2270, Pici, 60511-110, Fortaleza Ceara, Brazil.)

A new fungus species herein referred as *S. anacardii* is described causing typical angular leaf spots on cashew plants in Brazil. Spots are more conspicuous on seedling leaves. The fungus produces black or dark brown pycnidia, erumpent, which are ostiolate, mainly *hypophyllus* seldom *epiphyllus*. Conidia are hyaline, moderately to strongly curved, 38-66X2.5-5.0 mm, and have 3-8 septa. *S. anacardii* is nowadays widespread throughout cashew plantations of the Brazilian northeast but it does not appear to pose a threat for cashew crops.

**433.** OLIVEIRA, JMS dc. 2001. **Anther and pollen development in *Anacardium occidentale* clone CP76.** *Phytomorphology* 51(1): 91-100

The CP76 clone of cashew bears perfect and staminate flowers; the androecium shows nine small stamens and one large stamen, all of which have the same anatomical structure. The wall of the sporangia has four layers between the epidermis and the sprogeneous tissue: fibrous endothecium, 2 middle layers and secretory tapetum. Meiosis is simultaneous, resulting in tetrahedral tetrads. The pollen grain wall presents anexine, medine, and intine. The exine is longitudinally striated. The ectoaperture is elongate and the endoaperture is elongate, and therefore they do not coincide. At shedding,



the pollen grains are 2-celled; the generative cell is initially lenticular; the vegetative cell occupies almost all of the pollen.

**434.** OLIVEIRA, MEB de., OLIVEIRA, GSF de and MAIA, GA. 2002. **Main free amino acids in cashew fruit juice: variation during harvest.** *Revista Brasileira De Fruiticultura* 24(1): 133-137

Investigations were conducted during August - November of 1995 using the juice producing cashew clone CCP 09 in the state of Piauí, Brazil. Data are tabulated on medium values and statistical variation of medium values of alanine, serine, phenylalanine, glutamic acid, proline and tyrosine.

**435.** OLIVEIRA, PKB., OLIVEIRA, TS and CAMELO, AM. 2003. **Growth of cashew plants affected by increased soil density and temperature.** *Revista Brasileira De Ciencia Do Solo* 27(1): 11-18

This study investigated the growth and development of cashew nut plants at different levels of soil temperature and density, to corroborate the hypothesis; the higher the level of these factors, the lower the expected plant growth and biomass production. PVC tubes were filled with samples of eutrophic Red-Yellow Typic Podzolic soil collected from Ceará, Brazil, under controlled conditions and these soil columns exposed to two temperatures. In one of the treatments, PVC columns were insulated with polystyrene sheets and painted in aluminium colour, and in the other treatment, PVC columns without sheets were painted black to absorb more sun light. Density levels used in the compressed soil layers were 1.2, 1.3, 1.4, 1.5, 1.6 and 1.7 t m<sup>-3</sup>, and 1.3 t m<sup>-3</sup> in the rest of the column. The experimental design was completely randomized in 3 replications,

for six density and 2 temperature level treatments. After 12 months, plant shoots were collected to determine biomass, height, stem diameter and number of branches. Soil rings and roots were separated to determine the root area, root length, and root density by pixel number. Results indicated that higher soil temperatures and densities reduced growth, affecting both above-ground biomass and roots of the cashew nut plants.

**436.** OLIVEIRA, PKB., OLIVEIRA, TS and NUNES, RP. 2004. **Influence of environmental factors on the water relations of dwarf cashew plants subjected to 2 soil temperature regimes.** *Revista Ciencia Agronomica* 35: 149-156

This study aimed to measure the effects of environmental factors on the water relations of early dwarf cashew plants submitted to 2 different soil temperatures. Ninety day - old plants were cultivated under different temperatures on plastic tubes filled with red-yellow soil. The tubes were divided in to 2 groups. On the first group, the tubes were isolated with polystyrene foil and painted with aluminium-like colour. On the second group, the tubes were painted black for best sun light absorption. Path analysis was used to determine the effects, direct and indirect, of environmental factors, the relative water content, water potential, transpiration, stomatal conductance and CO<sub>2</sub> flow in the crop. Soil temperature reduced the relative water content and water potential of early dwarf plants, but did not affect transpiration, stomatal conductance or CO<sub>2</sub> flow.

**437.** OLIVEIRA, VH-de., MIRANDA,FR-de and SANTOS, FJS. 1999. **Behavior of grafted dwarf cashew clones under different**

**irrigation regimes.** *Agrotropica*. 11: (2): 63-66 (Empresa Brasileira de Pesquisa Agropecuária/Centro Nacional de Pesquisa de Agroindústria Tropical (EMBRAPA/CNPAT), 60511-110, Fortaleza, Ceara, Brazil.)

The effect of irrigation on the production of grafted dwarf cashew (*Anacardium occidentale*) clones was evaluated during 1996-97 in Paraipaba, Ceara, Brazil. Three cashew clones, CCP 09, CCP 76 and CCP 1001, were subjected to different irrigation regimes: (1) no irrigation, (2) irrigation at 1-day intervals, (3) irrigation at 3-day intervals, and (4) irrigation at 5-day intervals. The amount of water applied was based on class A pan evaporation. Irrigation increased cashew nut production in CCP 09 and CCP 76. However, CCP 1001 was the most promising cultivar under rain-fed conditions.

**438.** OLIVEIRA, VH., MIRANDA, FR and LIMA, RN. 2006. **Effect of irrigation frequency on cashew nut yield in Northeast Brazil.** *Scientia Horticulturae* 108(4): 403-407

The study was carried out in Ceara, Brazil, with the goal of evaluating the response of three dwarf cashew clones to different irrigation frequencies. Cashew trees were evaluated during seven consecutive seasons, from the 2nd to the 8th year after planting. Four irrigation treatments were used: no irrigation, and irrigation when accumulated evaporation on a class 'A' pan equaled 10mm, 30mm and 50mm. The sub plot treatments were three cashew clones (CCP 09, CCP76, and CCP 1001). Seasonal irrigation rates were the same for all irrigated treatments, and ranged from 400 to 500mm per year for fully developed plants. Response to irrigation varied among cashew

genotypes. Irrigation had a significant effect ( $P<0.05$ ) on nut yield of cashew clones CCP 76 and CCP 09. The highest nut yield was obtained with cashew clones CCP09, irrigated when accumulated pan evaporation reached 10mm. Cashew trees trended to alternate years of high yield and years of low yield, even when irrigation was applied. Irrigation did not influence nut weight of clones CCP 76 and CCP 09.

**439.** OLIVEIRA, VH de., BARROS, L de M and LIMA, RN. 2003. **Influence of irrigation and genotype on the nut production of precocious dwarf cashew.** *Pesquisa Agropecuaria Brasileira* 38(1): 61-66

The influence of irrigation and genotype on the nut yield of precocious dwarf cashew was evaluated in a 3-year trial (1996-98) in Ceara, Brazil. Treatments comprised: three clones (CP 09, CP 76 and CP 1001) and four irrigation treatments, irrigation at control, 1, 3 and five- day intervals. Cashew dwarf clones did not significantly differ in nut yield upon irrigation treatments. CP 09 and CP 76 showed better performance than CP 1001 in terms of stability of nut production. Clone CP 76, independent of irrigation treatments used, showed less productivity than CP 09 and CP 1001.

**440.** OLIVEIRA, VH. de. 2000. **Effect of irrigation and inflorescence position on sex expression in dwarf cashews.** *Pesquisa Agropecuaria Brasileira* 35(9): 1751-1758

In a study from 16 May to 28 August 1998 in Paraipaba, Ceara, Brazil, 3.5 year old cashew cv. CP 09 plants were grown with or without irrigation. The total length of the flowering period, and the percentages of the

whole, staminate and abnormal flowers were not affected by irrigation. The number of whole flowers was greatest on east and north facing sides of the stem, staminate flower numbers were greatest on the north facing side, and abnormal flower numbers were greatest in west and south facing sides.

441. OLIVEIRA, VH.de. and BARROS, L. de M. 2003. **Influence of irrigation and genotype on the nut production of precocious dwarf cashew.** *Pesquisa Agropecuaria Brasileira* 38(1): 61-66 (vitorcnpat. embrapa.br)

The influence of irrigation and genotype on the nut yield of dwarf cashew was evaluated in a three year trial (1996-98) in Ceara, Brazil. Treatments comprised: 3 clones (CP 09, CP 76, CP1001) and 4 irrigation treatments (irrigation at one, three, five day intervals and control). Cashew dwarf clones did not significantly differ in nut yield up on irrigation treatments. CP 09 and CP 76 showed better performance than CP 1001 in terms of stability of nut production. Clone CP76, independent of irrigation treatments used, showed less productivity than CP 09 and CP 1001.

442. OLUNLOYO, OA. 1998. **Initiation and prevalence of fungal rot of pseudoapples of cashew in the plantation.** *Nigerian Journal of Tree Crop Research* 2 (1) : 60-71

Field observations indicate that large quantities of cashew apples are lost to fungal rot in Nigeria. Studies showed that the apples became infected by a complex of fungi which included *Geotrichum candidum*, *Mucor spinosus*, *Aspergillus niger*, *Penicillium citrium* and *Botryodiplodia theobromae* all of which were found to be disseminated by the fruit flies.

In general fungal rot of the apples was most prevalent on wounded, undisinfected and unprotected apples on which 26 to 100% loss was obtained.

443. OLUNLOYO, OA. 1997. **Observation of a strange greenpoint gall disease on cashew.** *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania.

A hyperplastic enlargement of bud-like tissues in the form of greenpoint gall has been observed on both small and medium sized side branch of 3 cashew genotypes in the NW7 plot at Ochaja Substation. Initial symptoms of this abnormal growth started from a leaf scar or canker-like depression as small swellings on the surface of which are green bud-like points. The number of the green points increased as the gall developed. The gall could attain a diameter of 2 to 8cm depending on the size of the initial scar, within 6 months. This abnormality caused the death of the affected branches above the gall.

444. OLUNLOYO, OA. 1997. **Observation on a predisposing factor in *Curvularia* leaf spot disease of cashew seedlings in Nigeria.** *Proceedings of International Cashew And Coconut Conference*, Dar Es Salaam, Tanzania.

A peculiar leaf spot disease has been consistently observed on cashew seedlings in Nigeria. The leaf spot associated with *Curvularia senegalensis*, was preceded by interveinal chlorosis manifested on 8 week-old seedlings. Results showed that only chlorotic leaves were infected and yielded Koch's Postulates. In water culture experiments, iron deficiency was found to be responsible for the chlorosis which predisposed 8-week-old

cashew seedling leaves to infection by *Curvularia senegalensis*. This finding was strengthened by the failure of the fungus to infect seedlings that received a high dose of iron.

**445. OLUNLOYO, OA. 1998. Persistence of fungicide-insecticide combination on cashew flowers: a system for timing spray schedule. Nigerian Journal of Tree Crops Research 2(1): 72-82**

A system for timing chemical spray schedules in the field was developed by relating the extracts of cashew flowers treated with benomyl-dimethoate mixture with their ability to inhibit growth of *Lasiodiplodia theobromae* in bioassay tests. Results showed that benomyl persisted for 14 days after spray application at both prebloom and full bloom stages while dimethoate applied alone on the flowers persisted for 21 days after treatment. The mixture of benomyl and dimethoate applied on cashew inflorescence persisted for 28 days after treatment.

**446. OWAIYE, AR. 1996. The yield potential of cashew pseudoapple-colour types: a preliminary comparative assessment. Discovery and Innovation 8(1): 7-10 (Cocoa Research Institute of Nigeria, PMB 5244, Ibadan, Nigeria.).**

The yield potential of cashew pseudoapple colour types as evaluated in trials of pink and yellow pseudoapple types of the cultivar Iwo T11 grown in ferrallitic soil in the southern guinea savanna under 12 NPK fertilizer regimes between 1986 and '90. Pooled 4 year yields showed that the yellow pseudoapple colour type was significantly

higher yielding than the pink across sites. These preliminary results indicate that separation of varieties by pseudoapple colour is possible.

**447. OWUSU, J., OLDHAM, JH and ODURO, I. 2005. Viscosity studies of cashew gum. Tropical Science 45(2): 86-89**

Studies were conducted to compare the viscosity of cashew gum with commercial gum arabic and assess the potential of cashew gum in food processing. Solutions of 5, 10, 15, 20 and 25% w/v of both gums were prepared and left to stand for 30 minutes at room temperature. Both gum solutions showed an increase in viscosity with concentration, but the increase for gum arabic was more gradual than that of the cashew gum. Both gum solutions showed a rapid initial decline in shear rate followed by a gradual decreasing rate. The viscosity of the stored solutions declined with time but the rate was slower for cashew gum than for gum arabic. Both gums gave a slight reduction in viscosity with pH reduction. Cashew gum also had a slight decline in viscosity with temperature. Most viscosity characteristics of cashew gum were similar to commercial gum arabic, indicating that cashew gum could be used in food products.

**448. PADHY, SK., RATH, S and KAR, M. 1994. A note on the effect of sulphur dioxide fumigation on cashewnut. Orissa Journal of Horticulture 22(1/2): 80-83**

Seedlings (1.5 years old) of cv. Vengurla were fumigated with SO<sub>2</sub> at 0.25, 0.50 or 1.0ppm for 1, 2, or 3 h in polyethylene chambers and percentage leaf injury, effects on growth parameters, and plant S and chlorophyll contents were assessed. Cashew was shown to be particularly sensitive to SO<sub>2</sub>, as demonstrated

by leaf injury and loss of chlorophyll.

449. PAIVA, JR de, CAVALCANTI, JJV and CORREA, MC de M. 2004. **Influence of root stock on the performance of dwarf cashew clones under irrigation.** *Revista Ciencia Agronomica* 35: 220-226

The effects of 6 cashew root stocks (PE 15, PE 11, PE 17, PE 18, PE 19 and PE 12) on the performance of dwarf cashew clones (EMBRAPA 51 and CCP76) were determined. The effects of the root stock used was more evident on the clone EMBRAPA 5. The interaction of canopy x rootstock had no significant effects on the yield and nut weight of the clones.

450. PAIVA, JR de, Barros, L de M. and Cavalcanti, JJV. 2005. **Selection of common cashew clones for commercial plantation in the Northeast Region.** *Revista Ciencia Agronomica* 36(3): 327-332

A study was conducted to evaluate and select among the 40 common cashew clones for commercial production in Ceara, Brazil. Plant height (m) and canopy diameter (m) were measured for 5 years. Also nut yield control was done for 2 years. The clone Comum 30 showed the best nut yield performance, with 885 and 1117 kg/ha in the first and second year of production. Considering all agronomic and kernel traits together, the clones Comum 18, Comum 21, Comum 28, Comum 30, Comum 31 and Comum 36 are the most promising materials to be tested in wide scale. These clones may be recommended for commercial production under nonirrigated conditions in Beberibe county region, Brazil.

451. PAIVA, JR de., BARROS, L de M and CAVALCANTI, JJV. 2005. **Selection of dwarf**

**cashew clones for commercial plantation in Aracati county, Ceara, Brazil.** *Revista Ciencia Agronomica* 36(3): 338 -343

The attainment of new genotypes adapted to the climate conditions and soil of each environment contributes in a decisive way to the success of the cashew agribusiness in Brazil. This work aimed to select new dwarf cashew clones for the conditions of Aracati county, Ceara, Brazil. The traits plant height, canopy diameter and nut production were evaluated. The results obtained from 2000 to 2003 showed that 10 clones (66% of the total) in the first year, 8 clones in the 2nd year and 14 clones in the 3rd year did not differ from the CCP 76 (control). For both plant and kernel technological traits PRO 555/1 and CAPI 7 clones were considered the most promising materials.

452. PAIVA, JR de., BISCEGLI, CI and LIMA, AC. 2004. **Cashew nut analysis by magnetic resonance tomography.** *Pesquisa Agropecuaria Brasileira* 39(11): 1149-1152

A study was conducted to evaluate the technique of magnetic resonance tomography for cashew nut analysis compared to the traditional method of clone selection. Samples of cashew nut from 40 clones harvested in 2002 were analysed using both methods. Using the traditional method, most of the clones showed high and medium values of the industrial indicators, nut and seed mass, and industrial yield as well as low values of seed breakage. By magnetic resonance tomography, majority of the clones showed cashew nuts with empty spaces between the nut and the endocarp which can protect the seed during decortication. The results for the two methods were

complementary and the tomography, besides being a promising option for the quality evaluation of cashew nut, can give support to other research related to cashew nut.

**453.** PAIVA, JR-de., MOURA-BARROS, L-de and CRISOSTOMO, JR. 1998. **Inbreeding depression in early dwarf type progenies of cashew var. nanum.** *Pesquisa Agropecuaria Brasileira*. 33 (4): 425-431 (Embrapa-Centro Nacional de Pesquisa de Agroindustria Tropical (CNPAT), Caixa Postal 3761, CEP 60511-110 Fortaleza, Brazil.)

With a view to estimating the inbreeding depression rate in cashew plants, data on vegetative characters and yield traits of 12-, 18- and 29-month-old dwarf cashew progenies which had been obtained via selfing, open pollination or controlled pollination of CCP76 and CCP1001. Germination percentage was high in all groups of plants (81% to 94%), with the exception of self pollinated seeds of CCP1001 which gave only 63% germination. The damaging effects of endogamy were more pronounced for yield and number of seeds. Seed yield per plant was decreased by 37.6% in the CCP76 clone and by 48% in the CCP1001 clone; number of seeds per plant was decreased by 25.3 and 43.3% in CCP76 and CCP1001, respectively.

**454.** PAL, ARINDAM and SOMAYAJI, KS. 1999. **A status paper on cashew processing industry.** *The Cashew* 13(3): 41-50

Cashew processing like any other agro-processing unit is characterized by seasonal availability and price volatility of raw material. The study reveals that the industry is already having capacity. Care should be exercised while financing any new unit and providing adequate

working capital support to existing units may help in improving production capacity utilisation as well as profitability.

**455.** PALANISAMY, K., KUMARAN, PM and THIMMAPPAIAI. 1994. **Photosynthetic characteristics of released varieties and purple variety of cashew.** *The Cashew* 8(4): 19-22 (Tropical Forest Research Institute, RFFC,P.O., Mandla Road, Jabalpur-482 021, M.P.)

Photosynthetic characteristics was studied on 12 released varieties of different states which are planted in the evaluation trial. It was found that BLA 39/4 of Kerala origin showed maximum nut photosynthesis (Pn), transpiration (E) and stomatal conductance (gs). High rate of CO<sub>2</sub> fixation was also observed in H2/12, Tree No. 56, MIO/4, EPM/8, H2/11 and Ullal 1. No significant difference was noticed in E and gs in all the varieties except BLA 39/4. In purple variety Pn, leaf fresh and dry weight and leaf area were less when compared to normal cashew type.

**456.** PAL, S and MEDDA, PS. 2006. **Occurrence of wild silk moth, *Cricula trifenestrata* (Helfer) on cashew, *Anacardium occidentale* L. under terai conditions of West Bengal.** *Orissa Journal of Horticulture*. 34(1): 117 (Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal - 736 165, India. )

During October 2002 and May-June 2003, large numbers of larvae were found infesting a cashew plantation in Pundibari, Cooch Behar, West Bengal, India. The insect was later identified as *Cricula trifenestrata*. In the early stage, the larvae were found congregated on the under-surface of leaves.

Later, the larvae dispersed but were restricted to feeding on leaves of a few neighbouring branches. The larvae were seen feeding voraciously on leaves, resulting in complete defoliation with only the midribs being left. If left uncontrolled, the larvae can defoliate the whole plant as it moved from one side of the plant to another. During both seasons, the insect was effectively controlled by spraying with contact insecticides having a knock down action, such as cypermethrin. This is thought to be the first report of *C. trifenestrata* infesting cashew from this region.

457. PARAMASHIVAPPA, R. 2001 **Novel method for isolation of major phenolic constituents from cashew nut shell liquid.** *Journal of Agricultural and Food Chemistry* 49(5): 2548-2551

Commercially available CNSL mainly contains the phenolic constituents anacardic acid which exhibits enzyme inhibitory properties as well as antitumour, antimicrobial and antiacne properties; cardol which has many application in the form of phenol formaldehyde resins in varnishes, paints and brake linings; and cardanol which is active against the filarial parasite of cattle *Setaria digitata*. This paper describes the separation of anacardic acid, cardol, and cardanol for industrial application. Anacardic acid was selectively isolated as calcium anacardate. The acid free CNSL was treated with liquor ammonia and extracted with hexane/ethyl acetate (98:2) to separate the mono phenolic component, cardanol.

458. PATIL, VS., BULBULE, AV and NAGRE, PK. 2004. **Rejuvenation of unproductive cashew trees in Western Ghat Zone of Maharashtra State.** *Journal of*

*Plantation Crops* 32((supl)): 245-247 (Proceedings of PLACROSYM - XVI.)

Studies were conducted to identify the suitable period for beheading the cashew trees and subsequently grafting the same in Western Ghat Zone of Maharashtra State. Field experiment was conducted in high rainfall area during 1998 - 99 and 1999 - 2000 on 10 year old cashew trees of seedling origin. Trees beheaded in the first week of May and subsequently grafted in July recorded the highest grafting success rate (85.7%) followed by beheading of trees in first week of June and grafting new shoots in September (75%). The success rate was poor when the trees were beheaded in other months due to mortality of trees, low/high temperature and non availability of proper scion material.

459. PEARSON, SM., CANDLISH, AAG., AIDOO, KE and SMITH, JE. 1999. **Determination of aflatoxin levels in pistachio and cashew nuts using immunoaffinity column clean-up with HPLC and fluorescence detection.** *Biotechnology Techniques*. 13 (2): 97-99 (School of Biological and Biomedical Sciences, Glasgow Caledonian University, Glasgow G4 OBA, UK. )

A technique for the detection of aflatoxins in pistachio and cashew nuts using immunoaffinity column clean-up with HPLC and fluorescent detection is presented. Recoveries were in the range of 79-99% for pistachio samples artificially contaminated with 10 µg total aflatoxins / kg of food sample. For cashew samples recoveries ranged from 80-106%. This method is proposed as an accurate technique for aflatoxin detection in the range of µg aflatoxins/kg nuts.

460. PEETHAMBARAN, CK. 1996. **Cashew in Kenya.** *The Cashew* 10(3): 15-17 (Dept of Plant Pathology, College of Agriculture, Vellayani, P.O., Trivandrum 695 522).

The history of cashew production in Kenya, current production of cashews and reasons for the decline in cashew production (including the mismanagement of cooperatives set up to buy cashews which caused poor returns to growers which in turn resulted in improper management and neglect of trees), are discussed.

461. PENG, RK., CHRISTIAN, K and GIBB, K. 2005. **Ecology of the fruit spotting bug *Amblypelta lutescens* in cashew plantations, with particular reference to the potential for its biological control.** *Journal of Entomology* 44(1): 45-51

The fruit spotting bug, *Amblypelta lutescens lutescens*, is one of the principal insect pests of cashews in Australia. Its population dynamics were studied to find suitable management methods. Observations of bugs reared in netting bags showed a sequence of change in bug - damage symptoms after 12h and up to 3 days. Field observations revealed that adults preferred to feed and rest on the shady side of the tree. The number of bugs accounted for only 17-35% of the total variability in the number of damaged shoots with fresh damage symptoms was a more reliable parameter for determining the presence and level of activity of bugs than was a direct estimate of the number of bugs. The green tree ant was the most important factor regulating bug populations. Green tree ants should be considered as an important biological control agent for fruit spotting bug, and monitoring should be commenced when cashew trees start

to flush.

462. PENG, RK. 1999. **The effect of levels of green ant, colonisation on cashew yield in northern Australia.** *Biological Control in the Tropics*: 24-28 (Proceedings of the symposium on Biological Control held in MARD.)

Field surveys and experiments carried out over a period of four years 1995-98 in Northern Territory, Australia, showed that cashew trees fully occupied by green ants, *Oecophylla smaragdina*, produced higher yields than trees with low presence of the ants or without the ants due to predation of cashew pests by the ant. Yield was positively correlated with levels of ant colonization 83-90% of the total variation in yield was explained. After stopping the use of insecticides, the ant colonisation level increased from 0 to 80% for the first 2 to 3 years, and then the level oscillated under 80%.

463. PENG, RK and CHRISTIAN, K. 1998. **Potential of using colonies of the green ant, *Oecophylla smaragdina* to control cashew insect pests.** *Proceedings of the Sixth Workshop for Tro. Agril Entomology* 11-15 May; (Faculty of Science, NT University, Darwin, NT 0909, Australia..)

The green ant *O. smaragdina* is a dominant predator of the main insect pests in cashew plantations in NT, Australia but its potential with respect to cashew yield must be documented before cashew growers accept the ants as biological control agents. Yield was closely related to the abundance of green ants in trees, and the yield pattern followed the following series: trees fully occupied by the ants > trees partly occupied by the ants > trees with low presence of the ants. Yield was also



positively correlated with ant colonization level; 66- 90%. It is suggested that cashew growers cannot rely on natural dispersal of the ants to control cashew insect pests and the isolation of colonies is a way to achieve high yield.

464. PENG, PK., CHRISTIAN, K and GIBB, K. 1997. **Control threshold analysis for the TMB and preliminary results concerning the efficiency of control.** *International Journal of Pest Management* 43(3): 233-237 (Faculty of Science, Northern Territory University, Darwin NT-0909, Australia.).

*Helopeltis pernicialis* damage to a cashew crop in the Australian NT was very serious in each of 2 years, resulting in no harvest unless the trees were protected by either pesticides or biological control agents. Preliminary results showed that at the time when *H. pernicialis* caused serious damage to a tree without *Oecophylla smaragdina* nests, a tree with a constant ant population was only slightly damaged, and the damage level never exceeded the control threshold of 6-10. It is suggested that *O. smaragdina* has high potential as a biological control agent.

465. PENG, RK., CHRISTIAN, K and GIBB, K. 1997. **Bioecology of the TMB with particular reference to the control efficiency by the green ant.** *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp. 170-174

The bioecology of *Helopeltis pernicialis* and the effect of *Oecophylla smaragdina* on *H. pernicialis* were investigated from 1993 to 1996 in the Northern Territory of Australia. Techniques used included field surveys, field observations, and field and laboratory rearing. A flexible netting bag was developed to rear

insects on the tree canopy. A very patchy distribution was detected in the non sprayed area, and this was mostly explained by the distribution of green ants. It is suggested that *O. smaragdina* has potential as a biological control agent in cashew plantations in northern Australia.

466. PENG, RK., CHRISTIAN, K and GIBB, K. 1997. **The effect of green ants on insect pests in cashew plantations.** *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania. pp. 179-181

There were 3 main insects in cashew plantations in the Northern Territory of Australia, which caused enormous damage to cashew growing tips, foliar and floral flush, apples and nuts every year. They are the TMB, the fruit spotting bug and the mango tip borer. The green ant (*Oecophylla smaragdina*) was found to be an effective predator of these pests. The foliar and floral flush were damaged to a greater degree on the trees without green ants than on those with green ants. There was no difference in cashew flowering and fruiting between the trees protected by pesticides and those attended by green ants.

467. PEREIRA, MCT., CORREA, HCT and NIETSCHE, S. 2005. **Physical-chemical characterization of precocious dwarf clones cashew nuts and stalks in north of the Minas Gerais state, Brazil.** *Bragantia* 64(2): 169-175

An experiment was conducted to determine the Physical-chemical characteristics of precocious dwarf cashew nuts and stalks of clones CCP 76, CCP 06, CCP 1001 and CCP 09 from Minas Gerais, Brazil. The stalks of CCP 76 showed deep orange colouration, pear-

shaped form, good chemical features and stalks with adjusted firmness. CCP 09 presented minimum intense orange coloration and low firmness.

**468.** PEREZ-MIRANDA, M., PEREZ-VICENTE, LF and PUEYO-FIGUEROA, M. 2005. **Leaf spotting in cashew plants (*Anacardium occidentale L.*) caused by *Phomopsis anacardii* Early & Punith.** *Fitosanidad* 9(2): 21-24 (Laboratorio Central de Cuarentena Vegetal, Centro Nacional de Sanidad Vegetal, Ayuntamiento 231, c/ San Pedro y Lombillo, Plaza de la Revolucion, Ciudad de La Habana, Cuba. )

Symptoms consisting of necrotic blotches, shoot drying, leaf patches and inflorescence blights were observed on cashew plants (*Anacardium occidentale*) in Quivicán, La Havana Province, Cuba. Dried shoots and necrotic leaves were collected on paper bags and incubated in humid chambers for 48 hours in the laboratory, and all the present fungal structures were identified and measured. Fungal structures observed under microscopy were transferred to sterile Petri plates with potato dextrose agar (PDA). The morphology of the isolates agree with the description of *Phomopsis anacardii*. This is the first complete description of *P. anacardii* infecting cashew in Cuba.

**469.** PEROZO-BRAVO, A, RAMIREZ-VILLALOBOS, M and GOMEZ-DEGRAVES, A. 2006. **Germination and morphological characteristics of cashew seedling yellow type.** *Revista De La Facultad Agronomia* 23(1): 17-27

Germination and the morphological characteristics of cashew seedling yellow type were analysed. A total of 240 seeds were sown with the distal area up in gumbo limbo

composed by sand and organic matter (2:1). The number of germinated seeds was qualified daily for 14 days to determine the germination rate (TG), and was registered weekly for 28 days to measure the germination percentage. Within 28 days , variables were measured such as height of the plant (AP), root's longitude (LR), number of leaves (NH), and number of nodes (NN) per seedling. For each response variable, the frequency distribution, descriptive statistics and Spearman coefficient were used to correlate variables. Germination was 86.9% at 14 days and extended to 28 days with a PG of 97.9%, TG was of 99.9 days. AP was 33.7+ 6.8cm, LR was 20.6+4.1cm, NII was 10.4+1.4cm and NN was 7.2+1.4cm. AP and LR frequencies were classified in five well-defined groups, each one representing 20% of the population. NH tendency was from 10 to 11 and the one of NN was from 7 to 8 with frequency percentage of 59.4 and 54.3% respectively.

**470.** PILLAI, CKS. 1998. **Cashewnut shell liquid: recent research and developments.** *The Cashew* 12(3): 149-158 (Regional Research Laboratory, CSIR, Trivandrum- 695 019,Kerala.).

It has been shown that CNSL has the structural requirements for developing in to high value polymers. Out of the many novel findings outlined so far, it appears that the development of transparent resin from CNSL has the maximum possibility for ultimate utilization as an industrial technology. This resin can be utilized not only in surface coatings, but also as high tech products such as photo resist polymers, polymer supports, etc.

**471.** PILLAI, SP. and BHAT, KK. 1998. **Plant hygiene and infestation control in cashew processing units for quality improvement**

in cashew. *The Cashew* 1998 12(3): 133-136 (Central Food Technological Research Institute, Mysore-570 013, Karnataka.).

This paper dealt with the various control measures to be under taken for quality improvement of cashew kernels in cashew processing units of India.

472. PINO, JA. 1997. **The volatile constituents of tropical fruits. III. Feijoa and cashew.** *Alimentaria* 35(286): 41-45 (I.I.I.A., Carretera del Guatao, km 3.5, La Habana 19200, Cuba.)

Studies on the isolation and identification of the volatile constituents of feijoas and cashew fruits are reviewed. The volatile constituents identified in fruits of each of the above species are listed.

473. PINTO, SAA., ALVES, RE., MOSCA, JL and MOURA, CFH. 1997. **Fresh consumption quality of the apple of some Brazilian early dwarf cashew clones (*Anacardium occidentale*).** XXXXIII Annual Meeting, Guatemala City, Guatemala, 1-4 September 1997. *Proceedings of the Interamerican Society for Tropical Horticulture.*, publ. 1998, 41: 189-193 (Embrapa/Agroindustria Tropical, C.P. 3761-60.511-110, Fortaleza-CE, Brazil.)

In 1996, 11 cashew clones with orange to red coloured apple [fruit] (consumers' preferences) were selected within an experiment of clone competition and evaluation, set up under dry conditions in Pacajus, Ceara, Brazil. Clone CAP 29 (CCP-76) was used as control. From the 11 clones evaluated, only one was inferior to the control for apple colour. Clones CAP-11, CAP-15 and CAP-22, stood out as significantly ( $P < 0.05$ ) firmer than the control, which suggests that they

might have extended shelf lives as compared to the others. As related to the physical characteristics of the selected cashew apples, it was found that clones CAP-02, CAP-11 and the control CAP-29 (CCP-76) produced average apples (type 4), the most distinguished for market purposes. No significant difference was found among the clones for soluble solids and acidity, whose mean contents were respectively 11.88° Brix and 0.36%. The amounts of soluble solids (around 10° Brix) in this experiment were above those usually reported for cashew in Brazil.

474. PIRIA, RS. and MANIVANNAN, N. 2001. **Path coefficient analysis in cashew.** *Agricultural Science Digest* 21(2): 129-130 (National Pulses Research Centre, TNAU, Vamban Colony-622 303.).

The association between yield and yield components of cashew genotypes BPL 5, V4, VRI 1, VRI 2, VRI 3 and a local genotype was studied by path coefficient analysis, during 1997-98, in Tamil Nadu. Correlation analysis showed the significant and positive association of collar girth, leaf length and number of nuts per panicle with nut yield per tree. Most of the yield components had high positive indirect effect on yield through collar girth, and high negative indirect effect through fruit weight. The characters collar girth, panicle breadth, number of nut per panicle, and fruit and nut weight can be considered as selection indices in cashew improvement programmes.

475. PIRIA, RS. 1999. **Yield stability analysis in cashew.** *The Indian Journal of Agricultural Sciences* 69(12): 843-844

Six genotypes of cashew were evaluated for apple and nut yield during the fruiting season

(March-April) for 3 years during 1996-98. It was observed that the genotypes 'BPL-5', 'V4' and 'VRI 2' recorded superior mean performance and positive phenotypic index for nut yield and BPL-5 and VRI-2 for apple yield. The genotype grouping technique showed that V4 and VRI-2 for nut yield and VRI-2 for apple yield stability. Considering the overall performance, the VRI-2 could be adjudged as stable variety.

**476.** PITONO, J., TSUDA, M and HIRAI, Y. 2004. **Effect of shading on xylem vulnerability to dysfunction at the nursery stage in cashew.** *Japanese Journal of Tropical Agriculture* 48(3): 149-155.

The ability to maintain water continuity in the xylem under a low water potential is considered to be responsible for adaptation to drought in cashew. The effect of shading on the xylem vulnerability of cashew seedling was evaluated since the plants are grown under shading at the nursery stage. A strain with a resistant xylem (A3-1) and 2 strains with a vulnerable xylem (G-85 and Wonogiri -2) were grown in an open field and under shading for 4 months, and then the xylem vulnerability was determined. In A3-1, the applied pressure that induced a 50% loss of hydraulic conductivity (P50), which was the indicator of xylem vulnerability, was 1.55 MPa in the open field and A3-1 was found to be less vulnerable than G-85 and Wonogiri -2 in which the P 50 value was ca. 1.2 MPa. These results suggested that it would be important to grow the seedlings of A3-1 which displayed a resistant xylem under shading without spindly growth.

**477.** PITONO, J., TSUDA, M and HIRAI, Y. 2005. **Response of leaf temperature to soil water deficit in cashew seedlings.** *Japanese*

*Journal of Tropical Agriculture* 49(2): 126-131

The control of transpiration in cashew seedlings is important to enable them to cope with drought-prone environments. The response of the leaf temperature to soil water deficit, as an indicator of transpiration, was examined in 10 cashew strains from Indonesia. The seedlings were grown in 4.3 litre pots filled with soil for about 3 months, and irrigation was withheld from half of these pots to reduce the content of soil water, while the remaining pots were well-watered. During midday on sunny days, the leaf temperature of the well-watered plants and plants subjected to the soil water deficit was determined with a handheld infrared thermometer as well as the temperature of a wet filter paper and a dry leaf. Soil water content was also determined. Based on these data, the leaf temperature ratio (LTR) as a relative value of leaf transpiration to potential evaporation (wet filter paper) was calculated. In MDR and A3-1, LTR was smaller than in the other 8 strains. LTR in the well-watered plants (LTR) ranged from 0.74-0.87, and strains MDR and A3-1 showed a low LTR. In these 2 strains LTR decreased more sensitively in response to the decrease of the soil water content. These results indicate that MDR and A3-1 may conserve soil water better because their transpiration rate was low under both well-watered and drought conditions.

**478.** PITONO, J., TSUDA, M and HIRAI, Y. 2002. **Xylem vulnerability to dysfunction in Indonesian Cashew strains.** *Japanese Journal of Tropical Agriculture* 46(3): 129-135

To determine whether the ability to maintain water transport in xylem, which is often responsible for plant adaptation to

drought, is a suitable parameter for early evaluation of drought resistance at the seedling stage, differences in xylem vulnerability to dysfunction and the relationship to xylem vessel diameter were examined in ten high-yielding strains in cashew. The xylem vulnerability was evaluated by the applied pressure which induced 50% loss of stem hydraulic conductivity (P50). Variation in the P50 value from 0.32 MPa for Wonogiri to 1.50 MPa for A3-1 was recorded among the strains. However, since there was no difference in the mean vessel diameter, the use of the vessel diameter was not suitable for the evaluation of xylem vulnerability. It was suggested that plant ability to maintain the water continuity in the xylem would be a suitable parameter for the early evaluation of drought resistance at the seedling stage in cashew.

479. PIYALI DAS and ANURADDA GANESH. 2003. **Bio-oil from pyrolysis of cashew nut shell - a near fuel.** *Biomass and Bioenergy*. 25(1): 113-117 (Energy Systems Engineering, Indian Institute of Technology, Mumbai 400 076, India.)

Cashew nut shell (CNS) has been studied for the product distribution in a packed bed vacuum pyrolysis unit. The effect of pyrolysis temperatures on the product yields is also studied. The oil-to-liquid ratio in the pyrolysis products was found to remain almost constant in the range between 400 degrees C and 550 degrees C. The properties of CNS oil has been found to be amazingly near to that of petroleum fuels with calorific value as high as 40 MJ kg<sup>-1</sup>, the oil has a low ash content (0.01%) and water content is limited to 3-3.5 wt% of oil.

480. PIYALI DAS., SREELATHA, T and ANURADDA GANESH. 2004. **Bio oil**

**from pyrolysis of cashew nut shell-characterisation and related properties.** *Biomass and Bioenergy* 27(3): 265-275

Biomass in the form of cashew nut shell represents a renewable and abundant source of energy in India. Cashew nut shell (CNS) was pyrolysed in a fixed bed pyrolysis reactor under vacuum. The CNS on heating upto 175°C produced dark brown oil (oil CO<sub>2</sub>), which was extracted, and the CNS, after the removal of oil CO<sub>1</sub>, was pyrolysed under vacuum. The pyrolysed vapours were condensed to get a combustible oil fraction (oil CO<sub>2</sub>) as well as a noncombustible aqueous fraction. The detailed chemical compositional analysis of both the oils as well as aqueous fractions were carried out by various techniques like liquid column chromatography, <sup>1</sup>HNMR, <sup>13</sup>CNMR, FTIR, GC-MS. The CNS oils (CO<sub>1</sub> and CO<sub>2</sub>) were found to be a Renewable atural resources of unsaturated phenols with long linear chains and marked absence of anacardic acid. Unlike other bio oils, the CNS oils have been found to be fairly stable. The oils were completely miscible in diesel and were found to have low corrosivity towards Copper and Stainless steel and thus promise to be a potential fuel.

481. PRABHAKARA, B and MELANTA, KR. 2003. **Influence of media on growth of cashew rootstock and grafts.** *The Cashew* 17(4): 18-22

The efficacy of various media in the preparation of potting mixture was evaluated for raising cashew rootstock and grafts. The proprietary compound was combined with red earth and sand at different ratio (v/v) and these treatment combinations were compared to know their effect on growth of rootstock and production of grafts. The growth parameters of

rootstock / grafts and percentage of graft success was found best in the potting mixture holding equal proportion of red earth, proprietary compound and sand.

**482. PRASAD, MVR and LANGA, A. 2000. Selection of elite cashew genetic material in Mozambique. *The Cashew* 14(1): 8-23**

Considering the paucity of genetic variability for productivity and resistance to cashew powdery mildew disease in Mozambique, seed progenies of Brazilian dwarf cashew varieties and local cashew populations were screened for productivity and tolerance to powdery mildew. The clonal and seed progenies of the selected Brazilian dwarf derivatives and seed progenies of the local cashew trees were evaluated in RBD designs and further selections were made on the basis of progeny performance.

**483. PRASANNAKUMAR, B., REDDY, MLN and RADIIAKRISHINA, Y. 2006. Studies on the NPK requirement of clonally multiplied cashew in sandy soils of Bapatla, Andhra Pradesh. *The Cashew* 20(3): 23-29**

The present study with 3 levels of N, P and K were studied for the growth and yield characters of clonally multiplied cashew in sandy soils of Bapatla. In the prebearing stage the growth parameters like plant height, stem girth and canopy area were much influenced by the higher doses of Nitrogen and Nitrogen and Phosphorous combinations. Similarly the initial harvesting period, the cumulative nut yield per tree was influenced by the nitrogen and N P doses and to little extent to the NPK nutrient combinations in the period of study. The cashew is responding well primarily for Nitrogen, and also to other nutrient

combinations.

**484. PRATISSOLI, D. 1997. Occurrence of *Necrobia rufipes* (De Geer) (Coleoptera: Cleridae) damaging cashew nut from India. *Anais-da-Sociedade-Entomologica-do-Brasil*. 26 (3): 573 (Centro Agropecuario da UFES, 29500-000 Alegre, ES, Brazil.)**

The occurrence of *Necrobia rufipes* damaging cashew nuts (*Anacardium occidentale*) from India, was recorded in Ceara state, Brazil.

**485. PUNNAIAH, KC and DEVAPRASAD, V. 1995. Management of stem and root borer *The Cashew* 9(3): 17-23**

Studies on the management of cashew stem and root borer, *Plocaederus ferrugineus* were carried out in 10 years aged cashew plantations. Two sets of treatments, one before extraction of grubs from damaged trees and another after extraction, were imposed in two different experiments and the efficacy of treatments in affording protection against the pest was tested for a period of one year. All the trees from which grubs were extracted after or before imposing treatments recorded significantly lower damage than control throughout the period of observation. The trees treated with phorate granules by placement recorded comparatively less damage among the treatments imposed before extraction, recording 72.7 percent mortality of grubs of *P. ferrugineus*.

**486. PUNNAIAH, KC and DEVAPRASAD, V. 1996. Studies on population dynamics of cashew leaf folders. *The Cashew* 10(1): 5-8**

Studies were conducted in cashew plantations of Bapatla during the period from June 1986 to May 1989 on population dynamics

of cashew leaf folders *Hypotima haligramma*, *Dudua approbata* and *Caloptilia tiselaea*, which were not discriminated for recording the leaf folder population, in relation to seasonality, weather and age of plantations. The leaf folders were observed from second fortnight of August to first fortnight of March. However, prolonged occurrence was observed only during 1988-89 with highest population of 47.8 per 25 laterals during first fortnight of November causing maximum leaf damage of 16.8 per cent. Weather variables viz. maximum temperature, relative humidity and rainfall could combinedly explain 51.5% of the total variation in number of leaf folders. Maximum temperature and relative humidity had a significant negative effect while minimum temperature had a significant positive effect on population fluctuation independently. Higher population and damage of leaf folders were observed on the plantation of 8-11 years age.

487. RADHAKRISHNAN, D. 2000. **Neem products-more effective in control of tea mosquito bug in cashew.** *The Cashew* 14(3): 35

Neem based plant protection products like Achook and Rashshak were much efficient in controlling TMB. The use of neem based products will ensure safety in application as well as avoid residual toxicity and hence appreciated by farmers.

488. RAJABASKAR, D., SURESH KUMAR, RS and CHOZHAN, K. 2002. **Persistence and dissipation of lambda cyhalothrin in/on cashew.** *PLACROSYM - XV*: 596-598

Two supervised trials were conducted one at Vamban, NPRC and RRS, Viridhachalam during 1999-2000 and 2000- 01 respectively. Three applications of lambda cyhalothrin

10,15, 20, 30 and 40 ppm were given. Samples were collected on days 0,1,3,5,7 and 15 of treatment. Residues in 50 g samples were extracted with acetone, cleaned up with dichloromethane and final determination was done by GC, ECD. The initial deposit of 0.67 and 1.1 ppm was detected on immature cashew apples at the lowest concentration of 10 ppm during 2000 and 2001 respectively. The deposit was as high as 2.8 and 3.7 ppm at the highest concentration of 40 ppm. The residues dissipated to BDL. Irrespective of the concentrations on day 15 of application. The estimated half life was 0.9 - 1.0 days at the lowest dose and 1.4 -1.5 days at the highest dose. The tentative waiting period arrived was 4.4-5.7 days at the recommended concentration of 10 ppm a.i. considering the MRL of 0.02 ppm.

489. RAJAPAKSE, R. 1997. **The integrated management of important cashew insect pest of Sri Lanka: a case study.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp. 165-169

The studies on *Helopeltis antonii* were centered on population fluctuation, timely pesticidal schedules to coincide with emergence of new flushes and fruits and natural enemies with studies on life biology. Research on egg laying habits, contact action of 6 pesticides and use of a microbial agent were emphasized in *Plocaederus ferrugineus* control in Sri Lanka. An integrated management programme for the control of above 2 insect pests are presented based upon the results of above aspects carried out in Sri Lanka.

490. RAMAN, DIVYA S., PUSHPALATHA, PB and JOHN, JP. 2002. **Processing qualities**

**of cashewnut in relation to flowering phases of varieties.** *The Cashew* 16(3): 9-14

Corresponding to the phases of flowering in cashew, the phases of harvest can also be divided in to three, viz. early, mid and late. The mid crop recorded the highest nut and kernel weight, while shelling percentage obtained was highest in the nuts of early harvest. The late season crop recorded the highest white whole recovery and the minimum kernel pices. The nuts of early and mid harvest were superior in terms of nutritive value of the kernels.

**491.** RAMANAYAKE, SMSD and KOVOOR, A. 1997. *In vitro* micrografting and micro-propagation of *Anacardium occidentale* L. *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania.

Seedling of cashew were established *in vitro* for use of root stock. The embryonic axis together with a small part of the cotyledon excised from mature nuts cultured in a basal MS medium initiated germination. When these were transferred to a modified MS medium with BAP and activated charcoal the seedlings unfurled leaves and grew fast. An *in vitro* micrografting technique was also developed using seedling material. The induced axillary shoots or the shoot tips of seedlings were used as the scion. Reduction of browning and callusing of cut ends were controlled by the application of a mixture of GA.

**492.** RAMANAYAKE, SMSD and KOVOOR, A. 1999. *In vitro* micrografting of cashew (*Anacardium occidentale*L.) *Journal of Horticultural Science and Biotechnology* 74(2): 265-268 (Institute of Fundamental Studies, Hantana Road, Kandy, Sri Lanka.).

The requirements of *in vitro*

micrografting of cashew are described. Excised embryos germinated *in vitro* were used as rootstocks. Shoot tips and axillary shoots proliferated from seedling shoots were the source of scions. Flooding the cut surfaces immediately in the mixture that contained citric acid controlled oxidative browning. Firm contact between the scion and rootstock was assured through the use of an aluminium foil tube at the graft junction. An IAA pretreatment of the scions and a culture medium with NAA that enhanced rooting brought about graft fusion and development.

**493.** RAMESH, A and VIJAYALAKSHMI, A. 2002. Environmental exposure to residues after aerial spraying of endosulfan residues in cow milk, fish, water, soil, and cashew leaf in Kasaragod, Kerala, India. *Pest Management Science* 58(10): 1048-1054

A detailed study has been conducted to evaluate the residues of endosulfan and its principal metabolite which may have accumulated in environmental samples due to regular aerial spray application of endosulfan on cashew leaf plantation for a period of 20 years. Three months after the last spray of endosulfan at 350g/litre EC at 300ml/acre, a total of 93 samples of cow milk, fish, water, soil and dried cashew leaf were collected from a village in Kasaragod district, Kerala, India, where endosulfan contamination was likely to have occurred. All the samples were analysed for total residues of endosulfan, endosulfan sulphate and also the potential hydrolysis product endosulfan diol, using gas chromatography with electron capture detection. The minimum detection limits of total endosulfan was 0.001/ $\mu$ g/g. Analysis of soil samples showed the deposition of total



endosulfan residues in the range <0.001-0.010/µg/g, and dried leaf samples showed residues of endosulfan in the range <0.001-3.43 /µg/g dry weight. In cow milk, fish and water, endosulfan residues could not be detected above the minimum detection limit. Endosulfan diol was not observed in any sample. The data obtained was confirmed by GC-MS-EI using selective ion monitoring mode.

494. RAMESH, N., LINGAIAH, HB and KHAN, NM. 1999. **Economics of bio-fertilizer application in cashew graft production under eastern dry zone of Karnataka.** *Crop Research (HISAR)* 17(3): 336-341

In a trial in Chinthamani, India in 1996, cashew seeds were sown in bags of potting mixture to which *Azotobacter chroococcum*, *Azospirillum brasilense*, *Bacillus megatherium*, *Aspergillus awamori* (each at 2g/bag) was added. When seedlings were 8-10 weeks old, those suitable for grafting were selected and grafted with scions of cv. Ullal -1. Two months later, the number of successful grafts were recorded. Application of bio-fertilizers increased the number of graftable seedlings and the success of the grafts. The effect of inoculation was more pronounced during the rabi season than the kharif season. The cost-benefit ratio was higher in the bio-fertilizer treatments than in uninoculated controls.

495. RAO, ARK., NAIDU, VG., PRASAD, PR and BABU, KH. 2004. **Efficacy of different insecticides against cashew shoot and blossom webber *Lamida monocusalis* Walker.** *The Cashew* 18(3): 9-12 (AICRP on Tropical Fruits (Citrus), Tirupati - 517 502 (A.P), India.)

A field trial was conducted at Tirupati,

Chittoor District, Andhra Pradesh, India to evaluate the efficacy of different insecticides, i.e. endosulfan at 0.07%, quinalphos at 0.07%, monocrotophos at 0.05%, malathion at 0.15%, phosalone at 0.07%, dimethoate at 0.05%, and phosphamidon at 0.01% along with synthetic pyrethroid (fenvalerate at 0.01%) or chitin inhibitors (diflubenzuron at 0.05% and diflubenzuron at 0.05% + endosulfan at 0.07%), against cashew shoot and blossom webber (*L. monocusalis*). Five litres of the insecticide solutions were sprayed onto 12-year-old cashew trees on 2 September 1998 and 3 February 1999, both coinciding with peak incidence of shoot and blossom webber. The highest reduction in larval population was obtained with fenvalerate (91.06%), followed by monocrotophos (83.83%), diflubenzuron + endosulfan (79.97%) and malathion (77.18%).

496. RAO, AVDD, RAVISANKAR, C and REDDY, MLN. 2002. **Correlation between nut yield and plant characters in cashew nut.** *Journal of Research ANGRAU* 30(1): 98-100

Simple correlations among 17 selected characteristics, namely, mean nut yield per tree, tree height, stem girth, mean canopy spread, number of flowering laterals/m<sup>2</sup>, leaf area, duration of flowering, number of bisexual flowers per panicle, length of panicle, fruit set percentage, apple weight, apple length, nut weight, nut length, number of nuts per panicle, kernel weight, kernel length were studied on fourteen 5- year-old cashew clones in an experiment conducted in Bapatla, AP, India during 1997- 98. Nut yield had a highly positive correlation with stem girth, mean canopy spread, leaf area, number of flowering laterals /m<sup>2</sup>, number of bisexual flowers per panicle, fruit set percentage, number of nuts per

panicle and a significant positive relationship with panicle length.

**497. RAO, EVVB. 1997. Cashew crop improvement programmes in India.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp. 141-145 (National Research Centre for Cashew, Puttur-574202, Karnataka, India.).

The hybridisation programme was initiated first in Kerala and later at other CRS in different states with the primary objective of improving the nut size and realizing kernels with W-210 and W-240 grades. This attempt has enabled the release of 10 hybrids for cultivation in different cashew growing states. Breeding objectives also include development of ideal plant types with desirable attributes like bigger canopy, intensive branching, high sex ratio and bold nuts with export grade kernels. The results in the above breeding efforts generated in different Research Centres and at NRC for Cashew, Puttur, India are discussed.

**498. RAO, EVVB. 1997. Cashew industry in India.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp. 10-15 (National Research Centre for Cashew, Puttur - 574 202, Karnataka, India.).

Cashew processing in the country has been developed as an independent enterprise by the entrepreneurs and today there are over 730 processing factories providing employment for 300 thousand people with the processing capacity of 600 thousand mt. The majority of processing factories are located in the States of Kerala, Tamil Nadu, and Karnataka. The domestic production is around 417 thousand mt. which falls short of the processing capacity

established in the country. The present production trends, processing methods employed and development support extended and envisaged is presented in this paper.

**499. RAO, EVVB. 1996. Emerging trends in cashew improvement.** *Proceedings of 2nd Intl. Crop Science Congress. 1* Ed. By V.L. Chopra & R.B. Singh. -New Delhi: Oxford & IBH 1996: 675-682 (NRCC, Puttur-574 202, D.K. Dist; Karnataka).

Developing plant type which has got inherent advantages in pollination biology, fruit set, fruit retention, kernel size and kernel quality along with pest resistance is a possibility indicated by the various research results. Production constraints identified in different regions may require more careful reexamination in terms of genotype architecture for overcoming them. By understanding the basic floral biology and fruiting in cashew genotypes, it will be possible to develop varieties which are suited for diverse agroclimatic regions in which cashew is cultivated.

**500. RAO, EVVB. 1999. Cashew development - a futuristic approach.** In: *Improvement of Plantation Crops.* Edited by MJ. Ratnambal., PM. Kumaran and K. Muralidharan. CPCRI, Kasaragod. P.86-90

Review of the current cashew plantations in India and the production technologies available indicate that identifying location specific technology package should help us in achieving the goal of self-sufficiency in the production of raw nuts in the country. The review of available varieties and identification of varieties which are suitable for different States/ regions in the States and replacing the existing scion banks with the varieties which

have the production potential of 2 tones per ha, through top working.

501. RAO, EVVB and NAGARAJA, KV. 2002. **Recent developments in cashew research and future strategies to meet the requirements of cashew processing industry.** *Silver Jubilee Souvenir, PLACROSYM - XV: 22-27*

In this paper, authors list out the major research achievements on cashew includes high density planting, intercropping etc. and the future strategies to increase the production to meet the requirements of cashew processing industry.

502. RAO, EVVB., SWAMY, KRM and BHAT, MG. 1998. **Status of cashew breeding and future priorities.** *Journal of Plantation Crops.* 26: (2): 103-114 (National Research Centre for Cashew, Puttur 574 202, Dakshina Kannada, Karnataka, India. )

Breeding of cashew (*Anacardium occidentale*) nuts at the National Research Center for Cashew is summarized.

503. RAO, EVVB., YADUKUMAR, N and BHAT, MG. 2001. **Agro-ecological regions and varietal classification of cashew-developmental strategies.** *The Cashew* 15(3): 27-37. Also published in *Indian cashew: issues and strategies*, edited by HP. Singh., PP. Balasubramanian and VN. Hubballi. (National Research Centre for Cashew, Puttur-574 202, India)

The release of 36 cashew varieties in the country has shown impact on the increase in cashew yields. Varietal recommendation hitherto is mainly based on the results of trials of AICRP Centres. An attempt is made here to

recommend cashew varieties developed at different centres to similar soil, agro-environments elsewhere by utilizing information on soil type and agro climatic conditions. Different agro-ecological sub regions where cashew is grown is documented with suggestive recommendation of the varieties. It was indicated that areas which have different quantity of rainfall, but with similar Available Water Capacity (AWC) and Length of Growing Period (LGP) could be clubbed together for making varietal recommendation.

504. RAO, GSLHVP and THIRUMAI.ARAJU, GT. 2002. **Forecasting tea mosquito bug of cashew.** *Journal of Agrometeorology* 4(1): 45-52 (Dept. Agril Meteorology, KAU, Vellanikkara, Thichur-680 656.)

A field experiment was conducted to monitor pest surveillance on TMB of cashew orchards in relation to weather parameters at fortnightly intervals for 10 years from 1988 to 1998. Path coefficient analysis was carried out to understand the direct and indirect effects of the individual weather elements on tea mosquito incidence. Prediction equations were developed using multiple regression analysis with respect to TMB population and percentage damage. A minimum temperature between 15 and 20°C, cloudiness and relatively dry weather may be optimum for triggering the pest population of TMB; this coincides with flushing and flowering of cashew.

505. RAO, GSLHVP and GOPAKUMAR, CS. 1994. **Climate and cashew.** *The Cashew* 8(4): 3-9

The latitude where cashew grow, the relationship between latitude and flowering, the altitude, temperature and rainfall requirements of cashews, and the effect of relative humidity,

sun shine and day length, wind , waterlogging, drought and irrigation on the growth and production of cashews are discussed.

**506.** RAO, GSLIIVP, GIRIDHARAN, MP and JAYAPRAKASH NAIK, B. 2001. **Influence of weather factors on bud break, flowering and nut quality of cashew.** *The Indian Journal of Agricultural Sciences* 71(6): 399-402

Chronological data on the ontogeny of 3 test varieties (BLA 139-1, BLA 39-4 and NDR 2-1) of cashew graft, planted in July 1999, along with nut weight, shelling weight and nut percentage were recorded during 1995 - 96, 1996-97, and 1997-98. Daily meteorological data were also collected to study their impact on the reproductive phase of cashew. Bud break, which was dependent on the genotype, followed immediately after heavy wet spell of rains in the presence of bright sunshine. The flowering of cashew required mild winter, which may be defined as low minimum surface air temperature ranging between 16 and 20°C coupled with more dew nights having moderate dew in humid climates. It also required bright sunshine (>9 h/day) with moderate dry weather having an RH between 60 and 40% in the afternoon. The unusual rains during Nov. and Dec. inordinately delayed the reproductive phase of late- season types. The availability of soil moisture played a key role in kernel development. Bud break in all the varieties was earliest during 1995-96.

**507.** RAO, GSLHVP. 1999. **Weather inflicted damage on cashew production- a remedy.** *The Cashew* 13(4): 36-43

The study in Kerala revealed that the vegetative phase of cashew was extended due to untimely rains during November and

December 1995 and 1996 which resulted in late flowering. A high number of bright sunshine hours also induced early bud break as was evident in 1995. A rise in night temperature (above 20°C) together with fewer dewy nights which coincide with the flowering phase was detrimental for cashew flower production. Heavy cloudiness during the flowering phase also appeared to be detrimental for the opening of hermaphrodite flowers. The impact of adverse weather could be mitigated to some extent if early flowering cultivars having different flowering periods are chosen for the replanting programme.

**508** RAO, YS., RAJASEKHAR, P and RAO, VRS. 2006. **Seasonal incidence and control of cashew shoot and blossom webber, *Lamida monocusalis* walker in Andhra Pradesh.** *The Cashew* 20(1): 8-12

The studies on the seasonal incidence of shoot and blossom webber was undertaken throughout the year during 2004 - 05 and the results indicated that April and May were favourable for the multiplication of the pest with highest peak. Correlation studies revealed a positive and significant correlation with maximum and minimum temperature and negative significant correlation with morning relative humidity. The chemicals spinosad (0.015%), thiodicarb (0.075%) and profenofos (0.05%) were found highly effective followed by chlorpyrifos (0.05%) in reducing shoot and blossom webber larvae. Among the biorational insecticides viz., neem and B.t., both were found to be ineffective.

**509.** RAO, YS, RAJASEKHAR, P and RAO, VRS. 2006. **Seasonal incidence and control of shoot tip and inflorescence caterpillar on cashew.** *Annals of Plant Protection Science* 14(1): 245-246

A study on the seasonal incidence and control of shoot tip and inflorescence larva on cashew was carried out in Bapatla, Andhra Pradesh during 2004-05. The insecticidal treatments comprised chlorpyrifos at 0.05%, thiodicarb at 0.75%, profenofos at 0.05%, cartap hydrochloride at 0.05%, spinosad at 0.015%, neem oil at 0.5%, *Bacillus thuringiensis* (Bt) at 0.2%, chlorpyrifos + neem oil and an untreated control. The three sprays were given, coinciding with flushing, flowering and nut development stages. The pest incidence was higher during the second fortnight of February and first fortnight of March, coinciding with flowering and inflorescence stage, and gradually declined with no infestation stage during the second fortnight of May to first fortnight of October. Among the insecticides, thiodicarb (0.075%), spinosad (0.15%) and profenofos (0.05%) were the best treatments, followed by chlorpyrifos (0.05%). At all stages, neem oil alone and Bt alone proved to be inferior in controlling the pest incidence. The overall efficacy of the third spray, indicated that thiodicarb, chlorpyrifos and spinosad were the best treatments.

**510.** RAO, YS., RAJASEKHAR, P., RAMASUBBARAO, V and SRINIVASARAO, V. 2006. **Seasonal occurrence of leaf eating caterpillars of cashew in Andhra Pradesh.** *Journal of Plant Protection and Environment.* 3(1): 132-135 (Department of Entomology, Agricultural College, Bapatla - 522 101, India).

Studies were conducted in Andhra Pradesh, India, from June 2004 to May 2005 to determine the seasonal occurrence and intensity of leaf-eating caterpillars. Leaf miner (*Aerocercops syngramma*) incidence was at its peak during the second week of December with no infestation during May-June and lowest

incidence was observed in July. A negative and significant correlation was observed between the leaf miner incidence and maximum and minimum temperatures, and positive and significant correlation with morning relative humidity. Leaf folder (*Caloptilia tiselaea*) incidence was highest during the second week of November coinciding with new flush and blooming stage and the pest was absent during parts of May, June and July. A negative and significant correlation was observed with maximum and minimum temperatures, while a significant positive correlation was observed with morning and evening relative humidity.

**511.** RAUT, PG and THAKARE, RP. 1997. **Employment generation through cashewnut and cashew apple processing factories in Goa State.** *The Cashew* 11(2): 12-14

The employment data pertained to the year 1993-94 indicated that in cashewnut processing factory, per factory per season employment generation is 43,665 man days with total employment generation of 21 lakh mandays per season. The employment opportunity for female labour in cashewnut processing is seen as high as 94.32 per cent. In cashew apple processing in to feni per factory per season employment generation was 2756.88 mandays with total employment generation of 1.05 lakh mandays through all the 38 feni producing factories in Goa state. The requirement of female labour in processing of cashew apples in to feni was as high as 55 per cent. In both the industries wage rate for male labour were higher by 25 per cent than paid for female labour.

**512.** RAVIPRASAD, TN and BHAT, PS. 2000. **Rearing techniques for cashew stem and root borers under laboratory condition.**

*Recent Advances in Plantation Crops Research* 13: 346-351 (Proceedings of PLACROSYM-1998.)

Rearing techniques for the cashew stem and root borers (CSRB), *Plocaederus ferrugineus* and *P. obesus* were standardised. Mean duration of egg, total grub and pupal periods were 6.3, 196.6 and 168.5 days for *Plocaederus ferrugineus* and 6.0, 210 and 176.3 day for *P. obesus* respectively. Survival of grubs to adulthood was 71.7 and 63.8 per cent while fecundity ranged from 29 to 81 eggs and 22 to 63 eggs per female for *Plocaederus ferrugineus* and *P. obesus*, respectively.

513. RAVIPRASAD, TN., SUNDARARAJU, D and BHAT, PS. 2002. **Efficacy of Botanicals against *Helopeltis Antonii* Sjgn. (Miridae: Hemiptera) infesting Cashew.** *Plantation Crops Research and Development in the New Millennium.* p. 485-488 (National Research Centre for Cashew, Puttur-574 202, Dakshina Kannada, Karnataka)

The efficacy of various plant extracts and commercial formulations was evaluated against the tea mosquito bug *Helopeltis antonii* Sig. infesting cashew (*Anacardium occidentale* L). Under laboratory evaluations, carbaryl induced 43.5 per cent mortality within 12 hours and had the least damage grade of 0.89 after 48 hours after treatment; the other eleven candidate botanicals recorded mortality ranging from 10.2 to 36.7 per cent which were significantly lesser than carbaryl. Damage grade exceeded 2.25 for all botanicals evaluated. The residual feeding deterrence trials were conducted for five candidate botanicals with monocrotophos as standard check. Under these trials also only the synthetic pesticide (monocrotophos) could

exhibit feeding deterrence upto 7 days after treatment, while the botanicals could not deter pest damage. Field evaluations were conducted for 3 commercial neem formulations viz. Godrej Achook, Limanool and Nimbecidine (all at 1.0% concentration) with carbaryl as check. The post treatment percentage of damaged shoots and damage grade after 30 days after treatment indicated an increase in pest damage with the exception of carbaryl (0.1 %) which resulted in 14.3 per cent reduction in mean percentage of attacked shoots and 7.9 per cent reduction in damage score. These results indicate the necessity of judicious pesticide intervention with proper time scheduling for managing incidence and damage by *H. antonii* in cashew.

514. RAVIPRASAD, TN and BHAT, PS. 2002. **Olfactometer and Free - Choice evaluation of Cashew plant parts and attractants to Cashew Stem and Root Borer: *Plocaederus ferrugineus* (Cerambycidae : Coleoptera).** *Plantation Crops Research and Development in the New Millennium.* p. 147-149 (National Research Centre for Cashew, Puttur-574 202, Dakshina Kannada, Karnataka, India)

Cashew stem and root borers are known to re-infest the attacked cashew trees and those beheaded for rejuvenation; their nocturnal activity suggests the possibility of an olfactory stimulus for identifying the infested tree. Hence, these laboratory investigations were undertaken to identify the possible source of stimulus. Cashew plant parts viz., infested host bark, exuded cashew gum and fresh frass material were evaluated against unmated and mated male beetles as well as virgin and mated female beetles, using a glass wind tunnel olfactometer. Virgin females showed the highest response

(50.0%) followed by mated females (40.8%) to fresh frass; exuded cashew gum elicited response from 37.5 and 28.3 per cent of virgin and mated female beetles' of *Plocaederus ferrugineus* respectively. Both mated and unmated beetles displayed low response to all test materials, which did not differ significantly from the check (only air blown). This suggests possibility of an attractant volatile components in fresh frass, which needs to be characterised. Free choice selection for oviposition by mated female beetles indicated significantly highest mean oviposition of 30.31 eggs on infested bark, while in the second trial the percentage of total eggs deposited on various substratum was 23.65 per cent on frass/exuded gum and 23.53 percent on infested bark which were the highest and were on par with each other hinting the possibility of ovipositional stimulus in infested bark also. The healthy host bark and cashew branch pieces has 8.86 and 5.55 per cent of total eggs deposited on them, indicating their non-preference for oviposition by the pest.

515. RAVIPRASAD, TN and BHAT, PS. 2007. Standardisation of egg collection technique and laboratory rearing of young grubs of Cashew stem and root borers (CSRB). National Seminar on Research, Development and Marketing of Cashew, 20-21st Nov. 2007, Goa. *Souvenir and Extended Summaries*. p. 56 (National Research Centre for Cashew, Puttur - 574 202, DK, Karnataka)

A study was undertaken at NRC for Cashew, Puttur to standardize the egg collection technique and laboratory rearing of young grubs of CSRB. The cashew twigs wrapped with cotton tape elicited the maximum oviposition. This facilitated easy collection of eggs without any damage in comparison to the other

substrates evaluated. Duration of feed change was standardized to be 8 days as the grubs had minimum damage during removal and cannibalism set in after 8 days. These techniques could be effectively adopted for obtaining test insects by rearing CSRB grubs individually on host bark.

516. RAY, SK. and MANDAI., S. 2001. *In vitro* response of certain cashew germplasm. *The Cashew* 15 (2): 21-27

One significant finding of the present study was that the best medium for establishment was equally good for multiplication too as B5 basal medium supplemented with 2mg/l BAP promoted highest percentage of multiplication of the established shoots. Moreover, maximum proliferation of auxillary shoots was also attained in this medium as these grew up to 3.90 cm on an average. Rate of multiplication, however, was far from satisfactory as the highest rate of multiplication was 2-3 auxillary shoots per explants in case of variety Jhargram 1.

517. REDDI, EUB. 2003. Fly-pollination in the cashew nut tree. *Journal of Palynology* 35/ 36: 107-115

A study was conducted in Andhra Pradesh, India to investigate fly-pollination in cashew. Several populations of insect foragers were observed on the flowers, and representative species were caught. Pollen production was investigated by collecting and analyzing mature and undehisced anthers. In spite of the meager flower reward, about 20 species of different insects belonging to Hymenoptera, Diptera and Lepidoptera were observed. The list of insects comprises 5 species of bees, 3 species of ants, 3 species of wasps, 4 species of flies and 5 species of butterflies. The

plants produced fruits only when the insects were allowed to forage. Results showed that ants are not good pollinators.

**518.** REDDY, MLN., KUMAR, BP and GOUSE-MOHAMMED. 2004. **Growth performance of cashew (*Anacardium occidentale L.*) genotypes during pre-bearing stage under Bapatla conditions.** *The Cashew* 18(3): 19-21 (Department of Horticulture, Agril, College, Mahanandi (A.P), India. )

An experiment was conducted in Andhra Pradesh, India, during 1997, to evaluate 52 cashew genotypes for vegetative parameters. T.No. 277 recorded the tallest plant (262.5 cm), while the shortest plant was recorded in T.No. 30/1 (127.5 cm). The maximum girth was recorded in T.No. 71 (30 cm) which was at par with T.No. 277 (29.5 cm), T.No. 268 (29.0 cm), T.No. 4/5 (28.3 cm) and T.No. 2/3 (28.2 cm). The plant spread in both directions was greater in T.No. 268, T.No. 12/1, T.No. 4/5, T.No. 10/2, T.No. 2/5 and T.No. 277. The highest number of primary branches per tree were produced in T.No. 2/3 (13.25) followed by T.No. 17/5, T.No. 277, T.No. 95-2, T.No. 95-4, T.No. 94-5, T.No. 7/12, T.No. 139-1 which were at par with each other. The total number of secondary branches per tree were greater in T.No. 12/8 (49.8) followed by T.No. 17/5 (49.25), T.No. 4/5 (48.40), T.No. 8/7 (47.10), T.No. 3/33 (46.90), ABT-2 (46.80) and T.No. 3/4 (46.30). T.No. 4/5 recorded the highest number of shoots per tree. T.No. 71, T.No. 277, T.No. 268, T.No. 4/5, T.No. 2/3 proved to be the most vigorous genotypes.

**519.** REDDY, MLN., KUMAR, BP and GOUSE-MOHAMMED. 2002. **Evaluation of high yielding clones under Bapatla conditions for nut yield and their characters.**

*The Cashew* 16(4): 26-31

The thirteen high yielding selections developed at different CRS have been studied under local agro-climatic conditions at Bapatla for nut yield, flowering and plant characters. Genotypes differed significantly for all characters except for shelling percentage. T.N. 10/19 was superior for plant height, stem girth, leaf area and hermaphrodite flowers per panicle. M44/3 was superior for number of panicles per square meter, sex ratio, number of nuts per panicle, while M15/4 was for number of nuts per panicle. The nut size and apple size was inferior in M- 44/3, medium in M15/4, and medium bold nut type in T.N.10/19.

**520.** REDDY, MLN and GOUSE - MOHAMMED. 2001. **Studies on flowering and sex ratio in cashew germplasm selections.** *The Cashew* 15(4): 18-22

Significant variations were observed among germplasm of 52 entries for flowering period, flowering phase, number of perfect, staminate flowers and sex ratio. In the present study, the performance of 9 entries, viz. 8/7, 4/5, 275, 139-1, 4/3, 3/7, 2/14, 17/5 and 228 was superior.

**521.** REDDY, MLN., KUMAR, BP and GOUSE-MOHAMMED. 2004. **Phenotypic stability analysis of cashew hybrids & varieties for nut yield under rainfed environment.** *Journal of Research ANGRAU.* 32(2): 52-54 (Cashew Research Station, Bapatla - 522 101, India. )

Nut yield per tree was recorded for 15-year-old trees of 6 cashew cultivars (BPP-1 to 6) grown under rainfed conditions from 1996/97 to 2000/01 in sandy soils at Bapatla, Andhra Pradesh, India. Phenotypic stability analysis



revealed that genotype (G), environment (E) and G x E components were significant. Among the cultivars, BPP-2 and BPP-5 recorded significantly higher yield over the mean yield. BPP-2 was more suitable in better environments, while BPP-5 was more stable in average environments.

**522. REDDY, MLN. 1998. Cashew production technologies for different agro- climatic tracts of Andhra Pradesh. *The Cashew* 12(3): 103-108 (Cashew Research Station, APAU, Bapatla, A.P.)**

The state of Andhra Pradesh is divided into 7 agro- climatic zones based on its rainfall, soil characteristics and cropping patterns. In this paper the author listed the different cultivation methods suitable for different agro climatic zones including crop protection measures. The future strategies to be carried out includes evaluation of all high yielding cashew varieties under different agro-climatic tracks and establishment of scion banks.

**523. REDDY, SE., REDDY, VJ. and REDDY, PS. 1997. Synthetic approach to the distribution of certain micro elements (Cu, Fe, Mn and Zinc) in cashew trees. *Cashew Bulletin* 34(5): 7-14 (APAU, Dept of Horticulture, Hyderabad-500 030.).**

Eight year old cashew cv. BPP 52 trees were uprooted and separated into different component parts viz., leaves, stems, wood, bark and roots. Concentrations of certain micro elements- copper, iron, manganese and zinc present in them were tracked. A synthetic approach expressing the quantities of elements in a part of the tree as percentages of that in the whole tree is made available to understand the proportionate distribution of copper, iron,

manganese and zinc in cashew trees.

**524. REDDY, SN., LINGAIAH, HB., JANAKIRAMAN, N and SHIVAPPA. 1998. Relationship between nut weight and apple characters in cashew. *Cashew Bulletin* 35(6): 14-15 (Agricultural Research Station, UAS(B), Chentamani - 563 125, Karnataka.).**

The relationship between nut size and apple characters is of great importance for effective selections. The nut and apple size was recorded by using the nuts collected from the middle harvest. Data pertaining to simple correlation coefficients and regression coefficients computed between nut size and apple characters are presented.

**525. REJANI, R and YADUKUMAR, N. 2006. Effect of soil and water conservation techniques for cashew plantations grown on steep slopes. *Journal of Plantation Crops* 34(3): 304-308**

Cashew being an unirrigated crop, it is highly essential that proper soil and water conservation is necessary to increase its yield. With an aim to select best soil and water conservation on steep slopes (18-43%) in cashew, an experiment was laid out with treatments namely, 1. Modified crescent bund, 2. Staggered trenches with coconut husk burial between 2 rows of cashew, 3. Reverse terraces, 4. Catch pits and 5. control plot with out any soil and water conservation measures. The results showed that proper soil and water conservation technique like modified crescent bund, or coconut husk burial treatments has increased the mean soil moisture content significantly (15.6% and 16.1% dry basis compared to 11.5% dry basis in control in March), reduced the annual runoff (25 and 19%

of the annual rainfall compared to 37% of the annual rainfall in control), reduced the soil loss (68 and 58% of control) and also showed a trend of increased growth and yield. Hence, the barren land even in steep slopes can be effectively utilized for cashew cultivation using proper soil and water conservation techniques.

**526.** REJANI, R and YADUKUMAR, N. 2007. **Response of cashew plantation grown in slope areas of west coast region of India for soil and water conservation measures.** National Seminar on Research, Development and Marketing of Cashew, 20-21st Nov. 2007, Goa. *Souvenir and Extended Summaries*. p. 63. (National Research Centre for Cashew, Puttur, D.K., Karnataka)

Cashew is generally grown as an unirrigated crop. Therefore, soil and water conservation techniques are very much essential for cashew plantations. Hence, the present study was taken up to test soil and water conservation techniques coupled with manuring with the following main objectives: To determine the effect of soil and water conservation measures in reducing runoff and soil loss and in increasing the soil moisture content, cashew nut yield and net profit. To find the best soil and water conservation measure technique coupled with organic or inorganic manuring for maximizing the cashew yield.

**527.** REKHA RAVINDRAN., JISHA, KG and PADMA NAMBISAN. 1997. **Effect of antioxidants on the self life of cashew kernels.** *Cashew Bulletin* 34(10): 13-17 (Plant Biotechnology Unit, Dept of Biotechnology, Cochin-682 022.).

Cashew kernels have high nutritive value. Upon exposure to air, kernels turn rancid

and their nutritive value decreases. From this study it is concluded that chemical treatment using antioxidants reduced oxidative rancidity but failed to prevent deterioration in organoleptic characteristics and decrease in protein and carbohydrate content of stored kernels.

**528.** REKHA CHAUDHURY; and MALIK, SK. 2004. **Genetic conservation of plantation crops and spices using cryopreservation.** *Indian Journal of Biotechnology*. 3(3): 348-358

Germplasm conservation in the form of seed is convenient and most cost-effective *ex situ* conservation method for plant species producing orthodox seeds. Several species of plantation crops and spices produce non-orthodox seeds, which exhibit intermediate or recalcitrant seed storage behaviour. Storage of these species requires the use of *in vitro* conservation techniques for short- to medium-term conservation and cryopreservation to achieve long-term conservation. Various cryotechniques applicable to 11 genera totalling 16 species (rubber (*Hevea brasiliensis*), cocoa (*Theobroma cacao*), coconut (*Cocos nucifera*), arecanut (*Areca catechu*), oil palm (*Elaeis guineensis*), Coffea spp., tea (*Camellia sinensis*), black pepper (*Piper nigrum*), cardamom (*Elettaria cardamomum*), cashew (*Anacardium occidentale*) and nutmeg (*Myristica fragrans*)) are reviewed in the present paper. Physical and physiological factors determining the success or failure of cryopreservation are discussed.

**529.** REMESH, N., LINGAIAH, HB., RADHAKRISHNA, D., VISHNUVARDHANA and JANAKIRAMAN, N. 1998. **Effect of Bio-fertilizers on the growth of cashew root**

stock. *The Cashew* 12(1): 10-14 (AICRP on Cashew, Agricultural Research Station, UAS, Chintamani - 563 125, Karnataka.).

Effect of nitrogen fixing and phosphate solubilizing microorganisms on growth of cashew root stocks with or without chemical fertilizers was studied during kharif and Rabi seasons of 1996. Significant increase in growth parameters viz., plant height, stem girth, number of leaves and leaf area, root length, number of roots and plant biomass was recorded in the biofertilizer inoculated plants compared to uninoculated control plants during both the seasons studied.

530. RENGANAYAKI, PR and NARGIS, S. 2001. **Influence of position of nut sowing on germinability of cashew genotypes.** *The Cashew* 15(3): 8-11 (Dept. of Seed Science & Tech., TNAU, Coimbatore-641 003).

The variation among the genotypes and orientation of nut at sowing were highly significant. Among the orientations, irrespective of genotypes sowing of nuts in flat position where nuts were placed horizontally, outperformed the other methods, recording the maximum germination of 92%. Orientation of nut based on sinus position was found to follow the flat position, in which orientation of sinus region upwards, recorded was six per cent higher germination than 92% germination which sinus region downwards. Among the genotypes the performance of yellow large round was the best and was followed by yellow small round due to their genetic constitution.

531. RICKSON, FR and RICKSON, MM. 1998. **The cashew nut, *Anacardium occidentale* (Anacardiaceae), and its perennial association with ants: extrafloral**

**nectary location and the potential for ant defense.** *American Journal of Botany*. 85(6): 835-849 (Department of Botany, Oregon State University, 2082 Cordley Hall, Corvallis, Oregon 97331-2902, USA.)

Cashew nut trees are consistently ant-visited throughout the year, with the ants [Formicidae] attracted to a large number of extrafloral nectaries on the leaves, inflorescences, flowers, and developing nuts. The commercial production of cashew nut, for example, in India, Brazil, and east Africa, consistently applies pesticides, especially insecticides, in large monoculture plantings. Each year prophylactic spraying begins with the first flush of new leaves, continues through flowering, ending at about mid-nut development. Ant diversity was surveyed in sprayed and unsprayed cashew monocultures of various sizes and ages in Sri Lanka, India, and Malaysia to document the ant-cashew relationship and to explore the potential of ants replacing chemical pesticides in insect control. Using commercial-size plantations as examples, information is presented that cashew has a strong potential for arthropod-dependent protection from pests. It is suggested to create favourable habitats for encouraging ants within cashew plantings.

532. ROCHA, AMR. 2000. ***In vitro* regeneration capacity of cashew cotyledons.** *Revista Brasileira De Fruiticultura* 22(2): 153-155

Dwarf cashew cv. CP76 cotyledons were cultured on a medium containing 0.045, 2.30 or 4.30/ $\mu$ M 2, 4-D for 4, 6 or 8 days. Callus and root formation were greatest with 2.30/ $\mu$ M 2, 4-D for 4 days.

533. ROSSETTI, AG. 1998. **Recovery of**

**young dwarf cashew orchards propagated by seed.** *Revista Brasileira De Fruticultura* 20(2): 202-205

Yields of young topworked trees, grafted trees and seedling trees were compared in cashew orchards in Canto do Buriti, Piauí, Brazil, between 1990 and 1995. The trees were grafted or topworked with the dwarf clone CCP 76. At the end of the fourth year, cumulative yield was similar in top worked trees (968.90 kg/ha) and grafted trees (1057.05 kg/ha) and both were higher than the cumulative yield in seedling trees (257.76 kg/ha).

**534. ROY, SK., MANDAL, S and GHOSH, PD.** 2001. *In vitro* response of certain cashew germplasm. *The Cashew* 15(2): 21-27 (Dept. of Botany; University of Kalyani, Kalyani, Naida, W.B.).

This paper discusses the standardization of a reliable protocol for the micropropagation of cashew using cotyledonary node, terminal and nodal explants of seedlings of cultivars Jhargram 1, Bhubaneswar 1, TN and M.I.T. Details are given of seed germination, as well as establishment and multiplication (basal media, growth regulators, explants).

**535. RUF, F and LANCON, F.** 2004. **From alley cropping to cashew farms.** *From slash and burn to replanting: green revolutions in the Indonesian Uplands.* 2004; 95-101 (Regional and Sectoral Studies, The World Bank, 1818 H Street NW, Washington, DC 20433, USA.)

This chapter examines the adoption of cashew as a new crop in the Sikka district, an already densely populated and cultivated region of Flores, Indonesia. The introduction of such a profitable crop as cashew reverses the cause

and consequences of the alley cropping adoption process. It is no longer the pressure on the land that triggers the adoption of a new cultural practice, but the adoption of a new crop that stimulates an increase in farm size or even migration to a new location where land is still available.

**536. RUFINO, MSM., VASCONCELOS, LFL., CORREA, MPF and RIBEIRO, VQ.** 2004. **Initial plant development in different genotypes of cashew (*Anacardium spp.*) originating from the mid-north region of Brazil.** *Proceedings of the Interamerican Society for Tropical Horticulture.* 47: 146-148 (UESPI, Rua Jose Moita, S/N, Sao Sebastiao, 64.120-000, Uniao, PI, Brazil.)

A study was conducted from January to March 2001, in Teresina, Piauí State, Brazil, to evaluate the initial development of plants of 30 wild cashew genotypes. Nut weight, stem diameter, plant height and leaf number were evaluated at 30 and 60 days after germination, whereas dry weight of roots and shoots were evaluated at the end of the experiment. Genotype 8 showed the best behaviour; thus, it was considered for use as a cashew rootstock. Wild cashew nut weight had strong correlation with stem diameter, plant height and leaf number.

**537. SAGVEKAR, VV., PATIL, BP and SHINGRE, DV.** 2005. **Success of cashew grafts cv. Vengurla-4 as influenced by polyshed environments.** *Journal of Agrometeorology.* 7(2): 262-267 (Agricultural Research Station, Mulde, Tal: Kudal, Dist: Sindhudurg, M.S. (Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth), India.)

Cashew cv. Vengurla-4 grafts were grown in closed polyshed or open field

conditions in an experiment conducted in Maharashtra, India from December to April of 2001-03. The mean grafting success ranged from 78.95 to 79.47% in grafts grown under a polyshed and from 30.26 to 40.53% in grafts grown in the open field. Grafting success was very low in grafts grown in open field and was fairly high in grafts grown in polyshed during hot (April) and cold (December) seasons. The success of grafting showed highly significant positive correlation with the maximum temperature and with the difference in maximum and minimum daily temperature.

538. SALAM, M.A. 1999. **Cashew and pepper live in harmony.** *The Cashew* 13(3) : 54-60

Use of cashew trees as a growth support for pepper is described. It is concluded that the association of these two cash crops presents a more efficient use of resources, and yields agronomic and economic advantages to the farmer.

539. SALAM, MA. 2000. **Performance of cashew genotypes under Kerala conditions.** *Journal of Plantation Crops* 28(3): 185-190

Eighteen cashew cultivars developed or released in different Indian states were evaluated for adaptability under the environmental conditions of Kerala, India, in a field experiment conducted from 1987 to 1999. The cultivars Vridhachalam - 3, Kanaka and Dhana were rated as the best adapted among the cultivars in terms of nut yield and nut characters, and can be recommended for wide scale cultivation in Kerala.

540. SALAM, MA., PUSHIPALATHIA, PB and SUMA, A. 1995. **Root distribution pattern of seedling-raised cashew tree.** *Journal of Plantation Crops* 23(1) : 59-61

Studies on 19- year-old cashews in a plantation at Thrissur showed that in a shallow laterite soil cashews develop an extensive root system with the majority (89.3%) of the roots within 300cm of the plant laterally and within the top 100cm of soil.

541. SALAM, MA. 1996. **Traditional rubber planters turn to cashew.** *The Cashew* 10 (2) : 3-4

Compared to the gestation period, dependance of the rubber tapper to get good yield and other cultivation cost of rubber, farmers feel that cashew is more remunerative than rubber.

542. SALAM, MA. 2001. **Cashew and pineapple live in harmony.** *The Cashew* 15(4) : 12-13

The crop association involving cashew and pineapple proved as an excellent combination to the agro- ecological condition that prevails in that area. It yields all the agronomic advantages in terms of sharing of nutrients, smothering of weeds, conservation of soil and water and enhanced growth for cashew. It also provide good returns to the farmer.

543. SALAM, MA. 2000. **Cashew variety Vridhachalam-3 recommended for Kerala.** *Cashew Bulletin* 38(2): 3-4 Also published in *The Cashew* 14(1):39-40, 2000.

The experiment conducted at Madakkathara from 1987 to 1999 confirmed the adaptability of Vridhachalam-3 under Kerala conditions. During 5th to 11th year after planting, the mean nut yields per tree were 6.58, 14.47, 10, 10.22, 11.99, 10.54 and 12.88 Kg respectively. The apple of Vridhachalam - 3 is

red in colour.

**544.** SALAM, M.A., SUMA, B and KURIEN, SUSANNAMMA. 1998. **Amrutha (H-1597), a new high yielding cashew hybrid.** *The Cashew* 12(4): 10-12 (Cashew Research Station, (KAU), Madakkathara - 680 656, Kerala.).

Amrutha is a cross between BIA 139/1 and H3-13. It has the plant height of 8.0 m. The inflorescence is conical in shape with a sex ratio of 1:10 (bisexual: male). The apple colour is yellow with a mean apple weight of 40.5g. The apple contains 72.2 juice with astringent taste. The mean nut weight is 7.18 g., the kernel weight is 2.24g. and the shelling percentage is 31.58. The kernels of Amrutha is graded as W 210 for export. The adult trees of Amrutha gives a yield of 18.35 Kg/ tree.

**545.** SALAM, MA. 1997. **Cashew apple: potential and prospects for industrial utilization.** *Cashew Bulletin* 34(11) : 3-7 (Cashew Research Station, Madakkathara-680 656, Thrissur, Kerala.).

The estimated availability of cashew apple in the country is 41.9 lakh tonnes. The lion share of this quantity is being wasted. Cashew apple is very rich in vitamin C, Ca, Fe and Riboflavin. The apple can very well be utilized industrially for the production of a number of products useful to human beings. By setting up small scale processing units considerable employment opportunities can be created. Willing entrepreneurs should be encouraged to exploit this valuable natural product on a commercial manner.

**546.** SALAM, M.A. 1997. **Cashew plantation- establishment and management.**

*The Cashew* 11(3) : 13-32 (CRS, KAU, Madakkathara-680 656, Thrissur, Kerala.).

Decisions in cashew plantation management are discussed with reference to site selection (climatic factors including altitude, temperature, humidity, rainfall, waterlogging, drought, soil factors and cultivar selection), critical inputs in plantations (planting material, N and water), critical management practices (season and method of planting, pit size, planting density, fertigation, intercropping, harvesting and drying) critical operations, grafting, staking, mulching, trenching, pruning and pest control), and economics of cultivation.

**547.** SALAM, M.A. 1999. **Cashew varieties suitable for high density planting.** *Cashew Bulletin* 37(6): 3-5 (Also published in *The Cashew* 13(4):15-19, 1999.)

An attempt was made at CRS Madakkathara, to identify relatively dwarf and compact varieties suitable for high density planting. From the study, it was found that the varieties 44/3, Anakkayam-1, and H1608 are relatively less statured and compact and are better suited for high density planting.

**548.** SALAM, M.A. 1999. **Commercial cashew plantations - key to success.** *The Cashew* 37(4): 3-10 (Cashew Research Station, KAU, Madakkathara - 680 656, Thrissur, Kerala.).

In this paper, an attempt is made to identify the vital decisions, inputs and management strategies essential for the successful establishment and maintenance of commercial cashew plantations. Selection of suitable sites, considering agronomic, climatic and ecological requirements of cashew is very

important. Soils with pH more than 8 are not suitable for commercial cashew plantations. The selection of planting material, the method of fertigation and other agronomic practices were listed in this paper.

549. SALAM, MA., PUSHPALATHA, PB., USIIA, KE and SUMA, A. 1997. **Comparative performance of 18 cashew varieties in the Oxisols of Kerala.** *Cashew Bulletin* 34(9): 11-17 (Cashew Research Station, KAU, Madakkathara-680 656, Thrissur, Kerala.).

The performance of 8 high yielding cashew varieties evolved at 6 research centres of India has been evaluated in the oxisols of Kerala. The yield data recorded from the 4th year after planting to the 10th year after planting indicates that the varieties M 26/2, H-1598, M 44/3, Vengurla-5, Anakkayam-1 and H-1608 perform better in Kerala. H-1598, H-1608 and Anakkayam-1 are the varieties released by KAU and recommended for the state of Kerala, but the variety M 26/2 evolved at RARS, Vridhachalam, Tamil Nadu also show all the desirable characters and as such this can also be recommended for cultivation.

550. SALAM, MA. 1997. **High density planting in cashew-principles and practices.** *The Cashew* 11(4): 12-20 (CRS, Madakkathara, Thrissur-680 656, Kerala.)

High density planting (HDP) is a technique useful for enhancing production and productivity of cashew in India. Instead of the normal planting density of 100-177 plants/ha, 312-625 or more grafts/ha are planted. The population is regulated in later years by selective felling. The productivity of HDP plantations is compared with that of normal plantations. A system analysis involving the

factors influencing canopy expansion rate is required to take meaningful decisions regarding initial planting density and time of thinning.

551. SALAM, MA. 1998. **Processing characteristics and production potential of cashew varieties.** *The Cashew* 12(1): 27-37 (CRS, KAU, Madakkathara-680 656, Thrissur, Kerala.)

A study was conducted to evaluate the processing characteristics and production potential of cashew varieties at CRS, Madakkathara. The data on processing characteristics of nut and nut yield were analysed to identify the best varieties with higher yield and desirable processing characteristics. The varieties H1598, M26/2 and H1608 were found to be the best. The varieties V3, Anakkayam-1, M44/3, H1600, V4, V5, M33/3, VTH 30/4, T2/15, VTH 59/2, H1610 and T 2/16 were rated to be medium and V 2, T 40 and T 129 are rated to be low.

552. SALAM, MA. 1998. **Region specific production technologies for cashew for different agroclimatic zones of Kerala.** *The Cashew* 12(3): 61-74 (Head, Cashew Research Station, (KAU), Madakkathara, Kerala.)

The state of Kerala is divided into five agro-climatic zones based on their soil and climatic characteristics. Therefore, in this paper an attempt is made to modify the existing technologies to suit the soil and climatic conditions prevail in the five well defined agro-climatic zones of Kerala. These modified technologies may be treated as ad-hoc recommendations still location specific and precise technologies are developed by researchers for every agro climate.

553. SAMAL, S., LENKA, PC AND ROUT,

GR. 2002. **Genetic differentiation among cashewnut cultivars through morphological analysis.** *PLACROSYM - XV*: 43-46

Genetic divergence of 20 cultivars of cashew nut was assessed through numerical taxonomic approach. Observation on eight important characters like number of laterals and flowering laterals per square meter, length of panicle, sex ratio, number of nuts per panicle, nut weight, shelling percentage and yield per plant were recorded consecutively for 2 years. The dendrogram based on main data showed clusters at appropriate phenon levels indicating that the entries were broadly classified in to 4 clusters at 70% phenon level, seven clusters at 75% phenon level and at 80% phenon level they are grouped in to 11 clusters.

554. SAMAL, S., LENKA, PC., NANDA, RM., NAYAK, S and ROUT, GR. 2004. **Genetic relatedness in cashew (*Anacardium occidentale* L.) germplasm collections as determined by randomly amplified polymorphic DNA.** *Genetic Resources and Crop Evolution*. 51(2): 161-166 (Department of Horticulture, Orissa University of Agriculture and Technology, Bhubaneswar, Orissa 751 003, India.)

In the present investigation, we have assessed the genetic relationship of twenty varieties of cashew by using RAPD (Randomly Amplified Polymorphic DNA) markers. Analysis started by using forty 10-mer primers that allowed us to distinguish 20 varieties. The selected primers were used for identification of cashew varieties. A total of 80 distinct DNA fragments ranging from 0.2 to 3.0 Kb were amplified by using 11 selected random 10-mer primers. Genetic similarity analysis was conducted on the presence or absence of bands

in the RAPD profile. Cluster analysis clearly showed that 20 varieties of cashew grouped into 2 major clusters based on similarity indices. First major cluster again divided into one minor cluster. Another major cluster again divided into two sub-minor clusters, one sub-minor cluster having three varieties and another sub-minor cluster represented by 15 varieties. Among the 20 varieties, ULLAL-3 and H-1608 showed highest similarity indices (87%). It was noted that 'Vengrula-2' and 'Vengrula-3' were not grouped into a single cluster but 'Vengrula-4' has 82% similarity with 'Vengrula-3'. The variety Vengrula-2 has very close similarity (85%) with variety VRI-3. Analysis of genetic relationships in cashew using RAPD banding data may be useful for plant improvement, in descriptions of new variety and also assessing variety purity in plant certification programmes.

555. SAMAL, S., ROUT, GR and LENKA, PC. 2003. **Analysis of genetic relationships between populations of cashew (*Anacardium occidentale* L.) by using morphological characterisation and RAPD markers.** *Plant, Soil and Environment* 49(4): 176-182 (Plant Biotechnology Division, Regional Plant Resource Centre, Nayapalli, Bhubaneswar, 751 015 Orissa, India).

In the present paper, the genetic relationships between twenty cultivars of cashew are described on the basis of morphological characters and randomly amplified polymorphic DNA (RAPD) markers. The results obtained for the phenotypic characters based on similarity coefficient were divided into four clusters with 70% similarity. By means of similarity coefficients, cluster I was found to consist of twelve cultivars. Cluster II consisted of a single cultivar (NRCC-1),



cluster III consisted of six cultivars and cluster IV had only one cultivar (Vridhachalam-2). The analysis started by using RAPD markers that allowed us to distinguish the 20 cultivars. A total of 80 distinct DNA fragments ranging from 0.2 to 3.0 kb were amplified by using 11 selected random 10-mer primers. Genetic similarity analysis was conducted for the presence or absence of bands in the RAPD profile. Cluster analysis clearly showed that the 20 cultivars of cashew grouped into two major clusters based on similarity indices. The first major cluster comprised one minor cluster. The other major cluster was divided into two sub-minor clusters, one sub-minor cluster having three cultivars and the other sub-minor cluster having 15 cultivars. Among the 20 cultivars, Ullal-3 and Dhana (H-1608) showed the highest similarity indices (87%). It was noted that Vengurla-2 and Vengurla-3 were not grouped into a single cluster, however Vengurla-4 had 82% similarity to Vengurla-3. Vengurla-2 had very close similarity (85%) with Vridhachalam-3 (M-26/2). The analysis of genetic relationships in cashew using morphological traits and RAPD banding data can be useful for plant improvement, descriptions of new cultivars and for assessment of varietal purity in plant certification programmes.

556. SAMAL, S., ROUT, GR. and LENKA, PC. 2003. **Primer screening and optimization for RAPD analysis of cashew.** *Biologia Plantarum* 46(2): 301-304 (grrouthotmail.com.)

Primer screening and optimization for random amplified polymorphic DNA (RAPD) analysis of 20 cashew cultivars was investigated. Among 4 series (A,B,D and N) of 10-mer primers, A-series performed better

amplification of fragments than the other series. The maximum amplification fragments was obtained using OPA-02, OPA-03, OPA-09, OPB-06, OPB-10, OPD-03, OPD-05 and OPN-03 primers. The primers OPA-02 and OPN-03 produced the highest number of DNA fragments of cashew cv. II-320. Primers OPB-08 and OPN-05 produced the least number of amplification fragments. RAPD profile also indicate that some primer did not produce good amplification.

557. SANKARANARAYANAN, R and SHAH, HA. 1996. **Hybridisation studies in cashew.** *The Cashew* 10(3): 18-23

The general combining ability effects of thirteen genotypes of cashew were studied using ten parents as testers and three as lines in a Line Tester mating design. The parents along with their thirty hybrids were studied for the expression of heterosis for germination percentage and vigour index. High relative heterosis of over 100 per cent was observed in three cross combinations. For vigour index, the maximum relative heterosis of 62.80 was observed in M44/3 x PU6. The parents M44/3, M3/2 and M33/3 were good general combiners for germination percentage while M 10/4 and M33/3 were the good general combiners for vigour index.

558. SANKARANARAYANAN, R and SHAH, HA. 1999. **Genetic divergence and combining ability in cashew.** *The Cashew* 13(3): 28-40

Investigations were carried out to assess the genetic variability for 21 morphological characters of 50 genotypes in two seasons at CRS, TNAU, Virdhachalam during 1992-1994. The heterosis and combining ability were

estimated in a set of 30 hybrids for 13 seedling characters. Considering the heterotic expression and gca effects of the parents, three crosses viz; M10/4 x M33/3, M10/4 x M45/4 and M26/2 x M33/3 were selected as best hybrids.

**559.** SAPKAL, BB. 2000. **Integration of foliar application of urea and insecticidal spray for yield maximization in cashew.** *The Cashew* 14(1): 41-44

Spraying of 3 or 4% urea along with insecticidal spray resulted in significantly high yield of nuts 11.5 and 12.5 Kg nut/ tree over the control (7.7 Kg nut / tree). It was obvious that the spraying of insecticide does help to control the incidence of TMB. Spraying of urea helped to increase fruit set and retention of fruits up to harvest thereby increased the yield.

**560.** SAPKAL, B.B., HULAMANI, NC and NALWADI, UG. 1994. **Flowering and sex-ratio in some cashew selections.** *The Cashew* 8 (1): 7-10 (Dept. of Hort., Coll. of Agric., Dapoli, Maharashtra.)

Nine promising clones were grown at Dharwad during 1984- 86 and evaluated for a number of flowering related traits. Ten flowers panicles were randomly selected in each selection and tagged. Once in every 2 days the open flowers in each panicle were removed and counted. Duration of flowering lasted for about 4 months, from the first week of November to the last week of February. Clonal differences were observed, with duration of flowering ranging from 95.1 days in 4/43 Wynad Kerala to 119.8 days in 2/48 Taliparamba Kerala. Male flowers were generally produced throughout the flowering period.

**561.** SAPKAL, BB., DESHPANDE, SB and RAJPUT, JC. 1998. **Hybrid-225 a promising**

**cashew hybrid from RFRS, Vengurla Maharashtra.** *The Cashew* 12(1): 15-17 (Regional Fruit Research Station, KKV Vengurla, M.S).

Hybrid no.225 is a cross between Vengurla-3 and M- 10/4. Its performance was evaluated for about 12 years. It has recorded an average yield of 14.5 kg/tree/year. The nut size is bold, weighing 10g and shelling percentage is also quite high i.e.30.5. Its kernel grade is 180 count/lb and its mean kernel weight is 2.5g. It is suitable for cultivation in Maharashtra, Goa, North Karnataka and Orissa

**562.** SAPKAL, BB., RAJPUT, JC. and RANE AA. 1998. **Regionalisation of technological inputs of different agroclimatic tracts of Maharashtra.** *The Cashew* 12(3): 89-92 (Regional Fruit Research Station, BCKV Vengurla, Maharashtra.).

The results of research on cashew carried out by the Regional Fruit Research Station Vengurla, in respect of variety, planting time, spacing, fertilizers, irrigation and plant protection measures made it possible to pass on the recommendations to economically backward, marginal and progressive cashew growers. Further the progressive farmers earn per hacter net profit of Rs. 30734/- and average farmers earn Rs. 23180/- by using higher than the recommended practices.

**563.** SARANGA, J and CAMERON, R. 2007. **Adventitious root formation in Cashew in response to phytohormones and removal of roots.** *Scientia Horticulturae* 111(2): 164-172

In this study, soft wood cuttings of cashew, a species considered as difficult - to - root was used. The authors aimed to test the hypothesis that speed, and extent of early

rooting, is critical in determining success with this species, and that the potential to form adventitious roots will decrease with time in the propagation environment. Using 2 genotypes, initial rooting rates were examined in the presence or absence of exogenous auxin. In cuttings that formed adventitious roots, either entire roots or root tips were removed, to determine if further root formation was feasible. To investigate if subsequent root responses were linked to phytohormone action, a number of cuttings were also treated with either exogenous auxin or cytokinin. Despite the reputation of *Anacardium* as being difficult to root we found high rooting rates in 2 genotypes (AC 10, and CCP 1001). Removing adventitious roots from cuttings and returning them to the propagation environment, resulted in subsequent rerooting. Root expression was faster after the removal of previous roots compared to when the cuttings were first stuck. Exposing cutting to IBA at the time of preparation, improved initial rooting in AC 10, but no in CCP 1001.

**564. SARANGI, PK. 1999. Cashew grafting in root trainers.** *The Cashew* 13(4): 27-35

Raising cashew seedlings in root trainers was investigated as a means of overcoming the high mortality rates occurring with conventional soft-wood grafting. The modules are conical polyethylene or polystyrene containers and 4 sizes (165,210,350 and 500cm<sup>3</sup>) were tested. The modules were kept on stands so there was good airflow at the base. The potting mixture was compost + Vermiculite to give good drainage. After grafting the plants were kept in an airtight polytunnel with high humidity and 50% shading. Grafting successes was 95% and field establishment was 90%.

**565. SARAVANAN, MP., PONNARASI, T and CHANDRAKUMAR, M. 2002. Study on the efficiency of cashewnut processing units in Tamil Nadu.** *The Cashew* 16(4): 19-25

This paper attempts to analyse the efficiency of cashew processing units and the constraints faced by the processors. Thirty processing units each from Kanyakumari and Cuddalore districts were selected randomly for the study. A frontier production function was formulated and estimated using Corrected Ordinary Least Squares method. Timmer's measure was used to analyse the technical efficiency of the cashew processing units. Constraints faced by the processors were analysed using percentages. The results indicated that technical efficiency in the units of Cuddalore district (90.26) and Kanyakumari district (89.01) were equal.

**566. SARUBBO, LA., OLIVEIRA, LA., PORTO, ALF and DUARTE, HS. 2000. New aqueous two-phase system based on cashew-nut tree gum and poly(ethylene glycol).** 11th International conference on partitioning in aqueous two-phase systems, Gulf Shores, AL, USA, 27 June-2 July 1999. *Journal of Chromatography-B-Biomedical Sciences and Applications*. 743 (1-2) 79-84 (DESQ-FEQ, UNICAMP, CxP-6066, CEP 13081, Campinas, SP, Brazil.)

The characterization of a new system based on cashew-nut tree (*Anacardium occidentale*) gum, a branched acidic heteropolysaccharide found in Brazil, and poly(ethylene glycol) (PEG) was studied. Phase diagrams are provided for the PEG-cashew-nut tree gum system. The influence of PEG molecular mass, tie-line length and pH on bovine serum albumin (BSA) partition was

investigated. Protein partition coefficient was little influenced by changing PEG molecular mass. Increasing the tie-line length decreased the partition. Increasing the pH also raised the BSA partition coefficient. It is shown that systems formed by PEG and cashew-nut tree gum may be considered as an interesting alternative for use in protein purification.

**567. SASALA, DV and MKAYULA, LL. 1995. Preparation and characterization of activated carbons from cashewnut shell liquid and shells. *Pakistan Journal of Scientific and Industrial Research* 38 (5/6): 186-191 (Dept of Chemistry, University of Dar Es Salaam, P.O.Box 35061, Dar Es Salaam, Tanzania.).**

**568. SATAPATHY, CR. and DEVARAJ URS, KC. 1996. *Aspergillus tamaritii* kitta: a pathogenic fungi for management of *Helopeltis antonii* on cashew. *Proceedings of PLACROSYM - XII* : 260-263 (Orissa University of Agriculture and Technology, Bhubaneswar-751 003.).**

The pathogenicity of the fungus *A.tamaritii* against all 5 nymphal instars of the TMB was tested through contact inoculation method and spraying of aqueous spore suspension method. In the former method mortality of the TMB, infected at first to fifth instar stages were 61.2, 80.5, 77.6, 91.4 and 90.6 and the mortality of the pest in corresponding instars in the latter method were 46.7, 56.7, 53.3, 46.7 and 43.3 respectively. Maximum mortality of the nymphs was recorded within 3-5 days of infection. The possibility of managing the TMB on cashew through *A.tamaritii* is foreseen through the above investigation.

**569. SATHE, SK. 1994. Solubilization and electrophoretic characterization of cashew nut proteins. *Food Chemistry* 51(3): 319-324**

The major protein in cashew nuts were found to be soluble in aqueous solvents. The proteins had a minimum solubility at pH 5.0. Among the protein solubilizing agents tested, 0.1M NaOH was the most effective solubilizer of cashew proteins. Electrophoretic analyses indicated that the cashew nut protein composition was dominated by a single multimeric protein. This dominant protein was composed of 2 major kinds of polypeptides linked together via disulphide bond(s). The estimated MWs of the subunit polypeptides were 30-32 kDa and 20-22 kDa. Amino acid analyses of the albumins and globulins indicated methionine to be the first limiting amino acid in both fractions. Hydrophobic, acidic, basic and uncharged polar amino acids accounted for 34.39, 25.87, 19.77 and 19.97% of total albumins while the corresponding percentages for the globulins were 34.25, 26.14, 18.93 and 20.68.

**570. SATHE, SK., SZE-TAO, KWC and WOLF, WJ. 1997. Biochemical characterization and *in vitro* digestibility of the major Globulin in Cashew nut. *Journal of Agriculture and Food Chemistry* 45 (8): 2854-2860**

The major Globulin in cashew nut is a 13 S globulin. The globulin is not a glycoprotein and is composed of at least two major types of polypeptides with estimated molecular weights in the range 18000-24000 and 30000-37000. The globulin has A1280nm of 9.88, 10.56, 9.68, and 9.56 in distilled water, 0.5 M NaCl, 0.02 M Sodium phosphate buffer pH 7.5, and 0.02

MTris- HCl buffer pH 8.1, respectively. Among the proteinases tested , pepsin was the most efficient in hydrolyzing the globulin *in vitro*.

**571.** SCHAPER, H., CHACKO, EK and BLAIKIE, SJ. 1996. **Effect of irrigation on leaf gas exchange and yield of cashew in Northern Australia.** *Australian Journal of Experimental Agriculture* 36(7): 861-868 (CSIRO Division of Horticulture, PMB 44, Winnellie, NT 0821, Australia.).

Gas exchange, leaf water status, soil water use and nut yield of cashew trees of the Indian cultivar BLA 39/4 were monitored during the reproductive phase in 2 consecutive years at a plantation near Darwin. Treatment 1 (T1) comprised continuous irrigation from the end of the wet season; T2, irrigation between flowering and harvest. Irrigation was applied by under-tree sprinklers at 43mm/week in 1988 and 64mm/week in 1989. Measurement of leaf gas exchange, chlorophyll content and nut production showed that trees in T2 were as productive as those in T1 (>1.3kg kernel/tree).

**572.** SEBASTIAN, S., THOMAS, KJ and THOMAS, EK. 2004. **Area, production and productivity of cashew in Kerala - a trend analysis.** *The Cashew* 18(3): 22-26

This study estimates trends in area, production and productivity of cashew in Kerala, India, based on secondary data for the years 1952/53-1999/2000. Results reveal that growth rate in area was positive for the entire period, with stagnant production, and declining productivity.

**573.** SEKAR, C and KARUNAKARAN, KR. 1994. **Economic analysis of cashew plantations under agroforestry conditions of**

**central Tamil Nadu.** *Journal of Tropical Forest Science* 6(4): 523-528

The data reported here are as per the yield of 3-15 year- old trees and give conventional analyses of net present value (NPV, Rs. 9871/ha), benefit cost ratio (BCR, 1.65), internal rate of return (IRR, 40.83%) and annuity value (AV, Rs. 1769/ha). The study indicates that growing cashew under rainfed conditions in this area is a more profitable enterprise than growing other rainfed crops. The 15th year data include the wood value of the cashew plantation (Rs. 25,480/).

**574.** SELVAMUTHUKUMARAN, T and NACHIAPPAN, RM. 2005. **Survey of tea mosquito bug *Helopeltis antonii* Signoret: incidence in the major cashew growing tracts of Tamil Nadu.** *Insect-Environment*. 11(1): 16-18 (Department of Entomology, Faculty of Agriculture, Annamalai University, Annamalainagar - 608 002, Tamil Nadu, India.)

A survey of tea mosquito bug (*Helopeltis antonii*) incidence was conducted from May 2000 to April 2001 in major cashew growing areas of eastern Tamil Nadu, India, i.e. Vridhachalam and Kurinjipadi areas of Cuddalore district, Kattukudalur and Kadampuliyur areas of Villupuram district, and Andimadam and Srimushnam areas of Ariyalur district. Percent damage was worked out from 25 newly emerged shoots/panicles per tree and 20 such trees were selected from 2 fields in each village. Based on percent damage, incidence was categorized as very high ( $\geq 30\%$ ), high (15-30%), medium (5-15%) and low ( $\leq 5\%$ ). Very high damage was observed at both locations surveyed in Cuddalore and Villupuram districts during January and

February 2001. High damage was noted during March 2001 at Vridhachalam and Kadampuliyur and during December 2000 at Kurinjipadi and Kadampuliyur. High damage was recorded during February to March 2001 in Ariyalur district, probably due to the presence of more number of old trees in these areas. A declining trend in percent damage was observed after February in all three districts probably due to the rise in temperature. These results indicate that the tea mosquito bug is well distributed in the major cashew growing areas of eastern Tamil Nadu.

**575. SELVARAJAN, M and DHARMALINGAM, V. 1998. Production technologies for cashew for different agroclimatic tracts of Tamil Nadu. *The Cashew* 12(3): 93-102 (Regional Research Station, (TNAU), Vridhachalam, Tamil Nadu.)**

Based on rainfall, ecological, and soil characteristics Tamil Nadu state could be classified in to 7 distinct agro-climatic zones. The technologies so far developed at the RRS, Vridhachalam hold good only for the red lateritic soils of Cuddalore dist. So, it is highly imperative to stimulate research on standardization of suitable root stocks for problem soils and evolving suitable agro techniques for different soils under different agroclimatic condition and forestry plantation is essential. The highest productivity of cashew in Kanyakumari dist. is due to deep and fertile soils and high rainfall.

**576. SENA, DK., LENKA, PC and MAHARANA, T. 1995. Physico-chemical properties of cashew apples of some promising clones. *The Cashew* 9(1): 14-16**

The present investigation 'physico-

chemical studies of cashew apples' revealed that maximum apple weight was recorded in VTH-30/4 (87.28gm), highest specific gravity in H-1608 and maximum apple length in VTH-30/4 (7.85cm). The juice recovery varied from 64.25% to 74.25%. Titrable acidity was minimum in cashew apple Vengurla - 4 and maximum in BPT-40 and BBSR Cluster-1. The sugar content was highest in Vengurla -3 (10.5%) and lowest in M-26/2 (6.58%).

**577. SENA, DK., LENKA, PC and RATH, S. 1995. Studies on floral characters of different cashew types. *The Cashew* 9(2): 5-7**

Studies on floral characters of different cashew types revealed that the panicle initiation started from end of November to last part of January under Bhubaneswar condition. Flowering panicle per sq.mt. was highest in Vengurla - 2 and lowest in TN 129. The duration of flowering ranged from 53.26 days to 90 days. Open and compact types of panicles were observed in the cultivars under study. Highest panicle length and breadth was observed in H-1608, the lowest length in M-26/2 while the lowest breadth was observed in BBSR CI-1. The variation in sex ratio ranged from 0.093 to 1.038.

**578. SENGUTTUVAN, T. 1999. Behavioural control of the cashew stem and root borer. *Pest Management in Horticultural Ecosystem* 5(1): 72-73**

A field trial was conducted in Tamil Nadu to test the response of *P.ferrugineus* to CNSL. Relatively more oviposition occurred during February, April and May on cashew trunks smeared with CNSL, with up to 8 eggs/tree. Only 0.7 eggs were observed on logs smeared with CNSL. Moringa logs smeared with CNSL failed to attract *P.ferrugineus* to oviposit. An

increase in infestation during the treatment period occurred in all treatments, but was significantly less on trunks smeared with CNSL. The results indicate that swabbing CNSL on basal trunks of 2 to 4 unproductive trees during the period of adult emergence in December to May and collection and destruction of eggs laid by attracted adults, may help to control stem borer.

**579.** SENGUTTUVAN, T and MAHADEVAN, NR. 1998. **Comparative biology of cashew stem and root borer, *Plocaederus ferrugineus* L. on natural host and semi-synthetic diet.** *Journal of Plantation Crops*. 26 (2): 133-138 (National Pulses Research Centre (TNAU), Vamban-622 303, Pudukkottai, Tamil Nadu, India.)

Biological studies on *P. ferrugineus* revealed that adults mated a day after emergence, and mating occurred 3 to 6 times a day mostly during night. The mean pre-oviposition and oviposition periods were 3.6 and 7.2 days, respectively. A female beetle laid an average of 62 eggs and the incubation period was 6.9 days. In cashew root logs, the grub period, pupal period and total life cycle were 163.9, 60.3 and 249.6 days for male and 168, 70 and 261 days for female, respectively. On a semi-synthetic diet, the grub period, pupal period and total life cycle were 219.7, 53.3 and 284.3 days for male and 212.3, 63.3 and 291.5 days for female, respectively. About 6 to 7 instars were noticed in both male and female. There was an increase in total life cycle by one month when reared on a semi-synthetic diet. The grubs did not form calcareous cocoons on a semi-synthetic diet. The adult beetles developed from moringa and cashew logs were larger in size, lived longer and laid more eggs than those on a semi-synthetic diet.

**580.** SENGUTTUVAN, T. 1999. **Prophylactic control of stem and root borer in cashew.** *The Indian Journal of Agricultural Sciences* 69(2):163-165

Swabbing the basal trunk of cashew trees with BHC 0.2%, coal tar + kerosene (1:2), neem oil 25%, neem cake extract 25%, NSKE 25%, karanj oil 25%, mahua oil 25%, white cement and waste oil, spraying fenthion 0.1% and pasting with red earth were compared for *P. ferrugineus* control in field trials in Tamil Nadu. In each trials a block of 80- 100 trees contained 2-3 severely infested trees, which served as a source of infestation. Spraying with fenthion, or swabbing with HCH + coal tar + kerosene or neem oil to a height of 1 m from the ground 4 times a year was effective in reducing stem borer incidence by 70-90%.

**581.** SENGUTTUVAN, T and MAHADEVAN, NR. 1997. **Integrated management of cashew stem borer, *Plocaederus ferrugineus* L.** *Pest Management in Horticultural Ecosystems* 3(2): 79-84 (National Pulses Research Centre (TNAU), Vamban Colony-622 303, Tamil Nadu.).

Field studies on the effect of cultural and mechanical control measures against cashew stem and root borer and a laboratory study on the ovicidal activity of insecticides on eggs of the stem borer were conducted. The results indicated that the damage was less than 3 in healthy orchards practising mechanical removal of grubs and application of BHC on the affected portions at early infestation. Control of early infestation was critical in the management of *P. ferrugineus*. The study showed that BIIC can be dispensed with, in the management of *P. ferrugineus*.

582. SENGUTTUVAN, T and MAHADEVAN, NR. 1997. **Studies on the population fluctuation and management of cashew stem and root borer.** Pest Management in Horticultural Ecosystems 3(2): 85-94 (National Pulses Research Centre (TNAU), Vamban Colony-622 303, Tamil Nadu.).

Studies on population fluctuation of *Plocaederus ferrugineus* L. revealed 2 peak oviposition periods in Tamil Nadu. Infested trees recorded more eggs than uninfested. Ovipositional preference was for infested trees. Higher grub population was noted during all months except February in trees with early, middle and advanced stages of infestation. Early instar grubs were more during January to July while middle and late instar grubs were more during March to Nov. and Aug. to Jan. Severely infested trees had a higher larval count, pre pupae and pupae with overlapping of generations.

583. SENGUTTUVAN, T. 1998. **Effect of botanicals against tea mosquito bug in cashew.** *Insect Environment* 4(3): 78 (National Pulses Research Centre, Vamban Colony 622 303, Pudukkottai, Tamil Nadu, India.).

Field trials were carried out in 1992-93 to determine the effectiveness of various botanical insecticides against the cashew pest *Helopeltis antonii*. Neem seed kernel extract at 5 was found to be equally as effective as the standard spray schedule (0.05 endosulfan, 0.05 monocrotophos and 0.1 carbaryl during flushing, fruiting and flowering, respectively).

584. SENGUTTUVAN, T and MAHADEVAN, NR. 1999. **Influence of tree characteristics on the incidence of cashew stem and root borer.** *Journal of Plantation Crops* 27(1): 59-

62 (National Pulses Research Centre, (TNAU), Vamban - 622 303, Pudukkottai, Tamil Nadu.).

The present study indicated that the stem and root borer damage in cashew was positively correlated with age of trees. An increase in age of 1 year led to an increase in damage by 1.93. Trees aged more than 10 years were more infested than the young trees and the median worked out showed that 50 of the total damage could occur only after 17 years of tree age. Trees with branching at collar region recorded higher damage than trees with branching at above ground level.

585. SENGUTTUVAN, T and MAHADEVAN, NR. 1998. **Morphometrics of cashew stem and root borer: I. immature stages.** *The Cashew* 12(2): 4-9 (National Pulses Research Centre, Vamban-625 104, Tamil Nadu.).

Morphometrics of immature stages of cashew stem and root borer were elaborately studied. The ellipsoidal eggs measured 4.20mm in length and 1.90mm in breadth. The grubs were 25.86, 42.43, 48.43, 53.03, 58.83, 61.86 and 67.43 mm in length with head capsule breadth of 1.79, 3.95, 5.50, 6.33, 7.13, 8.31 and 9.65mm respectively at first to sixth months of growth and before pupation. In each sex, 6 to 7 instars were noted. In starwise morphometrics studies indicated that the grub length ranged from 8.6mm in first instar to 82.1mm in seventh instar with the head capsule breadth ranging between 1.61 to 8.94mm. The dorsoventrally flattened calcareous cocoons measured 50.6mm in length and 24.9mm in breadth.

586. SEREDA, I. and NUNES, RCR. 1997. **Effect of phenolic resin on processing and mechanical properties of PP-NBR blends.**



Polymer mixtures based on polypropylene (PP) and acrylonitrile rubber (NBR) were prepared in a Haake Rheocord Mixer model 9000, coupled with a mixer chamber, in a proportion of 60:40/ PP: NBR. These mixtures were processed in the presence either of phenolic resin SP- 1045 or a phenolic derivative synthesized with CNSL distillate, in different concentrations. The influence of this component, as well as its concentration were evaluated by some processing data and through mechanical tests.

587. SETHY, BK., RATH, S and KAR, M. 2003. **Biochemical and yield attributing characters of cashew nut (*Anacardium occidentale* Lin.) as affected by crusher mill dust.** *Journal of Research, Birsa Agricultural University.* 15(2): 241-244 (Department of Horticulture, Orissa University of Agriculture & Technology, Bhubaneswar - 751 003, India.)

A study was conducted to investigate the effect of crusher mill dust on the yield and biochemistry of cashew. Five-year-old trees were at a specific distance from the crusher unit (control, 3 km; and 120, 170, 220, 270 and 320 m). The amount of dust deposited on the branches (at g/25 leaves), as well as biochemical parameters, were measured at bimonthly intervals. The values for fruit length, breadth, volume and weight were lowest in plants closest to the crusher unit, and were highest in the control. The control plants showed higher chlorophyll values compared to those in the other treatments. The control plants also showed the highest fruit TSS content.

588. SHARMA, GK., SEMWAI, AD and MAHESH, C. 2006. **Effect of antioxygenic**

**salt on the self-life of deep-fat fried cashew kernel under vacuum packaging.** *Journal of Food Science & Technology* 43(4): 417-419

Studies were undertaken to enhance the shelf-life of deep fat fried cashew kernels, using antioxygenic salt and vacuum packing. During storage, the changes in chemical parameters like peroxide value (PV), free fatty acid (FFA) content, thiobarbituric acid (TBA) value, total carbonyls (TC) and fatty acid profile were monitored and correlated to the sensory scores. Strong correlation ( $r > 0.8$ ) was found between chemical parameters and overall acceptability score. Vacuum packing of fried cashew kernels treated with antioxygenic salt extended the self-life and acceptability up to one year irrespective of frying medium under ambient temp. AA.

589. SHARMA, MR. 2002. **Credit support from NABARD for development of cashew nut plantation in India.** *The Cashew* 16(2): 5-22

This paper deals with the credit support facilities extended by NABARD for the development of cashewnut plantations in India.

590. SHARMA, NR. 1997. **Introducing HACCP to cashewnut processing industries.** *Cashew Bulletin* 34(1): 4-8 (Export Inspection Agency, Cochin-682 005.)

Hazard Analysis Critical Control Point System-the most modern armament of the Total Quality Management consists of 7 steps. Before a HACCP plan is formulated a systematic & scientific study of the process has to be conducted to identify hazards, CCPs, control procedures and verification mechanisms.

591. SHERLIJA, KK and UNNIKRIISHNAN, K. 1996. **Biochemical changes in shoot apex**

of cashew during transition from vegetative to reproductive phase. *Phytomorphology* 46(1): 25-30 (Dept of Botany, University of Calicut - 673 635, Kerala.).

Changing profiles of total protein, free aminoacids, sugars, starch and phenolics during transition from vegetative(v) to reproductive(r) phase in shoot apex of cashew were studied. The quantitative values of total protein did not differ very much in v and r phases of the shoot apex. The total aminoacides showed a downward slope from v to r phase while the values of sugar and starch contents ascended from the former to the latter. The total starch slightly decreased and the phenolic contents recorded steep rise in r phase. The percentage of dry weight was also high due to increased tissue.

592. SHERLIJA, KK and UNNIKRISHNAN, K. 1997. Morphohistology of normal and flag leaves of cashew during developmental phases of pseudocarps. *Phytomorphology* 47(3): 235-245 (Dept of Botany, University of Calicut, Kozhicode-673 635, Kerala.).

*A. occidentale* is a cross pollinated tropical tree bearing pseudocarps and eucarps. With the development of pseudocarps and eucarps 1-3 leaves in basipetal succession below the inflorescence turned from green to pale green and to nearly white. Such leaves were designated as flag leaves (fl). They gradually lost their normal abaxial protuberance of the midrib and developed adaxial projection. The internal morphology of nl and fl revealed differences in unit area of palisade and spongy tissues, intercellular space in palisade and spongy tissues. The phloem to xylem ratio also differs between nl and fl.

593. SHERLIJA, KK. and UNNIKRISHNAN, K. 1997. Variations in total phenolics of normal leaf, flag leaf, pseudocarp and parts of nut of cashew. *Annals of Plant Physiology* 11(1): 85-90 (Dept of Botany, University of Calicut, Kozhicode-673 635, Kerala.).

The changing profiles of total phenolics in normal leaves, flag leaves, pseudocarp and nut parts during development of cashews, growing in India were analysed. Total phenolics in normal leaves decreased up to anthesis, then increased with development. In flag leaves, the quantity of phenolics was highest during preanthesis. The content of phenolics in the pseudocarp decreased with development. The fruit wall and seed coat contained high phenolic contents.

594. SHESHAGIRI, KS. 1996. Studies on the flowering period and sex-ratio in cashew selections in hill zone of Karnataka. *The Cashew* 10(3):11-14 (Regional Research Station, Mudigere, Karnataka)

Fifteen elite cashew selections, growing at the RRS, Mudigere during 1993-94, were evaluated for flowering period and number of staminate and perfect flowers. Six selections had >45 perfect flowers (Kerala-8/46(61.68); Kerala-1/26 (55.33); Madras-1/61(54.2); Vengurla-19(45.38); Andhra-9/66 (47.06) and Kerala-2/97 (45.12)), 5 selections had between 25 and 45 perfect flowers and the remaining 4 selections had <25 perfect flowers. Three selections had sex ratios of perfect flowers to staminate flowers of >1 (Kerala-8/46, Kerala-1/26 and Madras-1/61). Five selections had sex ratios of >0.7:1.

595. SHILPA GOGTE. 2000. Induction of somatic embryogenesis in cashew nut. *In Vitro*

Somatic embryogenesis was induced in callus cultures derived from nucellar tissue of cashews. Callus was obtained from nucellar tissue after 3 weeks of culture on semisolid MS basal medium supplemented with 2,4-D + GA<sub>3</sub>, 15/μM + N<sup>6</sup>-benzyladenine (BA, 5/μM). This callus gave rise to an embryogenic mass after 9 weeks on maintenance medium containing 2,4-D + GA<sub>3</sub> + 4% sucrose + 0.5% activated charcoal + 10% coconut water + 0.05% casein hydrolysate. Embryogenic mass, after transfer to medium supplemented with 2,4-D (5/μM) + GA<sub>3</sub> (30/μM) + 4% sucrose + 0.5% activated charcoal + 10% CW + 0.05% CH, gave rise to somatic embryos.

**596.** SHINGRE, DV., GAWANKAR, MS and JAMADAGNI, BM. 2003. **Effect of irrigation and nitrogen on scion yield in cashew.** *The Cashew* 17(1): 19-22

The investigation was undertaken to assess the effect of different degrees of water stress on production of scions of cashew variety V-6. Three years data revealed that there were average 70 scions on the tree, which were subjected to stress free treatment. Mild and moderate stress did not show remarkable reduction in number of scions/ tree. Strong and severe stress showed 20 and 22% reduction in number of scions respectively. Application of nitrogen 750g/ tree/ year alleviated the effect of water stress by giving 33, 23.44, 7 and 10% increase in scion production under mild, moderate strong and severe stress condition respectively with reference to that under stress free condition. Higher levels of nitrogen were found to be less effective for stress management.

**597.** SHINGRE, DV., GAWANKAR, MS and JAMADAGNI, BM. 2003. **Standardization of the month of grafting and age of rootstock in cashew.** *The Cashew* 17(1): 35-39

An investigation was undertaken to assess the effect of season and age of the rootstock on success of grafting in cashew varieties V-4 and V-6. Three years data revealed that May is the most favourable month for grafting V-4 as well as V-6 varieties of cashew. The most appropriate age of rootstock for cashew grafting was 45 days. Grafting during April was a second promising option provided 45 to 60 days old rootstocks are available. A reasonable success could also be obtained by grafting in March, June and August, November to January was the most unfavourable months for cashew grafting.

**598.** SHINGRE, DV., GAWANKAR, MS and JAMADAGNI, BM. 2001. **Effect of nitrogen and irrigation on scions production of cashew variety Vengurla - 6.** *The Cashew* 15(4): 4-7

In a field investigation the response of cashew variety V 6 was studied to 5 levels of irrigation and 5 levels of nitrogen for production of scions required for softwood grafting. Three years data revealed that irrigation at 30mm CPE is most effective (86.63) followed by 60mm CPE (80.43 scions) for scions production. At 120 mm CPE number of the scions was equivalent to unirrigated condition (65 scions). With increasing level of nitrogen the scions production increased and reached a maximum (88.39 scions) at 750g N. / tree. With every additional level of nitrogen above 750g, there was a sharp decline in number of scions per tree.

599. SHIVARAMU, K., MANJUNATHA, D and MOHAN, E. 2004. **Impact of cashew demonstration on adoption of recommended cultivation practices by farmers.** *The Cashew* 18(2): 16-21

This study conducted in 2002-03, examined the characteristics of 30 farmers who participated in on-farm demonstrations of recommended cashew cultivation practices in Dakshina Kannada and Udupi districts of Karnataka. It also evaluated the level of adoption of improved practices by these farmers and another 30 neighbouring farmers who had constantly visited and interacted with the participating farmers. Majority of the participating farmers belonged to the high - adoption category and opined that the project on cashew demonstration should be continued.

600. SHI-WENGE., QIAO-GUANMING., WANG-YONGGANG and ZHU-XINTIAN. 2005. **Experiment of applying nitrogen and phosphate fertilizers for cashew nut.** *South-China-Fruits*. (1): 30 (Research Institute of Forestry, Honghe Harni and Yi Nationality Autonomous Prefecture, Yunnan, China.)

An experiment was conducted with young plants of 2 cashew (*Anacardium occidentale*) cultivars at a site with an elevation of 325 m, average yearly temperature of 22.6 degrees C, average hottest month temperature of 26.6 degrees C, hardiest month temperature of 16.0 degrees C, absolute minimum temperature of 6.2 degrees C and yearly rainfall of 1645.2 mm. The soil pH is 6.0 and the organic matter content was 18.59 g/kg. During 3 years, different amounts of urea, superphosphate, and urea + superphosphate were applied. Results indicated that the trees with applications of urea of 25-35 g and superphosphate of 20-40 g were

the best growing. It is recommended that the better ratio between N and P for the young cashew trees are 2:1.

601. SHOMARI, SH and KENNEDY, R. 1999. **Survival of *Oidium anacardii* on cashew (*Anacardium occidentale*) in southern Tanzania.** *Plant Pathology*. 48: (4): 505-513 (Cashew Research Project, Naliendele Agricultural Research Institute (NARI), PO Box 509 Mtwara, Tanzania.)

During March and April of 1993 and 1994, surveys on the incidence and severity of cashew powdery mildew (*Oidium anacardii*) were conducted in the Newala, Mtwara, Nachingwea and Tunduru areas of southern Tanzania to determine the variation in perennation between localities. Only immature cashew shoots, panicles and fruit can be infected by *O. anacardii* conidia. Cashew trees at sites in each district were assessed for shoot and panicle production and cashew powdery mildew. Survival of *O. anacardii* between seasons, in any area, was determined by the degree of production of shoots that were within the canopy and by the incidence of infection. Immature shoots produced from the main branches within the tree canopy were the main source of active powdery mildew in all districts; trees in the Newala district had the highest numbers of infected immature shoots in comparison with survey sites in the other areas. During the 1994 cashew-growing season (June-August), powdery mildew developed more rapidly and affected more shoots on the inside of the tree canopy than on the outside. Germination of conidia was reduced after aqueous suspension for 3 h. Germination on cashew leaves submerged under 2 mm of water was not affected. Appressorial and hyphal

formation by germinating conidia on leaves decreased with increasing duration under water. Germination of conidia on glass slides at 100% relative humidity was higher at 25 and 30°C than at 15°C and there was no germination at 35°C.

**602. SHUKLA, N. 2000. Response of grafting methods on success and growth of cashew in different periods of Bastar plateau. Orissa Journal of Horticulture 28(1): 38-42**

Three propagation methods viz; softwood, veneer and epicotyl grafting were compared over 6 months (July to December). The results revealed that softwood grafting was significantly superior to veneer and epicotyl grafting and recorded greater success rates in August (76.66%), September (73.33%) and October (76.66%). Softwood and veneer grafted plants did not differ significantly in height and number of leaves per plant. A correlation study indicated that the minimum temperature and relative humidity had the most significant positive correlation with percentage success of all the grafting techniques.

**603. SIJAONA, MER., REEDER, RH and WALLER, JM. 2006. Cashew leaf and nut blight - a new disease of cashew in Tanzania caused by *Cryptosporiopsis* spp. Plant Pathology 55 (4): 576**

In August 2002, a new and damaging leaf and nut blight disease was observed on young tissues of cashew in Southern Tanzania. Angular lesions, and dark tan with a dark reddish brown margin were formed on leaves, often vein-limited and containing conidiomata. Lesions subsequently enlarged and coalesced, causing blighting and defoliation. Older lesions became papery and silver/grey in colour and

developed shot-holes. During fruit setting, infection of young nuts caused rapid blackening and abscission, resulting in significant yield losses. On analysis, a new and undescribed *Cryptosporiopsis* species was consistently isolated from the nut and leaf lesions. Wounded and non-wounded leaves of cashew were inoculated with an aqueous conidial suspension or with water (control) and maintained at 24-28 °C and 95% RH for 24h. All inoculated plants showed leaf lesions similar to that observed in the field within 7-10 days after inoculation. None of the control plants developed any symptoms. A *Cryptosporiopsis* species was reisolated that was morphologically identical to the original isolate inoculated.

**604. SIJAONA, MER. 2001. Comparative analysis of powdery mildew development on leaves, seedlings and flower panicles of different genotypes of cashew. Plant Pathology 50(2): 234-243**

Resistance of cashew genotypes to powdery mildew was assessed on detached leaves, seedlings and flower panicles. Leaves were more susceptible before the development of a waxy cuticle, which confers a dull appearance. Some genotypes supported dense growth of mildew, whereas on others only slight infection was observed under comparable conditions. Mature leaves were immune to colonization. The AZA2 and AC6 genotypes proved to be partially resistant, while AM6, ATA19 and AIN 62 were highly susceptible. The relationship between leaf and flower mildew infection showed positive and highly significant correlations.

**605. SIJAONA, MER. 2001. Variation in the response of cashew genotypes to the targeted**

**application of fungicide to flower panicles for control of powdery mildew disease.** *Plant Pathology* 50(2): 244-248

Application of the fungicide triadimenol at 250g a.i./lt. directly to inflorescences of cashew was investigated in Tanzania in the 1995-96 season, as a means of controlling powdery mildew disease. Disease development and nut production were studied in 12 cashew genotypes that differed in their susceptibility to mildew. Triadimenol sprays reduced mildew to less than 9%, even in panicles of highly susceptible genotypes. The targeted treatment of flower panicles to control mildew is recommended, rather than the current practice of wastefully treating the whole trees on which all mature leaves are naturally immune to infection.

**606. SIJAONA, MER and MANSFIELD, J.** 1997. **Studies on aspects of cashew resistance to powdery mildew.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp. 241-248

Experiments showed that when challenged by a fungus, host tissue reacts violently by producing a sharp hypersensitive reaction at penetration points as a defence mechanism, this differed appreciably between clones. The rate of mildew infection as estimated from disease progress curves, varied significantly across test clones, higher on susceptible and lower in resistant clones. Similar investigations on leaf tissue of young seedlings, revealed similar rank order of clones. When treated with fungicide, susceptible clones such as AM6 and AIN62 responded quite well producing higher nut yield.

**607. SIJAONA, MER and MANSFIELD, J.**

**1997. Field studies on cashew resistance to powdery mildew on leaves and flowers.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.*

The rate of mildew infection as estimated from disease progress curves on both organs, varied significantly between genotypes. They were differentiated in to susceptible and partially resistant genotypes. A similar rank order for degree of resistance was determined from studies on leaves and inflorescences. Results indicated that the "slow mildewing" principle was operating in cashew. Brazilian introductions, AZA2 and AC6 genotypes proved to be partially resistant, while AM6, ATA19 and AIN62 were highly susceptible.

**608. SILVA, MR., SILVA, MS and OLIVEIRA, JS.** 2004. **Stability of ascorbic acid in refrigerated and frozen Cerrado cashew apple.** *Pesquisa Agropecuaria Tropical.* 34(1): 9-14 (Faculdade de Nutricao, Universidade Federal de Goias, Rua 227 quadra 68 s/n, Setor Universitario, Caixa Postal 131, CEP 74605-080, Goiania, GO, Brazil.)

The stability of vitamin C in refrigerated and frozen cerrado cashew apple (*Anacardium* spp.) over different storage times and packaging types was determined. Cerrado cashew apple from 2 different regions were divided into lots (lot 1 and lot 2) and the samples were put into opaque or transparent polyethylene bags. The samples in lot 1 were separated into 2 portions: one portion was refrigerated (4 degrees C) and the other was frozen in the freezer (-18 degrees C) and both were stored for 30 days. The samples in lot 2 was frozen (-18 degrees C) for 90 days. The cashew apples were analysed for

pH, titrable acidity, moisture, soluble solids and ascorbic acid. After 30 days under refrigeration, the moisture and pH values were increased, whereas the soluble solids, titrable acidity and ascorbic acid were decreased in comparison to the fresh Cerrado cashew apple. In lot 1, the ascorbic acid content of frozen cashew apple was increased in the final weeks, and the opaque bag was more efficient in preserving vitamin C. After being frozen for 90 days (lot 2), the ascorbic acid content of cashew apple was reduced by more than 60%. Freezing was more efficient in preserving ascorbic acid than refrigeration. The use of opaque or transparent bags did not affect the conservation of ascorbic acid, except for the first 30 days of freezing.

609. SILVEIRA, JAG., VIEGAS, R de A and ROCHA, IMA da. 2003. **Proline accumulation and glutamine synthetase activity are increased by salt-induced proteolysis in cashew leaves.** *Journal of Plant Physiology* 160(2): 115-123

Cashew plants were subjected to short and long-term NaCl exposures to determine the effect of salt-induced proteolysis and glutamine synthetase (GS) activity on proline accumulation. The leaves showed a significant proline accumulation in response to salt stress. In contrast, the root tissue had no significant changes in proline content even after drastic injury caused by salinity on the whole plant. The leaf proline accumulation was correlated to protease activity, accumulation of free amino acid and ammonia and the decrease of both total protein and chlorophyll contents. The leaf GS activity was increased by salt stress whereas in roots it was slightly lowered. Although several amino acids in the soluble pool of leaf tissue have showed an intense increment in its

concentrations in the salt-treated plants, proline exhibited a proportional increment from 50 to 100 NaCl/m<sup>3</sup> exposure. The prominent salt induced proline accumulation in the leaves was associated with higher salt sensitivity in terms of proteolysis and salt-induced senescence compared to the roots.

610. SINDONI, M. 2005. **Optimum harvesting date for pseudofruits of cashew early dwarf clones CCP 76 and 06 in the south of Anzoategui State, Venezuela.** *Proceedings of the Interamerican Society for Tropical Horticulture* 48: 65-68

Maturity indices based on the physico-chemical characteristics of pseudofruits were monitored during 2002 to determine the optimum harvest time for early dwarf cashew clones CCP-76 and CCP-06 in southern Anzoategui state. Data were taken at 2 day intervals from fruit initiation until one week after the maturity indices reached their maximum values under storage. The optimum harvesting date was estimated at 56 days. Fruits harvested on this date showed high fruit quality, acceptability and shelf life. CCP-76 recorded significantly higher total soluble solids content, a measure of quality than CCP-06.

611. SINGH, S.N. 1997. **Effect of bio-fertilizer (*Azotobacter chroococcum*) in cashew plantation.** *Environment and Ecology* 15(2): 482-484 (Regional Research Station, BCKV, Jhargram-721 507, West Bengal, India.).

The study was carried out at a cashew (cv.M 26/1) plantation at Kumari, WB. during 1993-95. *A.chroococcum inoculum* was applied at rates of 5,10,15 or 20g/plant, NPK(500:125:125) was applied for comparison, and the control was untreated.

Application of *A. chroococcum* inoculum at 15g/plant increased cashew yield over the control by 229.1 and 94.2 in 1994 and 1995 respectively. Yield was also 106.3 higher than for the chemical fertilizer in 1994, but no yield advantage was observed in 1995. The site was in a semi-arid zone, on a red laterite soil with low available N and P and high K.

612. SINISH, MS., MERCY, G and JOHN, PS. 2005. **Organic methods for cashew root stock production.** *The Cashew* 19(1): 8-15

An experiment involving organic methods for cashew root stock production was conducted in Madakkathara, Kerala during 2002-03 to select the best organic source of nutrients in the preparation of potting mixture and to determine the influence of biofertilizer inoculation on the growth of cashew seedlings. The treatments consisted of 3 types of potting media (cow dung, poultry manure and coirpith compost); 3 biofertilizers, i.e. Azospirillum, phosphorus solubilizing bacteria (PSB) and arbuscular mycorrhizal fungi (AMF) as single inoculation and in combination of all the 3 ; and an absolute control with only sand and soil in equal proportion. Data were recorded 4 days taken for germination, plant height, plant girth at the collar region, leaf number, root and shoot dry weights, nutrient (NPK) content of leaves and potting mixture at the time of grafting, i.e. at 60 days after germination. Earlier germination and higher germination percentage were obtained with cow dung and coirpith compost compared with poultry manure. The combined inoculation of Azospirillum, PSB and AMF in the potting mixture induced earlier germination with better germination percentage. Among the 3 biofertilizers, AMF was found to be the best. Among the different

potting mixtures, the sand: soil: cow dung was the best.

613. SMITH, DN., KING, WJ and TOPPER, CP. 1995. **Alternative techniques for the application of sulphur dust to cashew trees for the control of powdery mildew caused by the fungus *Oidium anacardii* in Tanzania.** *Crop Protection* 14(7): 555-560

Sulphur dust were widely used in Tanzania to control powdery mildew on cashew trees caused by *O. anacardii*. Sulphur distribution on mature cashew trees obtained using a motorized backpack duster, a manually powered backpack duster and locally developed dusting bag were compared. The most efficient application was from the motorized duster although sulphur distribution throughout the canopy of the tree was uneven with all three methods. The presence of dew when dusting was demonstrated to increase sulphur deposition. Following application, sulphur deposits on the canopy were found to decline by as much as 80% in 3 weeks.

614. SMITH, DN. 1997. **Comparison and evaluation of alternative methods for the application of fungicides to cashew trees.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania* pp. 282-285

Alternative methods for fungicide application to control PMD have been evaluated in terms of the distribution of fungicide over the cashew canopy and the efficiency of application. Equipment evaluated included a motorized backpack duster, a manually powered backpack duster and a locally developed dusting bag, for sulphur dusting, and a motorised backpack blower and lever operated



knapsack sprayer with various lance assemblies for water-based organic fungicide spraying. In both cases the most effective method of application was found to be the motorised knapsack duster/sprayer.

615. SMITH, DN., KING, WJ., TOPPER, CP., MHANDO, H and COOPER, JF. 1997. **Studies on spray deposition on cashew trees in Tanzania with reference to the use of fungicides.** *Crop Protection* 16 (4): 313-322 (Natural Resources Institute, Central Avenue Chatham Maritime, Kent ME4 4TB, UK).

Water based organic fungicides are being introduced in to Tanzania as an alternative to sulphur dust for the control of powdery mildew on cashew trees, caused by *O. anacardii*. Spray application trials were carried out in Tanzania using motorised knapsack mistblowers to determine the minimum volume of spray required to achieve acceptable canopy coverage. Further trials were carried out to assess the feasibility of using lever operated knapsack sprayers with both commercially available and customised lance assemblies. Using the motorized mistblower gave uneven canopy coverage of 45.

616. SMITH, RL., MALALUAN, RM., SETIANTO, WB and INOMATA, H. 2003. **Separation of cashew (*Anacardium occidentale* L.) nut shell liquid with supercritical carbon dioxide.** *Bioresource Technology*. 88(1): 1-7 (Department of Chemical Engineering, Research Center of Supercritical Fluid Technology, Tohoku University, Aoba-ku, Aramaki Aza, Aoba-04, Sendai 980-8579, Japan.)

Cashew nut shell liquid (CNSL) represents the largest readily available

bioresource of alkenyl phenolic compounds. In this work, separation of CNSL from the pericarp of the cashew nut with supercritical carbon dioxide was studied. In the initial extractions with CO<sub>2</sub> at 40-60 degrees C and at pressures from 14.7 to 29.4 MPa, low yields were obtained. However, when the extractions were performed with one or more intermediate depressurization steps, the yield of CNSL increased to as high as 94%. Most of the oil did not separate from the shell during the depressurization step, but was obtained during the subsequent repressurization. The CNSL extract had a clear light brownish pink colour and exhibited no evidence of polymerization or degradation. The pressure profile extraction method proposed in this work increases the possible CNSL extraction yields and greatly reduces the amount of CO<sub>2</sub> required for CNSL separation..

617. SOARES, ACD., COSTA, JTA., CRISOSTOMO, LA and MELO, FIO. 2000. **Germination and development of cashew seedlings under saline stress.** *Revista Brasileira-de-Fruticultura*. 22 (3): 458-462

In a nursery trial at Pacajus, Ceara, Brazil, seeds of the cashew rootstock clones CCP-1001 and CCP-06 were sown in plastic bags containing substrate at 6 salinity levels from 0.45 to 6.50 dS/m. Increasing medium salinity reduced germination percentage and rate, as well as seedling growth. Of the two cultivars, CCP-06 had the lower rates of seed germination and seedling growth. Foliar symptoms of salinity developed progressively in both rootstocks from 45 days after germination onwards.

618. SOMAN, CR. 1997. **Cashew kernel in**

**human health.** *The Cashew* 11(4): 7-11

Cashew kernels are excellent dietary supplements in the human diet. Protein is present in abundance and that too of a good quality. It provides a rich blend of minerals and many water soluble vitamins. The fat content in cashew makes it an energy rich food and the fatty acid profile is ideal for human consumption. The incorporation of cashew kernel in to the regular diets would enhance the nutritive qualities of the diet while improving palatability.

**619. SOSAMMA, VK.** 2003. **Utilisation of entomopathogenic nematodes in plantation crops. Current status of research on entomopathogenic nematodes in India :** *Workshop on the Entomopathogenic Nematodes in India* held on 22 and 23rd January, 2003. p. 109-119 (Central Plantation Crops Research Institute, Regional Station, Krishnapuram P.O., Kayangulam, Kerala 690 533, India.)

This paper covers the use of entomopathogenic nematodes in the control of important pests of plantation crops in India such as coconut, arecanut, oil palm and cashew..

**620. SOUSA, LB., FEITOZA, L de L and GOMES, RLF.** 2007. **Floral biology aspects of the early dwarf and common cashew.** *Ciencia Rural* 37 (3): 882-885

A knowledge of the floral biology is very important for the development of the cashew culture. In relation to botanical aspects, the morphological characteristics of flowers effectively contributed to the determination of the well-known species of *Anacardium*. Experiments were conducted to study the floral biology of the early dwarf and common cashew

cultivars using a 4 panicle per plant in north, south, east and west orientations. The common and early dwarf cashew cultivars presented little variation for most of the evaluated characteristics. The common cashew cultivars presented a larger proportion between the number of hermaphrodite flowers and the total number of flowers than the early dwarf cashew clones. This may facilitate a larger production of fruits in the common cashew. The number of developed fruits was very low in both cultivar types. The panicle placed in different cardinal orientations were similar in all the clones in relation to the aspects related to the floral biology of cashew.

**621. SOUZA, IH., ANDRADE, EM and BEZERRA, FML.** 2004. **Initial growth of early dwarf cashew plants under different soil water tensions.** *Proceedings of the Interamerican Society for Tropical Horticulture*. 47: 157-160 (Escola Agrotecnica Federal de Iguatu, CEP: 63.500-000, Iguatu, CE, Brazil.)

This study evaluated the effect of different soil water tensions (10, 20, 30 and 100 kPa) on the early growth of dwarf cashew 'CCp 76' on a sandy soil in a coastal area in Ceara State, Brazil. Data were recorded for plant height, number of leaves and diameter of the stem below and above the graft point. The results showed that cashew had high tolerance of water stress during the early stages, since there were no significant differences among treatments.

**622. SOUZA, RP DE., RIBEIRO, RV and MACHADO, EC.** 2005. **Photosynthetic responses of young cashew plants to varying environmental conditions.** *Pesquisa Agropecuaria Brasileira* 40(8): 735-744

The aim of this study was to characterize gas exchange responses of young cashew plants to varying photosynthetic photon flux density (PPFD), temperature, vapour- pressure deficit (VPD) and intercellular CO<sub>2</sub> concentration (C), under controlled conditions. Daily courses of gas exchange and chlorophyll a fluorescence parameters were measured under natural conditions. The maximum CO<sub>2</sub> assimilation rates, under optimal controlled conditions, were 13 mmol m<sup>-2</sup> s<sup>-1</sup>, with light saturation around 1000 mmol m<sup>-2</sup> s<sup>-1</sup>. Leaf temperatures between 25 and 30° C were optimum for photosynthesis. Stomata showed sensitivity to CO<sub>2</sub> and a closing response with increasing CI. Increasing VPD had a small effect on CO<sub>2</sub> assimilation rates, under excessive irradiance level with a small decrease above 2.5 kPa. Stomata, however, were strongly affected by VPD, exhibiting gradual closure above 1.5 kPa. The reduced stomatal conductances at high VPD were efficient in restricting water losses by transpiration, demonstrating the species adaptability to dry environments. Under natural irradiance, CO<sub>2</sub> assimilation rates were standard in early morning, following thereafter the PPFD changes. Transient Fv/Fm decreases were registered around 11.00 hr. indicating the occurrence of photoinhibition. Decreases of excitation capture efficiency, decreases of effective quantum yield of photosystem II, and increases in non- photochemical quenching were consistent with the occurrence of photoprotection.

**623. SREEKANTH, PD and RAO, EVVB. 2003. Model for forecasting yield in cashew. *The Cashew* 17(4): 23-31**

A preliminary study was attempted to develop a simple forecasting model for

predicting the cashew yield from available secondary (earlier years) data on area and production. For this purpose the yield data collected during 1985- 2000 were evaluated using a formula. The error variation calculated between estimated to yields for states viz., AP, Karnataka, Kerala, Goa etc. , and actual yields was found relatively low. This methodology may be adopted to forecast yield over large areas with minimum time utilizing.

**624. SRINIVAS, T and RAJU, VT. 1994. Margins and price spread in marketing of cashew in Andhra Pradesh. *Bihar Journal of Agricultural Marketing*. 2 (3): 235-240 (Department of Agricultural Economics, Banaras Hindu University, Varanasi, Uttar Pradesh, India.)**

The paper studies the marketing pattern and price-spread in cashew nut marketing in Andhra Pradesh, India. The study draws on data collected from all of the 11 processing units in Prakasan district. The processors act as wholesalers for cashew kernels. Five marketing channels were identified, with about 80% of cashew trading taking place through two of the channels. Processor/wholesalers command a major share of the consumer price marketing.

**625. SRINIVAS, T., SAIYANARAYANARAJU, S., RAJU, VT and LAL, SK. 1996. Capital productivity in plantations crops - a case study in cashewnut. *Proceedings of PLACROSYM-XI*. (Dept. of Agril. Econ., Banaras Hindu Univ., Varanasi- 221005**

An attempt has been made to study capital productivity in cashew, resource use efficiency and employment potential created from its cultivation with reference to Andhra Pradesh. The technique of discounting and

compounding were used for evaluating the profitability of cashew cultivation. Sensitivity analysis was also carried out with variations in costs as well as returns. Cobb-Douglas production function and tabular analysis were employed for estimating the resource use efficiency and labour potential created from its cultivation.

**626.** STONEDAHL, GM., MALIPATIL, MB and HOUSTON, W. 1995. **A new mirid (Heteroptera) pest of cashew in northern Australia.** *Bulletin of Entomological Research*. 85: (2): 275-278 (International Institute of Entomology, 56 Queen's Gate, London, SW7 5JR, UK.)

*Helopeltis pernicialis* sp. nov. is described from northern Australia, where it has become established as a serious pest of cultivated cashews, *Anacardium occidentale*. Information on the biology and pest status of the bug is provided from studies conducted near Darwin, Northern Territory.

**627.** SUBBIAH, CC. 1994. **A polyethylene glycol based medium for *in vitro* germination of cashew pollen.** *Canadian Journal of Botany*. 62 (12) 2473-2475. (CPCRI (RS), Vittal).

Several concentrations of the constituents of the medium were tested. The best, which gave 90-95% germination as well as pollen tubes comparable with those found *in vivo*. The better performance of this combination compared with media containing only sucrose and inorganic elements is discussed in relation to the superiority of polyethylene glycol to sucrose as an osmoticum.

**628.** SUBBARAO, IV., SUKUMARAN, MK and MADHULETY, TY. 2002. ***In vitro* studies**

**on endogenous levels of phenolics in different explants of cashew var. BPP-6.** *Indian Journal of Plant Physiology* 7(3): 277-281

Endogenous levels of phenols, OD-phenols and tannins were studied in the explants, i.e. young leaf (YL), mature leaf (ML), shoot bud (SB), and sub apical meristem (SAM), of 16-year-old field grown cashew cv. BPP-6. The explants were cultured on MS medium supplemented with or without antioxidants. The highest phenol content of intact shoot bud decreased to 0.01 mg/g fresh weight (89%) 6 days after inoculation (DAI) when cultured on medium and to 44% when supplemented with antioxidants. However, the SAM tissue maintained high initial level of phenols *in vitro* unaltered up to 18 DAI and reduced abruptly by 10-fold at 24 DAI. The OD-phenols of SAM were reduced to 50% until 12 DAI and maintained a plateau thereafter upto 24 DAI. The MS medium supplemented with antioxidants reduced tannins content from 92 to 88% in YL and effectively in all other explants. The SAM tissue however, consistently maintained low levels of tannin *in vitro*.

**629.** SUBRAMANIAN, S., SHAH, HA and THIANGAVELU, S. 1996. **Studies on flowering behaviour and the sex ratio in different cashew types at Regional Research Station, Vridhachalam.** *The Cashew* 10(4): 20-22

Studies were carried out on duration of flowering and sex ratio in different cashew types during 1992-93 at RRS, Vridhachalam. The study indicated that the duration of flowering varied considerably from 52 to 88 days in different cashew types. Among others the type M-33/3 produced the highest percentage of perfect flowers (54.3%) followed

by ME-5/4 (50.8%).

630. SUBRAMANIAN, S and HARRIS, CV. 1995. **Studies on method of fertilizer application in cashew.** *South Indian Horticulture* 43(1/2): 38-39

In a fertilizer placement trial on 15-year-old cashew trees, the highest number and weight of nuts per tree (1316.7 and 5.902 kg/year) were obtained when the fertilizer (250,125 and 125 g of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O per tree, respectively, in all treatments) was applied in a circular band 1.5m wide covering the area 1.5 - 3 .0 m from the trunk. The next best treatment was application in 2 circular trenches 1.5 and 3 m from the trunk (5.391 kg nuts/year) followed by broadcast application over the entire area up to the drip line (4.308 kg nuts/year), application in a single trench along the drip line (control; 3.732 kg nuts/year) and application in a single trench 1.5 m from the trunk (3.234 kg nuts/ year).

631. SUDARSANAN, PK. 2001. **Towards the better prospects of Indian cashew.** *The Cashew* 15(1): 29-31

Studies on chemical composition have indicated that 82% of the total fat content of cashew kernels in unsaturated fatty acids and that cashew kernels are free of cholesterol. India being the largest processor and exporter of cashew kernels on the world, the possible positive results of the studies will be invaluable use to India for promoting Indian cashews in a much more effective manner all over the world.

632. SUDERSANAN, PK. 2001. **Cashew nut - good for health.** *The Cashew* 15(1): 32-34

Cashew kernels may be used as a food

medium for loss of appetite, general depression, nervous weakness and scurvy. It is also a rich source of ribloflavin which keeps the body active and energetic. Cashew is useful in anemic, being rich in iron, its regular use is beneficial in the treatment of gastric, chest, urinary and liver disorders.

633. SUDRIPTADAS., JHA, TB and JHA, S. 1999. **Factors affecting *in vitro* development of embryonic axes of cashewnut.** *Scientia Horticulturae* 82(1/2): 135-144

Cashew embryos, cv. KV-26, as small as 1-2 mm were successfully cultured to obtain complete plantlets. The best results for both radicle emergence (99.7%) and seedling development (95.5%) were obtained in embryos 11- 14mm in size, cultured in MS basal media with 6- benzylaminopurine (2mg/litre) and GA (2mg/litre). Plants obtained were successfully transferred to the field with a 90% survival rate. This system may serve as an alternative, efficient propagation method for cashew.

634. SUMA, B., SALAM, MA., SUMA, A and GEORGE, TB. 1998. **Effect of planting densities on the nut yield of cashew.** *The Cashew* 12(2): 33-37 (CRS., (KAU), Madakkathara, Thrissur 680 656, Kerala.)

A field experiment was conducted at CRS., Madakkathara during 1982 to 1992 with variety K-22/1 to study the possibility of high density planting in cashew for obtaining high yields. The treatments involve 7 plant densities ranging from 625 to 156 trees/ha. The 10 year long study indicates that a plant population of 625 plants/ha. or 312 plants/ha is optimum for cashew upto 9th year after planting. Thinning of population is not necessary upto 9th yr. of planting under the agroclimatic conditions

prevail in the State of Kerala.

**635. SU, MN., VENKATACHALAM, M and TEUBER, SS. 2004. Impact of gamma - irradiation and thermal processing on the antigenicity of almond, cashew nut and walnut proteins. *Journal of the Science of Food and Agriculture*. 84(10): 1119-1125 (Department of Nutrition, Food and Exercise Sciences, Florida State University, Tallahassee, FL 32306-1493, USA.)**

Whole unprocessed almonds, cashew nuts and walnuts were each subjected to gamma -irradiation (1, 5, 10 and 25 kGy) followed by heat processing including autoclaving (121 degrees C, 15 psi for 15 and 30 min), dry roasting (138 and 160 degrees C for 30 min each, 168 and 177 degrees C for 12 min each), blanching (100 degrees C for 5 and 10 min), oil roasting (191 degrees C, 1 min) and microwave heating (500 W for 1 and 3 min). Rabbit polyclonal antibodies were raised against each major protein isolated from defatted, but not subjected to gamma -irradiation and/or any thermal processing, almond, cashew nut and walnut flours. Immunoreactivity of almond, cashew nut and walnut proteins soluble in borate saline buffer, normalised to 1 mg protein ml<sup>-1</sup> for all samples, was determined by inhibition enzyme-linked immunosorbent assay (ELISA) and Western blotting. ELISAs and Western blotting experiments indicated that almond, cashew nut and walnut proteins exposed to gamma -irradiation alone or followed by various thermal treatments remained antigenically stable.

**636. SUNDARARAJU, D. 2004. Evaluation of certain insecticides against tea mosquito bug on cashew. *The Cashew* 18(2) : 22-26**

The effect of some insecticides, i.e.

dillapiole (1.0%; a natural pesticide), endosulfan (0.05%), monocrotophos (0.05%), carbaryl (0.1%) profenofos (0.05%) + cypermethrin (0.005%) quinalphos (0.05%) cyhalothrin (0.05 and 0.005%) and acephate (0.075 and 0.75%), against tea mosquito bug on cashew was investigated in Karnataka, India during 1998-99 and 1999-2000. The insecticides had no ovicidal effect, but showed maximum residual action against first instar nymphs, except for endosulfan, dillapiole and quinalphos. However, cyhalothrin followed by carbaryl and monocrotophos exhibited the highest residual action for 7 days against late instar nymphs and adults of TMB, and showed the least oviposition on treated shoots. Although the combination of profenofos + cypermethrin exhibited the highest residual action against nymphs and adults, its residual effect on oviposition was on par with the untreated control.

**637. SUNDARARAJU, D. 2004. Evaluation of promising new insecticides in large plots for management of tea mosquito bug on cashew. *Journal of Plantation Crops* 32(supl): 285-288 (Proceedings of PLACROSYM - XVI.)**

Two large plot trials were conducted on cashew against tea mosquito bug (TMB) during 2002 - 03 cropping season at NRCC Experimental Station, Shanthigodu. In the first trial, two new insecticides, cyhalothrin (0.003%) and cartap (0.075%) were compared with carbaryl (0.1%) and untreated control in a larger plot in an exploded block design. Among them, cyhalothrin was found to be promising and was on par with carbaryl. The economic analysis indicated that cyhalothrin treated plot recorded higher net gain of Rs. 90/ tree and

benefit / cost ratio of 4.5 than carbaryl (Rs. 79/ tree and 2.73 respectively). In the second trial, cyhalothrin (0.003%) alone was sprayed with three rounds in a large area of 4 ha. immediately on the onset of outbreak of TMB. It contained significantly the outbreak of TMB and has not affected the pollination and overall composition of natural enemies except spiders.

638. SUNDARARAJU, D. 2004. **Influence of spiders and insect predators on the incidence of tea mosquito bug in cashew.** *The Cashew* 18(1): 9-13

The incidence of predators of the tea mosquito bug in cashew was studied during 2000 and 2002 at two locations in Karnataka, India. Six species each of spiders and ants and three species of heteropteran bugs. No significant difference in arthropod diversity were observed between the locations. All arthropod predators appeared to coexist together with least antagonism in cashew ecosystems, but they were ineffective in reducing the tea mosquito bug population.

639. SUNDARARAJU, D., RAVIPRASAD, TN and BHAT, PS. 2000. **Preliminary studies on distribution of *Helopeltis antonii* and estimation of its population on cashew.** *Recent Advances in Plantation Crops Research* 13: 307-313 (Proceedings of PLACROSYM - XIII, 1998.)

The whole and sample population of *Helopeltis antonii* along with its damage were assessed for 31 weeks on 14 and 20 three years old cashew trees, respectively. Distribution of the pest was found aggregated and the population dynamics was not significantly influenced by weather factors. Population and damage did not differ significantly in the four

quadrants of the trees, north, south, east and west. Each nymph/adult during its lifetime, on an average damaged 3.8 shoots. Sample sizes recommended for assessing its population for control, survey and life table studies is 52 leader shoots per tree and in each case, a total of 10 to 12 trees are required. Exploded block design with single replication is for insecticidal trials instead of randomised block design.

640. SUNDARARAJU, D. 2003. **Record and cumulative effect of recommended insecticidal spray schedule on arthropod predatory fauna occurring on cashew.** *The Cashew* 17(1): 30-34

The arthropod predatory fauna occurring on cashew panicles predominantly are six species of spiders (*Oxyopes sp*; *Plexippus sp*; *Camaricus sp.* and one unidentified species) and one species of mirid bug. The other groups encountered are ants, lygaeid and reduviid bugs. These predators appeared to be general predators and are not key predators of tea mosquito bug. At present, 3 rounds of insecticidal sprays are recommended for management of above pest with monocrotophos (0.05%) and carbaryl (0.1%). The first round of spray with monocrotophos during flushing and second and third rounds with carbaryl during flowering and fruiting were given in the cropping season of 2000-01 at three locations in a large plot (>2ha). The total population of predatory fauna occurring on tenth day after third round of spray was recorded on 12 trees per location and 52 panicles / tree by tapping method. The results indicated that out of three insecticides treated locations, the population of spiders recorded at 2 locations was on par with untreated control.

641. SUNDARARAJU, D., YADUKUMAR,

N and BHAT, PS. 2006. **Yield performance of 'Bhaskara' cashew variety in coastal Karnataka.** *Journal of Plantation Crops* 34(3): 216-219

Two cashew varieties (Bhaskara & NRCC Selection -2) released from NRCC were evaluated in research farm and farmer's field. At research farm, Bhaskara variety evaluated under unprotected condition yielded 10.7Kg of raw nuts/tree when planted at a spacing of 6 x 6 m at the 11th harvest and the overall damage of tea mosquito bug was found to be in the range of low to moderate during that year. In the large plot trials having all packages of practices, an yield of 2602 and 751Kg of raw nuts/ha was obtained from Bhaskara variety (planted in 4 x 4 m spacing) and NRCC Selection 2 variety (planted in 8 x 8 m spacing) respectively during fourth harvest, whereas in three farmer's fields when both varieties were grown at spacing of 8 x 8 m normal spacing, the yield of Bhaskara variety was around one tonne/ha. which was 4 to 6 times higher than NRCC Selection 2. At the same time in four farmer's field, Bhaskara variety (planted in 6 x 4m spacing as high density planting) gave a consistent yield of around one tonne and above per hectare during second and 3rd harvest itself. As Bhaskara variety has consistently performed better than NRCC Selection 2, it needs to be popularized for large scale cultivation in coastal Karnataka.

**642.** SUNDARARAJU, D and SUNDARABABU, PC. 1999. **Congeneric and conspecific sex attraction among *Helopeltis* spp. (Heteroptera: Miridae).** *Insect-Environment*. 4: (4): 115-116. (Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore 641 003, India.)

*Helopeltis antonii* coexists with *H.*

*theivora* and *H. bradyi* in cashew ecosystems of Western Ghats and west coast of India. A study was conducted to confirm the congeneric and conspecific sex attraction in coastal Karnataka by placing 1-week-old virgin females of each species separately in a bait cage. The number of males attracted within 1 h was assessed. All 3 species showed maximum conspecific sex attraction. Under field conditions, rare congeneric mating occurred between females of *H. bradyi* and males of *H. antonii*, and between females of *H. antonii* and males of *H. theivora* or *H. bradyi*. However, such mated females laid infertile eggs and exhibited continued conspecific sex attraction.

**643.** SUNDARARAJU, D and SUNDARABABU, PC. 2000. **Egg parasitoids of Neem mosquito bug from cashew.** *The Cashew* 14(1): 32-34

The studies conducted at different cashew regions of Tamil Nadu, the most important parasitoid *Telenomus* sp. *laricis* group existing in west coast was found to be absent in the east coast region. It will be worthwhile to introduce this parasitoid in east coast and thereby the natural biological control of neem mosquito bug can be improved.

**644.** SUNDARARAJU, D and SUNDARABABU, P.C. 1999. **Feeding behaviour of *Helopeltis antonii* sign. and histopathology of its feeding lesions on cashew.** *Journal of Plantation Crops* 27(2): 104-111 (NRCC, Puttur-574 202, D.K.Dist., Karnataka).

The nymphs and adults of *Helopeltis antonii* initially tapped the plant surface with the tip of their labium followed by immediate insertion of their stylet bundle intracellularly. Water-soaked lesion appeared within a minute around insertion of stylet bundle in the lamina



of cashew leaf and cotton boll indicating rapid diffusion of salivary secretion. Feeding on single site lasted for about 17 minutes. The cellular contents in the feeding lesions were emptied, cell walls were melanized, uncollapsed and subsequently hypersensitive reactions set in.

645. SUNDARARAJU, D. 2000. **Foraging behaviour of pollinators on cashew.** *The Cashew* 14(4): 17-20

Two groups of bees maintain constancy on fresh cashew flowers. The halictid bees (*Pseudopsis oxybeloides*, *Lasioglossum* sp. and one unidentified species) mainly collect pollen and occasionally feed on nectar, whereas the honey bees (*Apis cerana indica* F.) exclusively feed on nectar of cashew flowers. Among halictid bees, *Poxybeloides* is found to be most prominent and very active. Under field condition maximum of 53.6% of hermaphrodite flowers were pollinated and remaining hermaphrodite flowers were found in unpollinated condition on the same day evening of anthesis.

646. SUNDARARAJU, D and SUNDARABABU, PC. 1998. **Life table studies of *Helopeltis antonii* Sign. on neem, guava and cashew.** *Journal of Entomological Research* 22(3): 241-244

Relative multiplication of *Helopeltis antonii* was studied on its three main host plants. The net reproductive rate indicating the total female births was 65.63, 40.21 and 22.17; the population increased with an infinitesimal rate of 0.1255, 0.0857 and 0.1215; and finite rate of 1.134, 1.09 and 1.129 female per day and a generation was completed in 33.35, 43.12 and 25.51 days on neem, guava and cashew, respectively. The stable age distribution (%)

of eggs, nymphs and adults on these three hosts ranged from 65.883-68.499, 27.675-29.233 and 4.146 - 4.888, respectively.

647. SUNDARARAJU, D. and SUNDARABABU, PC. 1999. **Morphology and contents of salivary glands of *Helopeltis antonii* Signoret.** *Journal of Entomological Research* 23(1): 41-46

The salivary glands of *Helopeltis antonii* Sign. consisted of a pair of tetralobed principal gland and a pair of long tubular accessory glands with reservoirs situated lateral to first midgut. Adult female had larger sized salivary gland than nymphs and adult male. The pH of principal and accessory gland was in between 6.8 and 7.6. Both the hydrolytic and oxidoreductase enzymes, and free amino acids were detected. These enzymes and the free amino acids were implicated in the initiation of phytotoxaemia as well as detoxification of defensive phytochemicals.

648. SUNDARARAJU, D and SUNDARABABU, PC. 1999. **On cashew, Tea Mosquito bug or Neem Mosquito bug?** *The Cashew* 13(1): 3-6 (NRCC, Puttur-574 202, D.K. Dist., Karnataka).

*Helopeltis antonii* was first recorded on neem and it always spreads from neem to other crops particularly cashew at east coast, is quite appropriate to rename it as "Neem Mosquito Bug". But Neem trees are not prevalent in west coast and *H. antonii* exists on cashew only. As such, neem based formulations may not be effective against *H. antonii*.

649. SUNDARARAJU, D. 2002. **Pest and disease management of cashew in India.** *The Cashew* 16 (4): 32-38

Cashew stem and rootborers and tea mosquito bug are the major pests in cashew causing considerable economic loss when they are infected. For effective management of cashew stem and rootborer, adoption of integrated management like phytosanitation, proper surveillance, mechanical control followed by post treatment prophylactic chemical control is suggested. Varietal manipulation and timely control measures will help in reducing the economic damage caused by tea mosquito bug. Adoption of effective biocontrol measures need to be addressed and applied to protect the environment and ecology.

**650.** SUNDARARAJU, D. 1999. **Recent research on management of neem mosquito bug on cashew.** *The Cashew* 13(3): 51-53

Management of neem mosquito bug on cashews is summarized, including habitat management, varietal resistance, biological control and recommended insecticides.

**651.** SUNDARARAJU, D. 1999. **Screening of cashew accessions to tea mosquito bug, *Helopeltis antonii* Sign.** *The Cashew* 13(4): 20-26

A total of 75 cashew accessions consisting of released varieties, promising accessions and tolerant accessions located in hotspot area, germplasm and progeny evaluation trial were screened during 1988-92 under laboratory through cage screening technique in order to confirm genetic basis of resistance. The results revealed that all accessions were found to be susceptible. However, a single susceptible accessions (Goa 11/6) when evaluated during 1992-97 under unprotected field conditions in a large plot trial,

the severity of infestation was restricted upto 5 years and subsequently the infestation declined to a low level. It also recorded a mean yield of 7.2Kg/tree and 6.2Kg/ tree on 7th and 8th year respectively.

**652.** SUNDARARAJU, D., BAKTHAVATSALAM, N., JOHN, JOY, N and VIDYASAGAR, PSPV. 1994. **Presence of female sex pheromone in tea mosquito bug, *Helopeltis antonii* Sign.** *Entomon* 19(1&2): 47-51 (NRCC, Puttur 574 202.)

Attraction due to sex pheromone was studied in males and females of tea mosquito bug by using an olfactometer devised in our laboratory. It was observed that females started attracting males after becoming 3 day old. Although young females attracted more males, even old females attracted males. These studies indicate the existence of female sex pheromone in tea mosquito bug.

**653.** SUNDARAVARADARAJAN, KR and RAJESHKUMAR, KR. 2002. **Production and trade instability in cashew : an economic analysis.** *The Cashew* 16(1): 18-22 (Reader, Dept. of Agril. Economics, Annamalai University- 608002.)

The study indicates that there is a desirable instability in terms of quantity of kernels exported showing the hold of our country. Production of raw cashew exhibited a desirable instability and it was achieved by the constant and continuous efforts of various cashew research institutions in the country. High yielding cashew varieties should be popularised and infrastructure for post harvest operations, warehousing etc., should be created and non-traditional cashew markets should be strengthened.

654. SUPRIADI - ADHI, EM., WAHYUNO, D., RAHAYUNINGSIH, S., KARYANI, N and DAHSYAT, M. 2004. **Brown root rot disease of cashew in West Nusa Tenggara: distribution and its causal organism.** *Indonesian Journal of Agricultural Science*. 5(1): 32-36 (Indonesian Spices and Medicinal Crops Research Institute, Jalan Tentara Pelajar No. 3, Bogor 16111, Indonesia).

A disease survey was conducted in Pekat district, Indonesia, during 2003 to investigate the incidence of brown root rot disease in cashew in the area. The disease was found widespread in several villages in Pekat district, such as Pekat, Beringin Jaya, Sorinomo and Nangamiro. Some 1075 infected trees died in Sorisoga I and Sorisoga II in Pekat village, resulting in an estimated kernel yield loss of 5106 kg. The average number of dead trees was 3.71±or-2.54 and 12.13±or-9.71/ha in Sorisoga I and II, respectively. The infected trees showed leaf yellowing and defoliation, which lead to mortality. The lateral roots and tap roots near the collar were encrusted with gravel, earth and brown mycelia sleeves. The diseased trees tended to cluster, indicating a root-to-root contact mode of infection. The fungus produced arthrospores and brown pigmentation on agar medium containing 0.05% gallic acid. An isolate of the fungus induced typical disease symptoms following inoculation on 5-month-old cashew (cv. Balakhrisanan) seedlings. These results indicated that the causal agent of the mass decline of cashew in Pekat district was *Phellinus noxius*. In the field, the fungus also infected a barrier tree (*Lannea coromandelica*).

655. SURESH, S., RAMAMURTHY, R and VENUGOPAL, MS. 1994. **New record of host plants of cashew leaf webber, *Macalla***

***moncusalis walker* in India.** *Journal of Insect Science*. 7 (2): 221 (Dept of Agricultural Entomology, Agril College and Research Institute, Madurai - 625104, Tamil Nadu).

Country almond tree, *Terminalia catappa* L. and arjun tree, *Terminalia arjuna* have been recorded as new hosts of cashew leaf webber, *Macalla* (Lamida) *moncusalis* Walker from Tamil Nadu in India.

656. SURIANARAYANAN, P. 1998. **Cashew - the wonder nut - elixir of life.** *Cashew Bulletin* 35(7): 3-7 (General Manager, Apria Industries, Chennai, Tamil Nadu.)

Cashew kernels used as a food medicine for loss of appetite, general depression, nervous weakness and scurvy. It is also a rich source of riboflavin which keeps the body active, gay and energetic. Cashew is useful in anemia, being rich in iron, its regular use is beneficial in the treatment of gastric, chest, urinary and liver disorders. It is an excellent nerve tonic, a steady stimulant and a body builder. With its rare combination of fats, carbohydrates and proteins in cashew kernel is a source of high energy and a snack food of great taste.

657. SUTEDI, E., MATHIUS, IW and SURATMINI, NP. 2001. **The potential, variety, and nutrient content of natural vegetation as feedstuffs grown under cashewnut plantation.** *Jurnal-Ilmu-Ternak-dan-Veteriner*. 6 (2) 113-119 (Balai Penelitian Ternak, P.O. Box 221, Bogor 16002, Indonesia).

Results of a study showed that the native pasture growing in cashew nut plantations comprised dry-tolerant grasses and legumes, such as *Setaria* spp., *Themeda* spp., *Calopogonium mucunoides* and *Desmodium* spp. The fresh yield and dry matter production

of natural vegetation grown in plantations less than 8 years old was lower than that of natural vegetation grown in plantations more than 8 years old. This may be due to shading by the tree crop, which reduces the photosynthetically active radiation reaching the ground vegetation. Light was found to be the critical factor affecting the growth of vegetation underneath tree canopies. The carrying capacity of native forages grown in cashew nut plantations was only 0.5 AU of ruminant/ha/year.

**658.** SWAMINATHAN, C. 1999. **Early growth performance of mango and cashew coplanted with four nitrogen fixers in a tropical Alfisol.** *Journal of Sustainable Forestry* 8(2): 15-26

A five year field experiment was established in September 1989 at Pudukkottai, Tamil Nadu to get information which will facilitate the scientific development of tree mixtures in an agroforestry system with 2 fruit trees viz mango and cashew and four tropical nitrogen fixing trees. Observations on height and diameter increment of the trees were recorded 1-5 years after planting and edaphic parameters were measured at the beginning and end of the experiment. Height growth of cashew was enhanced by 25% when interplanted with Casuarina and plant girth (10.8cm) was maximum when interplanted with Leucaena, although differences between the 2 nitrogen -fixing trees were not significant.

**659.** SWAMY, KRM. 1997. **Technology for planting material multiplication in cashew.** *The Cashew* 11(1): 23-32

In this paper author had listed the technologies involved in multiplication of planting materials of cashew includes, management of Scion bank, raising of root

stocks, preparation of potting mixture, filling of polythene bags, preparation of scions, grafting, management of grafts in the nursery and estimated cost of production.

**660.** SWAMY, KRM. 1995. **Top working of cashew in Goa and Maharashtra states - a case study.** *The Cashew* 9(2): 12-17

Of the 19 top worked plots surveyed, only 6 plots were free from stem and root borer infestation and in the remaining 13 plots, the mortality of the successfully top worked trees due to CSRB was observed and the mortality varied from 2.5 to 100 per cent. Because of the inconsistent results obtained in different areas, top working technology may not be suitable for large plantations where regular follow up action is difficult and where the population of stem and root borer is maximum.

**661.** SWAMY, KRM., BHAT, MG. and RAO, EVVB. 1996. **Characterization of cashew germplasm.** *Proceedings of 2nd Intl. Crop Science Congress/* Ed. By V.L. Chopra, R.B. Singh. - New Delhi: Oxford & IBH. (NRCC, Puttur - 574 202, D.K. Dist; Karnataka).

The largest germplasm of cultivated types in cashew, *Anacardium occidentale* is assembled at NRC for Cashew, Puttur in India. National Cashew Gene Bank consists of only clonally collected germplasm accessions from different indigenous cultivation sites. In addition to *A. occidentale*, *A. microcarpum*, *A. pumilum* and *A. orthonianum* are also available in Gene Bank. The collections are maintained as active collections in the field and efforts are under way to characterise the accessions as per IPGRI descriptors suggested.

**662.** SWAMY, KRM., BHAT, MG. and RAO, EVVB. 2002. **Status of cashew germplasm collection in India.** p.48. National Research

Centre for Cashew, Puttur, DK., Karnataka.

This book narrated the cashew germplasm holding in India, assignment of national collection numbers, characterization and cataloguing and grouping of cashew accessions.

663. SWAMY, KRM and NAYAK, MG. 2003. **Soft wood grafting and nursery management in cashew.** p.23. National Research Centre for Cashew, Puttur, DK., Karnataka.

Various steps involved in the commercial multiplication of cashew varieties by adopting 'soft wood grafting technique' and nursery management practices are detailed in this Technical Bulletin.

664. SWARNAPIRIA, R and MANIVANNAN, N. 1999. **Correlation between nut yield and yield attributing characters in cashew.** *Agricultural Science Digest - Karnal.* 19 ( 4): 275-277 (National Pulses Research Centre, Vamban Colony-622 303, India.)

Information on correlation coefficients is derived from data on yield and 10 yield-contributing characters in 6 cashew (*Anacardium occidentale*) genotypes. The genotypes were planted at Vamban in 1990 and the data were collected during 1997-98. The data obtained indicated that collar girth, leaf length and number of nuts/panicle had positive associations with nut yield/tree and may be used as selection indices in cashew improvement programmes.

665. SWART, WJ. 2004. **First report of powdery mildew of cashew by *Oidium anacardii* in South Africa.** *Plant Disease* 88(11): 1284

In May 2002, at least 25% of 5-year-old

cashew tree grown in the Northern Kwazulu-Natal Province of South Africa were infected with powdery mildew. Symptoms included the extensive growth of white, superficial mycelium bearing upright conidiophores on young shoots with tender leaves, inflorescences and young receptacles. In severely affected trees, approximately 35% of young shoots and 45% of young receptacles showed signs of powdery mildew. Severely infected young leaves were brown and deformed in contrast to older leaves that were unaffected. The pathogen was subsequently identified as *O. anacardii* based on morphological analysis. This is thought to be the first report of *O. anacardii* occurring on cashew in South Africa.

666. SWASDISEVI, T., SOPONRONNARIT, S and NATHAKARANAKULE, A. 1999. **Cashew kernel drying using a rotating tray drier.** *Kasetsart Journal, Natural Sciences.* 33 ( 1): 159-169 (School of Energy and Materials, King Mongkut's Institute of Technology Thonburi, Suksawat 48 Rd., Bangkok 10140, Thailand.)

The research aimed to investigate the suitable conditions for drying cashew kernels using a rotating tray drier. The criterion examined were: quality of product after drying, drying time and specific energy consumption. Experimental results showed that the drying time decreased as drying air temperature increased. The most appropriate drying conditions for cashews were: drying air temperature 90°C, recycled air fraction 0.45 [45% recycled air] and specific air flow rate 70 kg dry air/h per kg dry cashew kernel (air velocity 0.07 m/s). The product quality after drying was acceptable and the duration of drying was short. The specific energy

consumption was 68.22 MJ/kg water evaporated or 6.85 MJ/kg cashew kernels. Drying cost was 260 baht/kg water evaporated or 26.13 baht/kg cashew kernels.

**667.** SYED, NH., SURESHSUNDAR, S and WILKINSON, MJ. 2005. **Ty1-copia retrotransposon - based SSAP marker development in cashew (*Anacardium occidentale* L.).** *Theoretical and Applied Genetics*. 110(7): 1195-1202 (Plant Research Unit, University of Dundee at SCRI, Invergowrie, Dundee, DD2 5DA, UK.)

The most popular retrotransposon-based molecular marker system in use at the present time is the sequence-specific amplification polymorphism (SSAP) system. This system exploits the insertional polymorphism of long terminal repeat (LTR) retrotransposons around the genome. Because the LTR sequence is used to design primers for this method, its successful application requires sequence information from the terminal region of the mobile elements. In this study, two LTR sequences were isolated from the cashew genome and used successfully to develop SSAP marker systems. These were shown to have higher levels of polymorphism than amplified fragment length polymorphic markers for this species.

**668.** TAWADE, ND and MEHTA, PG. 2002. **Dynamics of indigenous technical knowledge about cashewnut and arecanut crop of Konkan region in Maharashtra State.** *The Cashew* 16(3): 28-31

This paper documented a profile of ITK specialists and ITK related to cashew and arecanut crops to know the rationale of ITK as viewed by the farmers.

**669.** TEEUWEN, SD. 2003. **Organic**

**production:certification is the main hurdle for developing country farmers.** *Cashew Bulletin* 41(3): 7-9

The organic food ingredients sector has the potential of becoming a magic beanstalk for exporters in developing countries. In developing countries luxuries like artificial fertilizer and chemicals have out of reach for quite a few farmers, so a lot of agriculture is organic by default. The question is how to get a reliable certificate. The western buyer wants documented proof that the ingredients he's buying are indeed organic. It's a problem of controllability.

**670.** THIMMAPPAIAH., ANIL, SR and IYER, RD. 2001. **Cashew.** In: *Biotechnology of Horticultural Crops 1*: 609-629 (Ed. by Parthasarathy, et al.)

This book chapter explained about the micropropagation technique in cashew through shoot-tips, nodal cuttings, leaves, roots, immature and mature cotyledonary segments and nucellus tissues. Multiple shoot induction and plantlet regeneration have been obtained in the explants excised from young cashew seedlings raised either *in vitro* or *ex vitro*. For multiple shoot induction, a basal medium (MS) containing cytokinins like thidiazuron or BA alone or in combination with other cytokinins or IBA was useful. Agrobacterium transformation needs to be exploited in cashew for transferring resistance genes against cashew pests.

**671.** THIMMAPPAIAH. 2002. ***In vitro* grafting of cashew (*Anacardium occidentale* L.)** *Scientia Horticulturae* 92(1): 177-182

A successful micrografting technique in cashew was developed using *in vitro*

germinated seedlings as rootstocks and axenic shoot cultures established from mature tree source as microscions. *In vitro* germinated seedlings, which emerged 20-25 days after inoculation on absorbent cotton, were decapitated and used as rootstock. Mature tree explants initiated on hormone-free MS modified medium were made in to scion of 3-15mm length for grafting. Micrografts could easily cultured on hormone free liquid half-MS medium and were potted out after 10- 12 weeks of culture growth. Grafting success was dependent on the method of grafting and seize of the scion. Shoot- tip grafting and side grafting were equally successful.

**672.** THIMMAPPAIAH., ANIL, SR and SADHANA, PH. 2002. *In vitro* propagation of cashew (*Anacardium occidentale* L.) *In Vitro Cellular & Developmental Biology - Plant* 38 (2): 152-156

Regeneration of cashew from shoot explants of young grafts of mature tree origin is described. Establishment of shoot cultures was affected by season of collection, source, and type of explant. Explants from young grafts established better than those collected from field trees and nodal cuttings regenerated better than shoot tips. Maximum percentage, bud break and minimum contamination was noticed with shoots were collected in try months. Pre conditioning of stock plants by hormonal spray with 6- benzyladenine (BA) and gibberellic acid (GA3) and brief presoaking of shoots in BA had no significant effect on culture establishment. MS medium with half strength major nutrients, 2.74mM L-glutamine, 87.6mM sucrose, and 2.25gl<sup>-1</sup> phytigel was ideal for culture initiation. Inclusion of 0.1% polyvinylpyrrolidone (PVP-360) in the media

reduced phenolic exudation. Solidified media was superior to liquid medium. Sucrose as energy source was found essential in the medium and had significant effect on percentage bud break and shoot development. Thidiazuron (TDZ) at 0.45/mM/l was best for axillary shoot bud proliferation with maximum response (100%). *In vitro* rooting on auxin and pulsing microshoots in 10µM/l NAA was ineffective. Rooting inability was however, overcome by a micrografting procedure.

**673.** THIMMAPPAIAH and ANIL, SR. 2000. *Micropropagation in mature tree of cashew (Anacardium occidentale L.) Recent Advances in Plantation Crops Research* 13: 45-48 (Proceedings of PLACROSYM XIII, held at Coimbatore, 1998.)

Establishment of cashew explants from mature tree was low due to excessive amount of contamination, browning and slow growth. Contamination of explants was reduced by fungicidal sprays of stock plants, raising plants under protected environment and sterilization with either 0.1% mercuric chloride dip for 5 minutes or sequential sterilization with 20% of sodium hypochlorite (20min) and 0.05% mercuric chloride dip for 10 minutes. Budding depended on the age and source of explants. Explants from young cashew grafts shows higher percentage of budding than field grown trees. Similarly, explants collected from pruned frames respond better than shoots of seasonal flushes. Half strength MS medium supplemented with 0.2% charcoal and L- glutamine (400mg/l) and gelled with phytigel (2.25g/l) was found to be suitable for the establishment of nodal cultures. Multiple shoot induction (2-6 buds/explant) was observed on media containing either thidiazuron (0.1,2mg/

l) or BAP (2 to 1 mg/l) with GA3 (0.5mg/l) and IBA (0.1mg/l).

**674.** THIMMAPPAIAH and ANIL, SR. 1999. *In vitro* regeneration of cashew (*Anacardium occidentale* L.) *Indian Journal of Experimental Biology* 37(4): 384-390 (National Research Centre for Cashew, Puttur - 574 202, D.K.Dist., Karnataka).

Axillary shoot bud proliferation (1-13 shoot buds per explant) was observed when shoot-tip nodal explants from *in vitro* grown seedlings of cashew were cultured on  $\frac{3}{4}$  strength MS medium supplemented with thidiazuron (0.05 to 2 mg/l) alone and or in combination with other plant growth regulators (BAP, NAA, IBA). Medium containing thidiazuron (0.1mg/l) in combination with NAA or IBA (0.1mg/l) showed maximum proliferation (>4.0 buds/explant). Roots were induced *in vitro* when individual shoots were initially cultured on half strength MS semi-solid medium with auxins and then transferred to MS medium.

**675.** THIRUMALARAJU, GT., PUTTUSWAMY and REDDY, MNN. 2004. **Population fluctuations of tea mosquito bug (*Helopeltis antonii* Signoret) on tolerant/susceptible accessions/varieties of cashew.** *The Cashew* 18(4): 18-24 (AICRP on Seed Technology, U.A.S., Bangalore, India.)

The population of *H. antonii* in susceptible (Vengurla-1 and Bapatla-5), moderately susceptible (Chintamani-1 and Goa 1/11), and least susceptible (E 4/4 and 1/64 Madhuranthakam) cashew cultivars was studied in Chintamani, Karnataka, India. Pest population and damage on crops were evaluated at weekly intervals from the first week of

October to the last week of March during 1996/97 and 1997/98. *H. antonii* was initially observed on the highly susceptible cultivars on the second and fourth weeks of November in both years. In moderately susceptible cultivars, pest incidence was initially observed on the fourth week of November and fourth week of December in 1996-97 and 1997-98, respectively, despite the new flush that emerged on the first week of November in both years. The pest was initially observed in the least susceptible cultivars just before panicle emergence, despite the new flush that emerged on the first and second fortnights of November. The mean percent damage and pest population per tree were lowest for ME 4/4 (13.54 and 8.18) and 1/64 Madhuranthakam (13.71 and 7.90), and highest for Vengurla-1 (51.18 and 20.28) and Bapatla-5 (48.52 and 18.33). The results suggested that insecticides should be applied immediately after the emergence of new flush in highly susceptible cultivars, but insecticide application can be delayed for 2-3 weeks in moderately susceptible cultivars. One spray at the new flush stage may be skipped for the least susceptible cultivars.

**676.** THIRUMALARAJU, GT., SHANKARANARAYANA, V and LINGAIAH, HB. 1997. **Evaluation of different insecticides for the control of tea mosquito bug in cashew under maidan parts of Karnataka.** *The Cashew* 11(4): 37-40

The tea mosquito bug, one of the most destructive pest on cashew which causes more than 40% damage to the crop resulting in severe reduction in yield. To control the attack of TMB, insecticides tested were monocrotophos, endosulfan, methyl parathion, quinalphos all at 0.05 percent phosalone at 0.01 percent and



carbaryl at 0.1 percent. Three sprays were given at new flush stage, panicle emergence stage and fruit setting stage. All the chemicals tried are effective in control of TMB, however, carbaryl, monocrotophos and endosulfan are recommended as they are the most effective compared to other insecticides.

**677. THIVAVARNVONGS, T., OKAMOTO, T and KITANI, O. 1995. Development of compact sized cashew nut shelling machinery (part 1). Syntheses of effective manual and semi-automatic shelling methods. *Journal of the Japanese Society of Agricultural Machinery*. 57 (2): 57-65 (Department of Agricultural Engineering, Faculty of Engineering, Khon Kaen University, Khon Kaen 40002, Thailand.)**

The physical and mechanical properties of cashews were investigated in relation to shelling. Results show that a force of 50-70 kgf (kilogram-force) was required to crack the nutshell under compression loading on a 'raw' nut. Under the specific conditions of 'blade' loading (using a pair of contoured high strength spring steel blades) applied to a 'treated' nut, the cracking force was reduced to approx. 20 kgf. Design considerations of a manually operated cashew sheller are discussed, utilizing blades for cracking and the new principle of press-twist actions of the sheller's upper blade for opening, resulting in two versions of the manually operated sheller and one semi-automatic sheller. [1 kgf = 9.8 N]

**678. THIVAVARNVONGS, T, SAKAI, N and KITANI, O. 1995. Development of compact sized cashew nut shelling machinery- II: Testing and evaluation of manual and semi automatic shellers. *Journal of the Japanese Society of Agricultural Machinery* 57(3): 85-93**

Optimum cashew nut pre-shelling treatment was evaluated as being 30 min. boiling time and 24 h drying time, with a sizing method based on width and thickness parameters producing average whole kernel recovery of 82.7%. Results of performance tests of 6 manually operated shellers showed that the Model AE (KKU)2 sheller was the most promising, with a shelling rate of 0.871kg/h, shelling efficiency of 99.0%, and whole kernel recovery of 79.3%. The semi-automatic Model AE (KKU) SA1 sheller gave a maximum nut conveying rate of 40 nuts/min, corresponding to a shelling rate of 3.14kg/h, shelling efficiency of 75.0%, and whole kernel recovery of 80.0%. The Model AE (KKU)2 sheller was the most economical, giving the lowest break-even point and pay back period, and the highest net profit of over baht 1000/yr for shelling 100kg/yr. The semi-automatic sheller was economical only for shelling large amounts of nuts, giving a net profit of approx. baht 17,000/yr for 5 tons/yr.

**679. THOMAS, ALEYAMMA. 1997. Effect of hormones on fruit development of cashew and spices. *Ph.D.Thesis* Submitted in University of Calicut, Kerala.**

**680. THOMAS, JIM., GRACE, TONY and FAISAL, KK. 1997. Tea mosquito menace of cashew. *Cashew Bulletin* 34(3): 5-6 (Kerala Agricultural University, Vellanikara, P.O., Trichur, Kerala).**

Tea mosquito bug incidence on cashew starts with the onset of flushing in Oct.-Nov. The pest population gradually increases during Jan. at the time of blooming. There is a highly significant negative correlation between the bug population and meteorological factors like rainfall, humidity and minimum temperature. Cloudy and humid weather prevailing during

flowering season enhances their feeding activity.

**681.** TOPPER, CP., KASUGA, LJ and BOMA, F. 2003. **The approach and process of the Integrated Cashew Management Programme.** *Knowledge Transfer for Sustainable Tree Crop Development:* 98-118 Ed. by Topper, CP, ISBN 0-9545192-0-5.

This paper discusses the three exceptional innovative characteristics of the Integrated Cashew Management Programmes in Tanzania: 1. the move away from 'packages of recommendations' to a 'basket of options'; 2. the move away from farmer compliance towards a knowledge based system of technology transfer and choice; and 3. encouraging farmers to experiment and adapt a broad range of cashew management options. The resource persons and mechanisms involved in knowledge, technology and skill transfer are discussed as well as extension involvement in the Integrated Cashew Management Programme.

**682.** TOPPER, CP and KASUGA, LJ. 2003. **Cashew farm upgrading.** *Knowledge Transfer for Sustainable Tree Crop Development:* 173-190 Ed. by Topper, CP, ISBN 0-9545192-0-5.

This paper discusses the appropriate upgrading strategy to deal with either overcrowded farms or farms with a proportion of consistently very low-yielding cashew trees. To demonstrate the potential benefits of upgrading results of a trial on a 5.2 ha block trees at the ARI Naliendele in Tanzania are given.

**683.** TOPPER, CP., KASUGA, LJ and SIJAONA, MER. 2003. **Crop protection in cashew farming systems.** *Knowledge*

*Transfer for Sustainable Tree Crop Development* p. 138-172 (Ed. by Topper, CP. ISBN 0-9545192-0-5.)

The chapter gives an overview on pests and disease. The temporal relationship of the major parameters studied in this chapter are initially presented to provide the reader a better understanding of how the different factors relate to each other during the flowering and fruiting season. Cashew variability is then discussed, starting with phenological variation and then the variability of powdery mildew disease (PMD) caused by *Oidium anacardii*. The effect of PMD on yield is analysed, heterogeneity of individual tree yields in the absence of PMD is also noted. The remainder of the chapter deals with control strategies and how to maximise their efficiency and cost effectiveness in light of this heterogeneity.

**684.** TOPPER, CP., COOLS, N and MUGOGO, S. 2003. **Landscapes and soils of South Eastern Tanzania: their suitability for cashew.** *Knowledge Transfer for Sustainable Tree Crop Development* 229-239 (Ed. by Topper, CP, ISBN 0-9545192-0-5.)

The ecological requirements for cashew was reviewed. An overview is given of the characteristics of the climate and soil properties of south eastern Tanzania in relation to the landscape. The land suitability map for cashew is presented.

**685.** TOPPER, CP and BOMA, F. 1997. **Evaluation of fungicides for the control of PMD on cashew (A) Fungicide strategy development trials.** *Proceedings of International Cashew and Coconut Conference,* Dar Es Salaam, Tanzania. pp. 254-259

This paper presents the results from 2 large scale field trials to evaluate the efficacy of fungicides. In order to maximise efficiency, dose rate, volume of application were evaluated. While 250g of 99 pure sulphur/tree applied 5 times are needed for effective control, only 15ml of organic fungicide /tree applied 4 times are needed. There was no significant difference between application volumes of 1 and 5 litres/tree, but 0.5 litres/tree resulted in significantly worse mildew levels. There was no difference between applying fungicides in the early morning and afternoon.

**686.** TOPPER, CP and BOMA, F. 1997. **Evaluation of fungicides for the control of PMD on cashew. (B). On-farm testing of fungicide control.** *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp. 270-276

The large scale on-farm testing of a number of mildew control strategies over a 2 year period, has clearly demonstrated that the organic fungicides in particular, Bayfidan and Anvil, control PMD on cashew more effectively than the currently recommended sulphur dust, which in turn has resulted in significantly higher yields. One of the strategies tested was where the farmer chose the 50 of trees and only these were treated, while 250g of 99 pure sulphur/tree applied 5 times are needed for effective control, only 10 to 15ml of organic fungicide/tree applied 3 or 4 times are needed.

**687.** TOPPER, CP., GRUNSHAW, J., PEARCE, M., BOMA, F., STATHERS, T and ANTHONY, J. 1997. **Preliminary observations on *Helopeltis* and *Pseudotheraptus* damage to cashew leaves and panicles.** *Proceedings of International Cashew and Coconut Conference, Dar Es*

*Salaam, Tanzania.* pp. 182-184

The widely acknowledged success of controlling PMD by sulphur dusting and organic fungicides, has resulted in the increased availability of shoots attractive to insect pests. In particular, the sucking pest genera *Helopeltis* and *Pseudotheraptus* now pose a serious threat to cashewnut yield. Damage by these pests to cashew leaves, panicles and fruits are described and their role in causing dieback of shoots and inflorescences is highlighted and the implications for their control discussed.

**688.** TOPPER, CP and BOMA, F. 1997. Screening trials for the evaluation of fungicides for the control of PMD on cashew. (A) Using leaves of seedling plants. *Proceedings of International Cashew and Coconut Conference, Dar Es Salaam, Tanzania.* pp. 286-290

The objective of the work presented was to develop a technique for rapid screening of fungicides for the control of powdery mildew on cashew trees and thereby identify candidates for more detailed evaluation. The level of mildew control on (a) susceptible flushing leaves on seedling plants and (b) inflorescences on young trees were evaluated as possible parameters for screening chemicals. A total of 18 fungicides were evaluated and six were identified for further evaluation.

**689.** TOPPER CP., MARTIN PJ and KATANILA, N. 1997. **The historical and institutional background of the Tanzanian cashew industry.** *Proceedings of the International Cashew and Coconut Conference: trees for life - the key to development, Dar es Salaam, Tanzania, 17-21 February 1997.* pp. 76-83 (Naliendele Agricultural Research Institute, PO Box 509,

Mtwara, Tanzania)

Following an introduction to the Tanzanian cashew nut industry, a general background is presented. An historical review of the sector is presented in three sections: the early cashew industry up to 1973; decline of the cashew industry, 1974-87; and the recent industry revival. The grading, marketing and processing of cashews is detailed with consumption and exports also covered. Prospects for the future of the industry are considered.

**690.** TOPPER, CP., KASUGA, LJ and LAMBOLI, R. 2003. **Socio-economic studies undertaken in relation to cashew growing households.** *Knowledge-transfer-for-sustainable-tree-crop-development-A case-history-of-the-Tanzanian-Integrated-Cashew-Management-Programme.* pp. 61-84 . (ARI Naliendele, Box 509, Mtwara, Tanzania)

The social and economic background of cashew growing households in Tanzania is presented through the surveys within 1987 to 1998. Two main aspects are described: (1) the different components that make up cashew farmers' livelihoods, their financial assets, social organizations, human and natural resources; and (2) the conditions under which farmers' households operated prior to the start of the Integrated Cashew Management Programme, including aspects of family structure, financial assets and constraints, availability of labour, and other related aspects.

**691.** TOPPER, CP., KASUGA, LJ and KATINILA, NA. 2003. **Feedback and farmers' influence on the research agenda.** *Knowledge-transfer-for-sustainable-tree-crop-development A Case-history-of-the-Tanzanian-*

*Integrated-Cashew-Management-Programme.* 212-218 (ARI Naliendele, Box 509, Mtwara, Tanzania.)

This paper presents the mechanisms or channels through which exchange of information among the Integrated Cashew Management Programme (ICMP) participants was achieved. The practical examples of how farmer feedback has contributed to the development of the ICMP and influenced the research agenda, are discussed in detail.

**692.** TOPPER, CP and KASUGA, LJ. 2003. **Technology adoption rates and the success of knowledge transfer to ICMP and non-ICMP farmers.** *Knowledge-transfer-for-sustainable-tree-crop-development-A Case history-of-the-Tanzanian-Integrated-Cashew-Management-Programme.* pp. 191-211 (ARI Naliendele, Box 509, Mtwara, Tanzania).

Surveys were conducted within 1994-99 in Rwangwa, Tanzania, to examine critically important issues such as: (1) technology adoption rates by both Integrated Cashew Management Programme (ICMP) and non-ICMP farmers; (2) whether technologies from the basket of options and supporting knowledge have been adopted by a range of farmer types, from the resource poor to the resource rich; and (3) knowledge transfer and whether the ICMP has contributed to the knowledge base of farmers. The results of the wealth rankings of ICMP Programme households demonstrated that the programme had mainly focused on the middle and poorer cashew owning households and not just on the wealthy groups. The adoption rates found by the survey were generally good for ICMP farmers, maximum adoption rates in any one year ranged from 25% for the planting of polyclonal seed (not

necessarily undertaken annually since there would only be a finite number of gaps open for the planting of improved seed) to 92% for fungicide application (a technology required every year). The various technologies were grouped according to the degree of knowledge content required for their implementation. Three categories were used: (1) prescriptive (at the lower end of the knowledge continuum); (2) craft based (in the middle); and (3) those requiring a high degree of cognitive knowledge. Findings from the survey on the relative adoption rates for ICMP and non-ICMP farmers indicated that knowledge based technologies (i.e., scouting) were more difficult to transfer to non-specifically targeted groups (i.e., non-ICMP farmers) than craft based technologies, which in turn are harder than prescriptive technologies. It should be noted that no special conditions or incentives were made to encourage the transfer of knowledge or techniques from ICMP group members to other farmers, other than the ICMP meetings were open to all interested parties.

**693.** TOPPER, CP., KASUGA, LJ., SIJAONA, MER and ANTHONY, JK. 2003. **Crop protection in cashew farming systems.** *Knowledge-transfer-for-sustainable-tree-crop-development A Case-history-of-the-Tanzanian-Integrated-Cashew-Management-Programme.* pp. 138-172 (BioHybrids Agrisystems Ltd, PO Box 2411, Earley, Reading RG6 5FY, UK.)

This chapter gives an overview on pests and diseases. The temporal relationship of the major parameters studied in this chapter are initially presented to provide the reader a better understanding of how the different factors relate to each other during the flowering and fruiting season. Cashew variability is then discussed,

starting with phenological variation and then the variability of powdery mildew disease (PMD) caused by *Oidium anacardii*. The effect of PMD on yield is analysed, heterogeneity of individual tree yields in the absence of PMD is also noted. The remainder of the chapter deals with control strategies and how to maximize their efficiency and cost effectiveness in light of this heterogeneity.

**694.** TOPPER, CP., KASUGA, LJ and MFILINGE, AG. 2003. **Working with farmer groups.** *Knowledge-transfer-for-sustainable-tree-crop-development A Case-history-of-the-Tanzanian-Integrated-Cashew-Management-Programme.* pp. 119-137

This chapter elaborates further details on the specifics of working with farmer groups, such as how truly representative they are, their cohesion and survival and whether this has been a successful strategy for cashew farming.

**695.** TOPPER, CP and KASUGA, LJ. 2003. **Challenges for tree crops, research and extension in rural development.** *Knowledge-transfer-for-sustainable-tree-crop-development A Case-history-of-the-Tanzanian-Integrated-Cashew-Management-Programme.* pp. 1-42 (BioHybrids Agrisystems Ltd, PO Box 2411, Earley, Reading RG6 5FY, UK.)

This chapter is presented in 3 parts. Part A, 'Opportunities and challenges of tree crops', defines the unique benefits and opportunities of tree crops and the specific problems associated with their sustainable development and expansion. Part B, 'Challenges of research and extension', deals with the challenges facing research and extension, some of which are specific but many of which are common to both tree crops and agriculture in general. Given that the ultimate objective of research

and extension and of maximizing the unique potential of tree crops is improved rural development, some development perspectives are explored in Part C.

**696.** TORQUATO, DS and FERREIRA, ML. 2004. **Evaluation of antimicrobial activity of cashew tree gum.** *World Journal of Microbiology and Biotechnology*. 20(5): 505-507 (Embrapa Tropical Agroindustry, Rua Dra. Sara Mesquita, 2270 Pici, 60511-110 Fortaleza, CE, Brazil).

Crude and purified cashew tree gum were tested for their antimicrobial activity against bacteria, yeast and fungi. Their use was also evaluated as a carbon source for microbial growth. Cashew gum presented only a weak activity against *Saccharomyces cerevisiae* and no activity was observed against all other microorganisms tested. The possibility that removal of anacardic acid present in the raw gum during purification may explain the negative results obtained was discussed. When purified cashew tree gum was used as carbon source, only *Listeria monocytogenes*, *Saccharomyces cerevisiae* and *Kluyveromyces marxianus* did not grow after 5 days of incubation.

**697.** TORRES, M. 1999. **Characterization of the leaf anatomy of four species of fruit tree: Cashew, mango, Spanish Plum and guava.** *ERNSTIA* 9(3/4): 155-173

Anatomical studies indicated that leaves of cashew, mango and spanish plum were structurally similar although some differences were noted in thickness and sinuosity of the epidermal cell walls; stomatal and trichome density, location and type; thickness of and numbers of layers forming the leaf blade; the

form of association of the schlerenchyma with a vascular bundles and the arrangement of these in the midrib and petiole; and the presence of petiole hypodermis. Guava leaves had a greater number of characteristics which were different to the other species.

**698.** TYMAN, JHP. 2005. **Researches on the technology and bioactive properties of phenolic lipids: Cashew.** *Frontiers in Natural Product Chemistry*, 1: 107-120 (Bentham Science Publishers, ISBN 90-77527-04-4.)

Cashew, which contains the principal component phenols, anacardic acid, cardol, 2-methylcardol and cardonal, is a unique source of materials useful both for industrial technology, in semi-synthesis and for biological/ pharmaceutical applications. By industrial decarboxylation, anacardic acid in natural cashew gives predominantly cardonal in the product. Technical cashew nut shell liquid (CNSL), together with cardol/2- methylcardol and the cashew kernel, is the valuable desired main edible commercial product. Anacardic acid, together with cardol, is best recovered by cold cutting of raw cashew shells followed by solvent extraction to afford natural CNSL. Either from technical or natural CNSL, the individual component phenols can be separated by several different techniques notably by phase separation. Each separated component phenol contains saturated, 8(Z) monoene, 8(Z), 11(Z)- diene and 8(Z), 11(Z), 14-triene constituents. Subsidiary chromatographic separation can give the individual constituents. Technical CNSL without separation is widely used in the production of friction dusts for the automobile industry and in certain polymeric/ surface coating applications. Cardonal separated from technical CNSL has uses in semi-synthesis.

**699.** UMESH, KB and VISHNUVARDHANA. 2001. **Performance of cashew varieties in eastern dry zone of Karnataka - an economic analysis.** *The Cashew* 15(3): 12-17 (ARS (UAS), Chinthamani Campus - 563 125, Karnataka.).

Cashew being a perennial crop starts yielding from fourth year onwards, it can be seen that, on an average, to establish a cashew orchard in a hectare it requires Rs. 15,631/- during the first three years period. The maintenance cost required over the years varies between Rs.5640 to Rs. 8555/ha/year. Which appears reasonably low compared to other plantation crops, this should certainly make the prudent farmers to think of investing and expanding cultivation of cashew in maidan area of dry tracts. The productivity level in Ch-1 varied from 210 kg to 2273 kg/ha and in U-4, it varied from nil to 2535 kg/ha over the 18 years period considered.

**700.** USHIA, K and PRAKASAM, VR. 2002. **Skin sensitization with cashewnut shell liquid in Guinea Pig, *Cavia porcellus*.** *The Cashew* 16(3): 24-27

The sensitization potential of CNSL was studied using closed patch test in guinea pig. In the preliminary test conducted using 2%, 5% and 25% CNSL, it was found 5% CNSL was the highest concentration that caused 'very slight erythema' for induction phase and 2% CNSL was the highest concentration that produced 'no erythema' for challenge phase. The induction phase of the test with 5% CNSL showed no edema but scored 1 for erythema. After 14 days of test phase, test and control animals were challenged with 2% CNSL. It produced no erythema and edema confirming thereby that technical grade CNSL was a non-

sensitizer.

**701.** USHA, KE., PUSHPALATHA, PB and NARAYANANKUTTY, C. 1996. **Screening of cashew seedlings at nursery stage for the use as dwarfing rootstock.** *The Cashew* 10(1): 9-10

A study was conducted at CRS, Madakkathara to screen cashew seedlings for use as dwarf rootstocks. It was revealed that morphological and anatomical characters can be used as criteria for screening semi-dwarf cashew seedlings.

**702.** VALIA, RZ and PATIL, VK. 1997. **Growth, physiological parameters and nutritional status as influenced by soil salinity in cashew.** *Journal of Plantation Crops* 25(1): 62-67

Seedlings were grown in pots in naturally saline soil and artificially salinized soils with conductivities ranging from 1.2 to 20 dS/m for 12 months. A decrease in growth was observed with increasing salinity, however more pronounced effects were seen at levels of 14 dS/m and above. As salinity increased, leaf chlorophyll a, b and total chlorophyll contents, and transpiration rate decreased. With increasing salinity, all nutrients (N,P,K, Ca, Mg, Zn, Fe, Mn and Cu) except S were depleted in leaves and roots. A lower uptake of nutrients due to high concentration of Na in the soil solution appeared to increase the adverse effect of Na on plant growth in saline soils.

**703.** Valia, RZ and Patil, VK. 1997. **Tolerance of cashewnut and coconut to soil salinity.** *Proceedings of International Cashew and Coconut Conference*, Dar Es Salaam, Tanzania.

Tolerance tests of cashewnut and coconut

to evaluate the performance of seedling in naturally problematic soil and artificially salinized soils of Ece ranging from 4 to 20 ds/m for 12 months under pot culture. Cashewnut failed to grow at levels of Ece 14 ds/m and above. It grows well up to Ece at 12ds/m while coconut grows well up to Ece 20ds/m. Growth parameters like plant height, spread, number of leaves, stem diameter, leaf area, root length, fresh and dry weight of uprooted plants at the time of termination of experiment (12 months) decreased with increase in Ece levels.

**704. VEERKAR, PD., WADKAR, SS and BHOSALE, SS. 2006. Constraint analysis of cashew production in South Konkan region of Maharashtra. *The Cashew* 20(3): 11-22**

With the evolution of high yielding and hybrid varieties of cashew, the area and production of this crop has been increased many fold in the last two decade. However, cashew growers in Konkan region facing many constraints in achieving higher productivity per unit area. Unavailability of quality planting material, unawareness of recommended fertilizer dose and plant protection schedule were the common constraints. In addition to this, shortage of labour in production season and their high wages were the constraint reported by cashew growers.

**705. VELAVAN, C. 2004. Performance of cashew: a growth rate analysis. *The Cashew* 18(3): 27-31 (Department of Agricultural Economics, Tamil Nadu Agricultural University, Tamil Nadu, India.)**

Time series data (for the years 1980-2000) on cashew area, production, exports and imports in India are analysed. It is revealed that cashew nut production has increased from 1.8 lakh tonnes in 1980-81 to 5.2 lakh tonnes

in 1999-2000. The annual growth rate of cashew nut production was 4.94%. The production growth rate was lower in the post-liberalization period (1991/92-1999/2000) than that in the pre-liberalization period (1980/81-1990/91). However, the area growth rate increased in the post-liberalization period. Cashew exports from India increased from 26 257 MT in 1980-81 to 47 MT in 1998-99. The export growth rate was 6.31% and the import growth rate was 20.89% per year. This shows that India is highly dependent on imports to meet its demand. Constraints in the production, export and marketing of cashew nut in India are outlined.

**706. VENKATESWARLU, D., MURTHY, KVMK and REDDY, MLN. 2003. Effect of anthracnose disease of the cashew seedlings on graft success in cashew nurseries. *The Cashew* 17(2): 22-24**

The diseased cashew seedlings used as rootstocks significantly reduced the numbers of successful grafts as compared to control. A progressive decline in the number of successful grafts was observed with the increase in the disease severity of rootstocks. The grafts registered a significant decrease in the elongation of graft and mean leaf area over control as a consequence of diseased rootstock irrespective of the extent of disease severity.

**707. VENKATESWARLU, D., MURTHY, KVMK and REDDY, MLN. 2004. Isolation and identification of *Colletotrichum gloeosporioides* from cashew seedlings in nurseries. *The Cashew* 18(1): 36-40**

The casual agent of anthracnose disease was isolated from affected cashew seedlings and then identified as *Colletotrichum*



*gloeosporioides*. Pathogenicity tests in different plant species showed that cashew was most susceptible to the disease, followed by mango, citrus, annona and pomegranate. All weeds tested were susceptible to the disease. Symptoms associated with anthracnose of cashew seedlings are described.

**708. VENKATTAKUMAR, R., SREEKANTIL, PD and MURALIKRISHNA, H. 2004. Analysis of state-wise availability of cashew grafts. *The Cashew* 18(4): 9-17**

National Research Centre for Cashew, Puttur has been posting the information about the availability of cashew planting material in various approved cashew nurseries in its website for the benefit of Farmers all over the country. An attempt has been made to analyse such information pertaining to three planting seasons (2001-02 to 2003-04) to arrive at meaningful conclusions and suggest implications for the researchers and policy makers. The number of nurseries responded from West Coast states was more than those from East Coast and more private nurseries responded than govt. nurseries. The quantity of cashew grafts multiplied in nurseries of East Coast region was less than those from West Coast. The Performance of non-recommended varieties for the respective states should be studied in view of benefit of the stakeholders because these varieties are being multiplied in larger number by nurseries in states where these varieties are not recommended.

**709. VENKATTAKUMAR, R., RAVIPRASAD, TN and NAYAK, MG. 2005. Perception of cashew demonstration farmers towards recommended soil and water conservation and plant protection measures in cashew -**

**an analysis. *Journal of Plantation Crops* 33 (2): 135-137 (National Research Centre for Cashew, Puttur - 574 202, DK. Karnataka.)**

A study was taken up to assess the perception of farmers towards the recommended soil and water conservation and plant protection measures in cashew cultivation to work out the strategies for further popularization. The study was conducted with 50 randomly selected demonstration farmers, who had already adopted these technologies. The respondents were classified into three categories based on their perception towards recommended soil and water conservation and plant protection measures. It was found that most of the respondents had average to more favourable perception towards recommended soil and water conservation and plant protection measures. Since the farmers had adopted and were convinced about the soil and water conservation measures viz., terracing and opening of catch pits, and plant protection measures against TMB, they had favourable perception about these technologies.

**710. VENKATTAKUMAR, R. 2006. Socio-economic impact of cashew cultivation in Kamur dist. of Kerala. *Journal of Plantation Crops* 34(3): 709-714**

Adoption gap among the farmers cultivating cashew of seedling origin was more than that of the farmers having cashew gardens of graft origin. The cost of cultivation incurred by the farmers having cashew gardens of seedling origin was just half that of the farmers having cashew gardens of graft origin. However, the cashew yield obtained by the former group of farmers was double than the later group. The share of cashew area possessed

by both types of farmers was more than half of their farm size indicating that cashew cultivation had a definite impact on the socio-economic aspects of these cashew growers.

711. VENKATTAKUMAR, R and BHAT, PS. 2003. **Technical advice - a tool for effective transfer of cashew technology.** *The Cashew* 17(3): 26-31

NRC for Cashew, Puttur is providing technical advice, related to the problems, enquiries and doubts raised on various cashew cultivation aspects by the clients either through letters or E-mail. An attempt has been made to analyse these enquiries with the following objectives. 1. To analyse the enquiries on cashew production technology from various clientele groups towards technical advice. 2. To prepare readymade literature to be used for technical advice, based on the analysis. Based on the results the action taken were discussed in this paper.

712. VENKATTAKUMAR, R., BHAT, PS and YADUKUMAR, N. 2004. **Thematic campaigns in field training of cashew growers- an analysis.** *The Cashew* 18(1): 14-19

In this study, most of the respondents were young, had primary to middle school level of education and had less than 15 years of farming experience. In spite of their age, low level of education and minimum experience in farming, the intensive training using literature, exhibition, lecture-cum - discussion and field demonstration brought considerable impact in increasing the knowledge level of the respondents on soil and water conservation measures and plant protection aspects in cashew cultivation. However, the impact of these

programmes, in terms of adoption of the technologies on SWC and PP measures by the farmers and impact on increasing the yield have to be studied.

713. VENKATTAKUMAR, R., BHAT, PS., YADUKUMAR and BHAT, MG. 2003. **Cashew production technology.** p. 36. National Research Centre for Cashew, Puttur, DK. Karnataka.

In this technical bulletin, the technologies for increasing the production and productivity of cashew are detailed based on the results which are generated in various Research Institutes including NRCC and AICRP on Cashew Centres. Some of the technologies which are profitable and are being practiced by the farmers are also included in this technical bulletin.

714. VIEGAS, RA., MELO, ARB de and SILVEIRA, JAG. 1999. **Nitrate reductase activity and proline accumulation in cashew in response to NaCl salt shock.** *Revista Brasileira De Fisiologia Vegetal* 11(1):21-28

Twenty five day-old cashew clone CCP-1001 seedlings were grown in a nutrient solution with or without addition of 100mM NaCl. After 8 days of treatment the plants exhibited a decrease in shoot mass and an increase in the root to shoot ratio. The transpiration rate decreased 50% after the first day of salinity treatment started. Leaf  $\text{NO}_3^-$  content was only reduced after 8 days of NaCl treatment, whereas the *in vivo* leaf nitrate reductase activity decreased two fold after one day of salt treatment. On the other hand, the *in vitro* leaf NR activity was not changed in salt treated plants. Moreover, the direct effects of NaCl and  $\text{Na}_2\text{SO}_4$  salts added to the enzyme

reaction medium were not significant on the NR activity. The young cashew plants exhibited progressive increases both in proline and leaf free amino acid concentrations during the salt treatment. Leaf soluble protein content was higher in salt treated plants. These results suggested that the NaCl effect on *in vivo* NR activity is to a large extent an osmotic effect, rather than ionic toxicity, and support the hypothesis that a decrease in transpiration rate resulting in a reduction in  $\text{NO}_3$  flux from roots to leaves is responsible for leaf NR activity decreasing, particularly at the beginning of salinity treatment. Cashew seedlings exhibited an efficient protective mechanism of osmotic adjustment through accumulation of free nitrogenous compounds in the leaves.

**715.** VIEGAS, RA and SILVEIRA, JAG. 2002. **Activation of nitrate reductase of cashew leaf by exogenous nitrate.** *Brazilian Journal of Plant Physiology* 14(1): 39-44 (Universidade Federal da Paraíba, Campus VII, CP 64, Brazil.)

Nitrate reductase plays a central role in plant primary metabolism and exhibits complex regulation mechanisms for its catalytic activity. There is controversy in the literature concerning the possible direct effect of  $\text{NO}_2$  on the stimulation of NR activity. The influence of  $\text{NO}_2$  on the NR activity in the leaves of 30 day old cashew seedlings was examined. Addition of  $\text{NO}_2$  to the reaction mixture containing leaf enzymatic extract resulted in a remarkable increase in NR activity. A trace amount (5mole/litre) of  $\text{NO}_2$  was required to achieve full NR activity. The *in vitro* NR activity showed a steady time - dependent increase when incubated in the presence of  $\text{NO}_3 + \text{NO}_2$  only. In contrast, *in vitro* NR activity was practically

absent in a  $\text{NO}_2$  free reaction medium, even in the presence of a saturating  $\text{NO}_3$  concentration. No oxidation of  $\text{NO}_2$  to  $\text{NO}_3$  was detected during the experiment.

**716.** VIEGAS, RA. 1999. **Ammonia assimilation and proline accumulation in young cashew plants during long term exposure to NaCl-salinity.** *Revista Brasileira De Fisiologia Vegetal* 11(3): 153-159

Thirty five day-old cashew seedlings were cultured with 0, 50 or 100 mol NaCl /m<sup>3</sup> in the nutrient solution for 30 days. Shoot dry weight was 23 and 52% lower in plants growing with 50 and 100 mol NaCl /m<sup>3</sup>, respectively, whereas root dry weight was only reduced in the highest level of NaCl compared with the control. Leaf and root nitrate reductase activity was about 70% lower in both salinity treatments compared with the control. The total free amino acid, free proline and ammonium concentrations increased in the leaf whereas in the root they changed little in response to salinity.

**717.** VIEIRA, LL., OLIVEIRA, VH de and SILVA, FP da. 2005. **Types of flowers and fruitification of irrigated dwarf cashew clones.** *Revista Ciencia Agronomica* 36(3): 358- 363

A study was conducted during 2003-04 in Paraipaba county, Brazil to evaluate the influence of the panicle position on the flower type and yield of 2 dwarf cashew apple clones, i.e. CCP 09 and EMBRAPA 51, grown under irrigated system. Three plants under each cashew clones were sampled. Sixteen panicles from each plant were used in order to establish the number of staminate, complete, and anomalous flowers, following the north, south,

east and west direction. Up on opening of the flowers, data were taken from each inflorescence, in the morning from 9.00 to 11.00h. The results led to the conclusion that the clones did not differ regarding the number of mature cashew apples. The panicle average lifetime was not influenced by its position in the plant. The ratios complete to staminate flowers and young cashew apple to complete flowers were genotype- dependent.

**718.** VINITHA, CARDOZA. 1999. **Controlling contamination in cashew.** *Plant Tissue Culture & Biotechnology:Emerging Trends* p. 156-159 (Proceedings of the symposium held at Hyderabad in 1997.)

Contamination, a major problem in *in vitro* cultures of cashew was effectively controlled by agitating the explants with 0.1% bavistin on a rotary shaker for 1 hr followed by 0.1% mercuric chloride -sodium lauryl sulphate solution for 15 minutes. During the rainy season when humidity was high, contamination was high, whereas in summer and winter very little contamination was observed. Seedlings obtained by germinating seeds *in vitro* without the pericarp showed very little contamination as compared to seedlings germinated with the pericarp intact.

**719.** VINITHA, CARDOZA. 2000. **Direct somatic embryogenesis from immature zygotic embryos in cashew.** *Phytomorphology* 50(2): 201-204

Somatic embryos were produced directly from the radicle end of immature zygotic embryos in cashew cultured on MS basal medium with 2% sucrose and 2.02/ $\mu$ M picloram. The auxin 2,4-D (2.26-22.62/ $\mu$ M)

and high concentrations of picloram induced only callusing. Callus and somatic embryos were induced only when the zygotic embryos were cultured along with the nucellar tissue.

**720.** VISHNUVARDHANA., LINGAIAH, HB., KHAN, MM and THIRUMALARAJU, GT. 2004. **Economics of production of cashew grafts in different propagation structures under eastern dry zone of Karnataka.** *The Cashew* 18(4): 39-44 (AICRP on Cashew, CRS, Chintamani, India. )

The economics of the propagation of cashew grafts in a mist chamber, naturally ventilated greenhouse, low tunnel or shade net was studied in Chintamani, Karnataka, India, during the summer, monsoon and winter seasons of 1998-2001. The initial investment for the establishment of the propagation structure (100 m<sup>2</sup>) reached 8500 rupees for the shade net, 300 000 rupees for the mist chamber, 36 400 for naturally ventilated greenhouse, and 21 000 for the low tunnel. The total costs of production for one year reached 121 500, 84 300, 80 000 and 77 750 rupees under mist chamber, ventilated greenhouse, low tunnel and shade net conditions. The highest net profit was obtained with propagation in low tunnels (59 200/m<sup>2</sup>), followed by propagation in a naturally ventilated greenhouse (42 900 rupees/m<sup>2</sup>), mist chamber (21 300 rupees/m<sup>2</sup>) and shade net (12 250 rupees/m<sup>2</sup>).

**721.** VISHNUVARDHANA. and THIRUMALARAJU, GT. 2002. **Influence of different levels of Nitrogen, Phosphorous and potassium on growth and yield of cashew under eastern dry zone of Karnataka.** *The Cashew* 16(2): 39-42 (Agricultural Research Station, UAS, Chintamani-563125.)

Different levels of NPK did not significantly influence the plant height. But the same was significantly influenced by PK interaction. The maximum plant height was recorded in trees receiving 250g of P and no K followed by 250g of P and 125g of K (492 m) when compared to control. However, the cumulative yield of nine harvests was found to be influenced significantly by the levels of NPK and PK interactions. Among N levels, yield was highest in N2 (26.83Kg/tree) followed by N1(23.85 Kg/tree) and N0 (20.81Kg/tree) with each of these levels differing significantly at  $P = 0.05$ .

**722. WADKAR,SS., TALATHI, JM and TORANE, SR. 2005. Performance of cashew exports from India. Agricultural Marketing. 48(1): 24-27 (Department of Agril. Economics, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, India.)**

The export performance of cashews from India is analysed using time series data from 1980-81 onwards on cashew exports, production, world and domestic prices, and domestic consumption. It is revealed that the quantity of cashew kernels exported by India grew by 6.08%. This positive growth rate was due to increased domestic production and increased demand for cashew kernels in the international market. The simple growth rates were 1160.60 mt and 4140.94 mt for the periods 1980-90 and 1990-2000, respectively.

**723. WIJETUNGE, PMAPK., SAMITA, S and AHANGAMA, D. 2003. Incidence and severity of cashew pest (*Helopeltis antonii* Sign.) damage and the effect of flushing stage on severity during fruiting season. Tropical Agricultural Research. 15: 331-334**

(Postgraduate Institute of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka).

The incidence and severity of *H. antonii* damage on cashew and the effect of flushing stage on the occurrence of the pest were studied in a field experiment conducted in Sri Lanka from 2000-03. The linear logistic model gave the best fit for the progress of the damage ( $G^2=2.38, P=0.6662$ ). Kendall's correlation coefficients for severity against time and severity against flushing stage were 0.46 ( $P<0.0001$ ) and 0.42 ( $P<0.0001$ ), respectively. Significant correlation between infection severity and time indicates that the severity of the damage has progressed steadily through the season. Significant correlation between severity and the flushing stage of the crop indicates that the progress of the severity corresponds to the progress of the flushes.

**724. WIJETUNGE, PMAPK., AHANGAMA, D and RANAWEERA, B. 2003. Biology of the cashew pest *Helopeltis antonii* Sign. and it's predators. Tropical Agricultural Research. 15: 188-198 (Postgraduate Institute of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka).**

The biology of *H. antonii* infecting cashew was studied under laboratory and field conditions in Sri Lanka during November 2000 to April 2003. Morphometric studies indicated 5 nymphal instars in the development of *H. antonii*. The mean duration of the developmental period of males and females were 26.9 and 28.2 days, respectively. Females predominate in the natural population with a sex ratio of 1:0.46. The mean duration of mating was 1 h and 15 minutes and resulted in a fecundity of 15-42 eggs with an oviposition

period of 6 days under 31 degrees +or-2 degrees C and 75+or-5%RH. A mean pre-oviposition period of 5 days was recorded. While first to third instar nymphs were active and observed on young shoots and inflorescence, the older instars were not active and were concentrated in older tissues of the trees. The red ant *Oecophylla smaragdina* and the praying mantis were observed to prey on *H. antonii* in the field.

**725. YADUKUMAR, N. 2004. Organic manuring in cashew.** *The Cashew* 18(4): 29-38 (National Research Centre for Cashew, Puttur - 574 202, DK, Karnataka, India).

The current status of nutrient management in cashew in India is discussed. The preparation of compost and vermicompost from cashew biomass (including leaf litter) is described. Future strategies for nutrient management in cashew are presented.

**726. YADUKUMAR, N. 2007. Quality standards of planting materials and organic farming in cashew.** In: *6th National Seminar - Indian Cashew in the Next Decade - Challenges and Opportunities.*, 18-19 May, 2007, Raipur. *Souvenir*. p. 25-34.

Selection of suitable cashew grafts is most important in producing cashew organically. The quality standards of producing grafts of different high yielding varieties have been documented at National Research Centre for Cashew in order to achieve high yield in cashew. The details of producing quality planting materials are discussed in this paper.

**727. YADUKUMAR, N and BALASIMHA, D. 2006. Effects of drip irrigation and fertilizer levels on photosynthesis in cashew.** *Indian Journal of Horticulture* 63(3): 310-315

Five irrigation levels (0,20,40,60,80 L/

tree once in 4 days from December to March) in main plot and 4 levels of NPK fertilizers in sub-plots were imposed on to cashew in experiments conducted during 1996/97 and 1997/98 in Karnataka, India. Microclimate, photosynthesis and leaf water potential were determined in fully matured leaves at 7 and 8 years after planting in December and March. Soil moisture at 5 depths (0-25, 26-50, 51-75, 76-100, 101-125 cm) was also determined. Irrigation did not affect microclimate and photosynthesis in December mainly due to presence of moisture within available range and deeper depths in control plot also. Transpiration, photosynthesis and stomatal conductance were significantly higher in irrigated and fertilizer treated trees than in unirrigated trees receiving no fertilizers in March. The reduced levels of photosynthetic parameters in unirrigated trees were associated with higher air/leaf temperature and lower relative humidity during March. In March, moisture stress below the lower level of available moisture was observed in control plot receiving no irrigation.

**728. YADUKUMAR, N and REJANI, R. 2004. Evaluation of soil and water conservation techniques coupled with manuring in cashew grown under medium slope.** *Journal of Plantation Crops* 32 (supl) : 190-195 (Proceedings of PLACROSYM - XVI.)

With aim to develop suitable soil and water conservation techniques to boost cashew yield a field experiment was laid out in 2000 and continued up to 2004 at NRCC, Puttur on ten years old cashew grafts of VRI-1 variety. Main plot treatments consisted of 1. terrace with catch pit, 2. terrace with crescent bund, 3. staggered trenches between trees and 4. control plot. Sub plot treatments consisted of a)

recommended doses of fertilizers, b) recommended doses of fertilizers + 10 kg poultry manure and c) application of only 20 kg poultry manure / tree/year. It was found that the terrace with crescent bund treatment has increased the soil moisture significantly (14.5% dry basis compared to 11.2% in control), reduced the peak run off (4.6 l/s/ha compared to 5.1 l/s/ha in control and soil loss (0.77 t/ha/year compared to 1.54 t/ha/year in control plot) and resulted an increase in the cashew yield (732kg/ha compared to 497.2 kg/ha in control). Hence the available water during monsoon season can be efficiently harvested and used for higher yields using proper soil and water conservation techniques like terrace with crescent bund treatment coupled with the application of 20 kg poultry manure. Cost involved per tree for this structure is Rs. 30 at the present rates of wages under Dakshina Kannada conditions.

**729. YADUKUMAR, N., SWAMY, KRM and RAO, EVVB. 2003. Projection on economics of establishment and maintenance of cashew plantations under different plant densities. *The Cashew* 17(3): 6-16**

Unit cost of establishment and maintenance of cashew plantations has been worked out for different plant densities. It was observed that unit cost of establishment and maintenance for the first 10 years was high in high density planting system. It was also observed that net income expected from high density planting is 130 to 150% more than normal plant density. This paper deals with labour cost, material cost, expected yield, gross income, net income and economic analysis to see the feasibility of the project to take up cashew cultivation under different plant density situations for 10 years in 1 ha. area. The

information presented in this paper will be useful for financing institutions such as NABARD.

**730. YADUKUMAR, N and NAYAK, MG. 2006. Recent techniques and strategies for improvement of senile cashew plantations. *The Cashew* 20(1): 20-26**

In India, over sixty percent of the planted area is covered under senile plantations with age of the crop exceeding 20 years which contributes only 30% of the total yield in the country. The ways and means of improving the production and productivity levels of the existing senile cashew plantations raised with seedling progenies are discussed. Some of the techniques discussed are: 1. Soil and water conservation measures 2. application of manures and fertilizers 3. Vonsolidation of plantations by gap filling 4. Rejuvenation of old trees by pruning and 5. Rejuvenation by Top working.

**731. YADUKUMAR, N. 2003. Strategies for improved productivity through efficient water management. *The Cashew* 17(3): 21-25 ( Also published in *The Cashew* 16(2): 34-38, 2002).**

Under rainfed conditions the low soil moisture availability during the fruiting season that normally coincides with the onset of dry season in cashew growing areas, results in poor yield. Hence, the factor responsible for high productivity and the strategies required for getting increased yield in cashew through efficient water management practices such as soil and water conservation, supplementary irrigation etc. were discussed in this paper.

**732. YADUKUMAR, N and REJANI, R. 2006. Temporal and spatial variation of soil moisture content and development of a yield**

**model based on soil moisture content.** *Journal of Plantation Crops* 34(3): 364-367

An experiment was laid out during 2000 and continued up to 2006 at NRCC, Puttur on ten years old cashew grafts of VRI - 1 variety with an aim to find the relationship between soil moisture content and cashew yield. Main plot treatments consisted of (1) terrace with catch pit, (2) terrace with crescent bund, (3) staggered trenches between trees and (4) control plot. Subplot treatments consisted of a) recommended doses of fertilizers, b) recommended doses of fertilizers + 10kg poultry manure and c) application of only 20kg poultry manure/tree/year. It was observed that there was a drastic decline in soil moisture content (SMC) in all the treatments during the critical period. The SMC was in the lower limit or below the lower limit of available soil moisture range during Feb. itself in the control plot. The crescent bund with terrace treatment has conserved the soil moisture significantly and resulted in maximum cashew yield than other treatments. Maximum moisture content and yield was recorded in the year 2006 compared to previous years in all the treatments. A positive correlation ( $r^2 = 0.925$ ) between soil moisture content and nut yield shows that proper soil and water conservation measures or irrigation is essential to reduce the soil moisture stress and to increase the nut yield.

**733. YADUKUMAR, N., RAO, EVVB and MOHAN, E. 2001. High density planting of cashew.** *Tropical Agriculture (TRINIDAD)* 78(1): 19-28 (NRC for Cashew, Puttur-574202, DK, Karnataka.).

A density trial of cashew was carried out at the NRCC, Shanthigodu, India, during 1982-

94 with the objectives of studying growth behaviour, root distribution, photosynthesis, weed biomass, dry branch accumulation and yield under the varying densities. Densities adopted were 156 trees, 278 trees, 625 trees, 1111 trees and 2500 trees/ha. The density was reduced to 50% in the treatment with 1111 trees/ha. and to 25% in the treatment with 2500 trees/ha. in the seventh year. Yield levels were maintained in higher density plots by pruning to 80% light interception. Maintaining a tree density of 625/ha.(4m x 4m) for the first 11 years and diagonal thinning thereafter to reduce the population to 50% resulted maximum yield.

**734. YADUKUMAR, N. 2007. Development of suitable cashew based cropping systems - Inter and mixed cropping with cashew.** National Seminar on Research, Development and Marketing of Cashew, 20-21st Nov. 2007, Goa. *Souvenir and Extended Summaries.* p. 62. (National Research Centre for Cashew, Puttur, D.K., Karnataka)

Cashew is cultivated mostly on hilly slopes in the west coast. Here the climate is warm and humid with temperature ranging from 22°C to 38°C, relative humidity 75 to 85% and mean annual rainfall of about 3500 mm. The soils are mainly lateritic or gravelly in hilly tracts and porous with mostly acidic reaction. Because of undulating topography soil erosion is a major problem in exposed areas. Intercropping was not viable proposition earlier as cashew itself was grown on soils with low water availability and fertility. With the establishment of large plantations and adoption of systematic package of practices, intercropping is practiced to obtain returns during the initial years of cultivation. Once cashew canopy becomes dense, intercropping (legumes and millets) is



discontinued. Mixed cropping with other trees is not widely practiced although there are some reports of casuarina being planted along with cashew in Andhra Pradesh and Orissa. In order to utilize interspace and to check soil erosion during initial stages of cashew, this study is taken up with the objective of evaluating different annuals, biennials and perennials as inter and mixed crops. While soil erosion could be checked using cover crop, sustained additional income can be obtained by growing intercrops. The crops tested were pigeon pea, tapioca and sweet potato (food crops). Castor and sun flower (oil seed crops) and biennial and perennial intercrops such as pineapple and guava (fruit crops), and the pulp and fuel wood perennials like acacia, casuarina and subabul.

**735. YADUKUMAR, N., REJANI, R and NANDAN, SL. 2007. Green manuring for cashew orchards.** National Seminar on Research, Development and Marketing of Cashew, 20-21<sup>st</sup> Nov. 2007, Goa. *Souvenir and Extended Summaries*. p. 59-60. (National Research Centre for Cashew, Puttur, D.K., Karnataka -574202.)

Cashew (*Anacardium Occidentale L*) is generally grown on hillocks, where the top soil is eroded and the availability of both moisture and nutrients are less. Green manuring with glyricidia and sesbania in cashew garden increased the nutrient content of the soil and cashew yield. The dry matter production of green biomass obtained from glyricidia, sesbania, sunhemp and cover crop was 7.65, 5.75, 2.25 and 1.63 t/ha/yr. Soil organic carbon content and nitrogen content increased significantly in glyricidia plot compared to other plots. Nutrient concentration in cashew leaf was highest in plot where glyricidia and

cover crops were grown along with cashew. Cashew yield was highest in glyricidia plot (845 kg/ha in 2005 and 1048 kg/ha in 2006) and sesbania plot (856 kg/ha in 2005 and 925 kg/ha in 2006) compared to all other plots. More increase in dry matter production of green biomass and cashew yield over years was observed in glyricidia plot compared to all other plots. Hence, in long run, glyricidia as green manuring crop for cashew is more beneficial.

**736. YADUKUMAR, N. 2007. Organic farming in Cashew.** National Seminar on Research, Development and Marketing of Cashew, 20-21<sup>st</sup> Nov. 2007, Goa. *Souvenir and Extended Summaries*. p. 36-46 (National Research Centre for Cashew, Puttur - 574 202, DK, Karnataka)

In India cashew is one of the major foreign exchange earning horticulture crops with net export of 1, 14 lakh tonnes of processed kernels fetching total earning of 2514.9 crore rupees annually. India stands first in the export of cashew kernels in the world market (48%). At National Research Centre for Cashew, Puttur, Karnataka an attempt has been made to grow cashew organically and the yield is compared with cashew grown under inorganic system. Nutritional trials were conducted with main aim to understand crop response for organic and inorganic manures and combination of both and it was observed that application of recommended doses of fertilizers with 10 kg poultry litter/tree/year with soil and water conservation resulted in 210 per cent (1212 kg/ha) of control plot (561.4 kg/ha—Without application of both organic and inorganic manure). Next highest yield was recorded (1262 kg/ha) in the case of trees receiving 20 kg poultry manure only with soil and water

conservation (225 per cent of control plot). In another trial the treatment of 50 % N in the form of inorganic fertilizers and remaining 50 % applied in the form of compost of organically recyclable cashew biomass (ORCB) available in cashew garden and biofertilizer *Azospirillum* along with compost of OCB gave highest yield (1.053 t/ha.) compared to control (0.669 t/ha.) and application of recommended dose of fertilizers in the form of inorganic manure only (0.951 t/ha.). In order to produce cashew organically and utilize cashew waste effectively an alternate technique of producing compost and vermicompost have been developed. With this full nutrient requirement of the crop can be met with 33 kg organically recyclable cashew biomass compost per tree. In this paper

alternate manures to substitute inorganic manures are suggested taking into consideration nutrient concentration in each kind of organic manure. Future strategies on organic farming are also discussed in this paper

**737. ZAGADE, PM. 2000. Knowledge and adoption of recommended crop protection measures by the cashew growers in Sindudurg district. *The Cashew* 14(4): 22-25**

This paper lead to conclude that a large majority of the respondents had low to medium adoption of recommendations pertaining to crop protection measures in cashew and quite a considerable number of respondents had not undertaken any control measures against pest and diseases of cashew.

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Valia, RZ	702-703	Yadukumar, N	096,156,159,416, 503, 525-526, 641,712-713, 725-736
Varma, AS	109	Yessoh, JM	043
Varzea,VMP	387	Yogeesha, A	402
Veenakumari, K	235	Yokokawa, Y	258
Veerkar, PD	151,704	Zagade, PM.	737
Velavan, C	705	Zhu-Xin Tian	600
Vengadesan, G	034		