वार्षिक प्रतिवेदन
ANNUAL REPORT
2007 - 08

केन्द्रीय तम्बाकू अनुसंधान संस्थान

(भारतीय कृषि अनुसंधान परिषद)

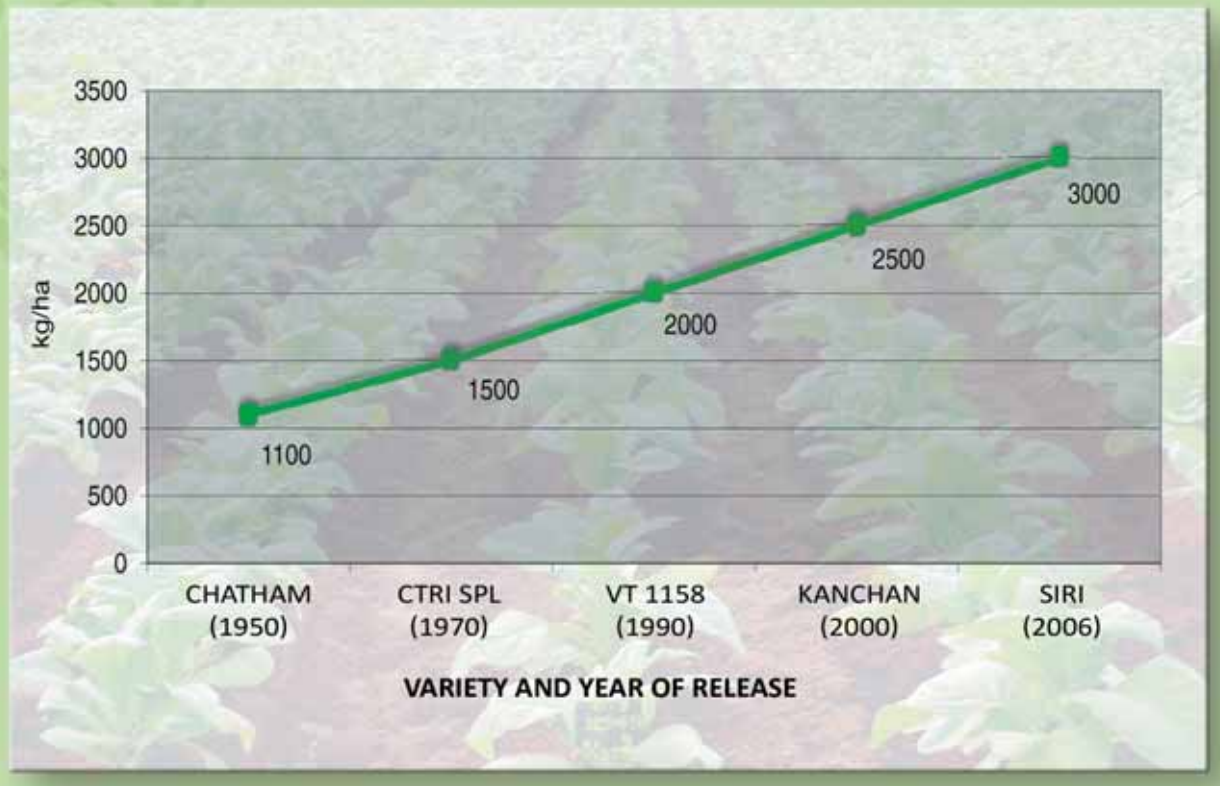
राजमन्द्री - 533 105, आन्ध्र प्रदेश

CENTRAL TOBACCO RESEARCH INSTITUTE

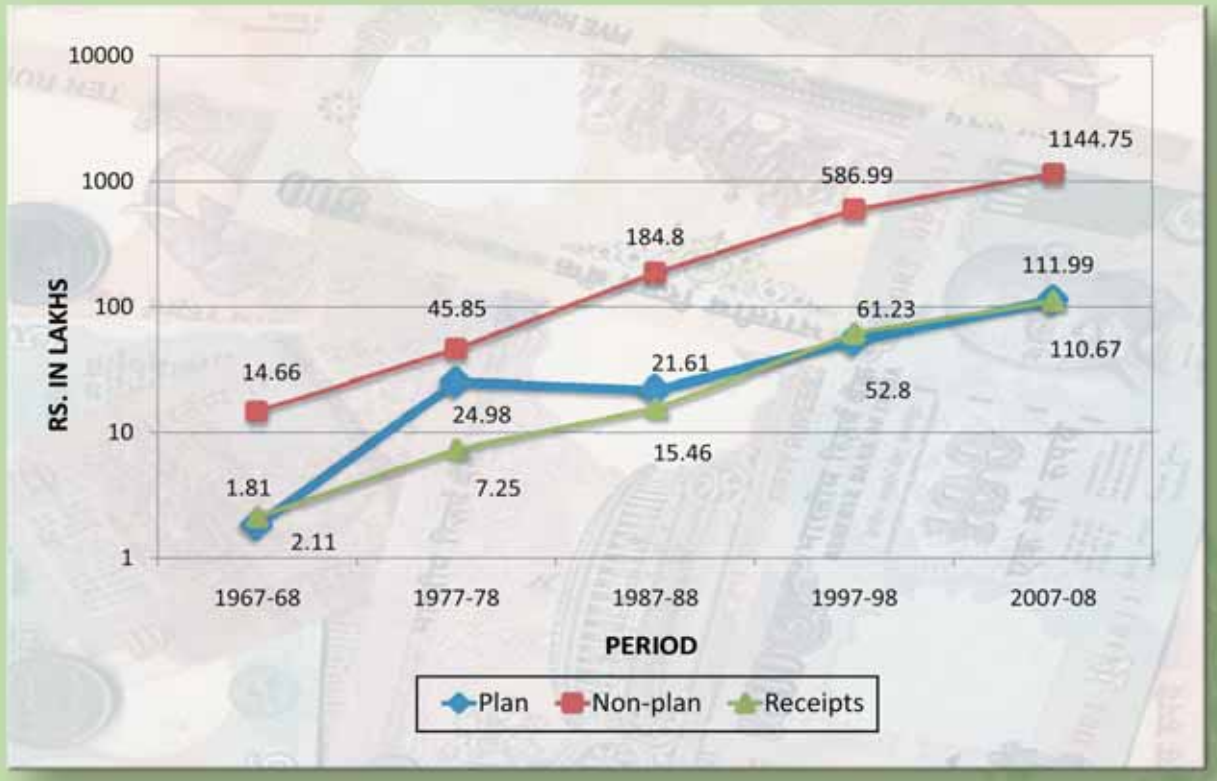
(Indian Council of Agricultural Research)

Rajahmundry - 533 105, Andhra Pradesh

VARIETAL IMPROVEMENT IN FCV TOBACCO



GROWTH IN BUDGET (1967-2008) AND REVENUE RECEIPTS



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CENTRAL TOBACCO RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
RAJAHMUNDRY - 533 105, Andhra Pradesh

भाकृअनुप
ICAR

CTRI ANNUAL REPORT 2007-08

60 Sixty Years of Tobacco Research

Published by

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Printed at
Swapna Art Home, Vijayawada-2
Phones : 0866 6520675, 9393435554

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Preface

I am happy to bring out the Annual Report of the year 2007-08, which coincides with the Diamond Jubilee celebrations of the Central Tobacco Research Institute, Rajahmundry. The Institute established on 01.04.1947 has completed 60 years of service to the farming community and celebrated the Diamond Jubilee on 01.12.2007. The Institute has made phenomenal progress in terms of human resource development, infrastructure facilities and research work over the past 60 years contributing to the improvement of productivity and quality of different types of tobacco grown in the country thereby significantly improving the economic conditions of the growers. The annual budget of the Institute during 1947-48 was around Rs. 3.5 lakhs and during 2007-08 it has increased to Rs. 16.30 crores, reflecting the strong support of the Council and spectacular growth of the Institute. It is my bounden duty to pay respects to all the past DGs, DDGs and ADGs of ICAR and Directors of the Institute for their vision, continued support and encouragement for the growth and development of the Institute.

At present, India is the 3rd largest producer and exporter in the world after Brazil and China. The country accounts for 10% of the area and 9% of the world's total tobacco production. The total tobacco production in India stands at 700 million kg out of which FCV tobacco constitutes 260 million kg and accounting for 77% of the total tobacco exports. India exports unmanufactured tobacco and tobacco products to over 80 countries in the world and there has been a steady growth in exports of Indian tobacco since 2002-03. In 2007-08, the exports of unmanufactured tobacco reached a new peak of 174.26 million kg valued at Rs. 1,475 crores and the total exports of tobacco and tobacco products reached an all time high of 203.40 million kg valued at Rs. 2,021 crores.

During the period under report, CTRI scientists have made significant contributions in the research areas of varietal development, crop production and protection technologies, quality improvement, energy conservation, reduction of harmful constituents in tobacco leaf/smoke and in alternative uses of tobacco. A caterpillar (*S. litura*) resistant chewing tobacco variety Meenakshi (CR) with a yield potential of around 3,500 kg/ha endowed with added resistance to *Spodoptera litura* - a major pest in chewing tobacco crop of Tamil Nadu - was released for cultivation in the inland chewing tobacco tracts of the state under irrigated conditions. The Controller of Patents, Patent Office, New Delhi has granted Patent No. 211204, dated 18.10.2007 for the invention "Process for purification of solanesol (95 + %) from crude/enriched extracts of tobacco green leaf/tobacco cured leaf/tobacco waste".

I fervently hope that it is the right time to consolidate the gains of 60 years of research by intensifying our efforts in the following five thrust areas: 1) Improving the productivity and profitability of tobacco, 2) Nutrient and water management and IPM strategies for resource-use-efficiency, 3) Remunerative alternative crops and cropping systems for different agro-climatic zones, 4) Reduction of harmful substances in tobacco and tobacco products and 5) Alternative uses of tobacco and their commercialization.

Also, keeping in view the obligations under the World Health Organisation (WHO) – Framework Convention on Tobacco Control (FCTC) and Government policies, a network project is proposed on "Alternative crops/cropping systems to tobacco in different AESRs", with Rs. 3 crores financial support from the Ministry of Health and Family Welfare, Government of India.

I express my deep sense of gratitude to Dr. Mangala Rai, Secretary, DARE and the Director-General, ICAR for his leadership and support for the overall development of the Institute. I am also grateful to Dr. S. P. Tiwari, Deputy Director-General (Education & CS), Dr. P.L. Gautam, Deputy Director-General (CS) and Dr. K.C. Jain, Assistant Director-General(CC), ICAR for their valuable guidance in our efforts to serve the tobacco farmers. I heartfully acknowledge the sincere efforts and whole-hearted co-operation of all the staff members of the Institute in fulfilling the targets before us.

In this Annual Report, we made an attempt to compile the salient research achievements, developmental activities, important events and the personalia so as to provide detailed information to researchers, policy makers in ICAR & other organisations and to the members of the tobacco trade & industry.

V. Krishnamurthy

(V. KRISHNAMURTHY)
Director

प्रमुख अनुसंधान गतिविधियाँ

इस संस्थान द्वारा दस मुख्य अनुसंधान कार्यक्रम पहचान किये गये और वर्ष 2007-2008 के दौरान इन कार्यक्रमों और अखिल भारत तम्बाकू जाली अनुसंधान परियोजना के महत्वपूर्ण उपलब्धियाँ संक्षेप में इस प्रकार हैं।

फसल सुधार

वर्ष 2006 के दौरान आन्ध्र प्रदेश के वर्षा आधारित वर्टिसोलों में कृषि के लिए सिरी, एक उच्च उत्पादक एवं बेहतर गुणवत्ता वाला फ्लू संसाधित वर्जिनया (एफ.सी.वी.) तंबाकू किस्म का विमोचन किया गया। इसने वर्ष 2006-07 के मौसम के दौरान 3,000 किलोग्राम प्रति हेक्टेयर का औसत उत्पादन एवं 10 मिलियन किलोग्राम का अतिरिक्त उत्पादन दिया। यह माना जा रहा है कि वर्ष 2006-07 के दौरान इसे काली मृदा क्षेत्र का करीब 75 प्रतिशत क्षेत्र में फैलाया जाएगा।

सिंचित परिस्थितियों के अंतर्गत तमिलनाडु के दक्षिण, मध्य एवं पश्चिमी चबाऊ तम्बाकू क्षेत्रों में कृषि के लिए वर्ष 2007 दौरान सूंडी (स्पोडोप्टेरा लिटुरा) प्रतिरोधी चबाऊ तम्बाकू किस्म मीनाक्षी (सी.आर.), जिसकी उत्पादन क्षमता 3,500 कि.ग्रा. प्रति हेक्टेयर है, का विमोचन किया गया।

परिक्रामी निधि योजना के अंतर्गत 16.2 टन तम्बाकू बीजों का उत्पादन कर तम्बाकू उत्पादन करने वाले किसानों में विस्तृत कर 58.35 लाख रुपये वसूल किया गया।

फसल उत्पादन

आंध्र प्रदेश के उत्तरी काली मृदाओं में एफ.सी.वी. तम्बाकू के विकल्पों के रुप में मक्का-तम्बाकू एवं सोयाबीन-चना प्रणालियां लाभदायक पायी गयीं। केन्द्रीय तम्बाकू अनुसंधान संस्थान का अनुसंधान केन्द्र, दिनहाटा में जूट-अमन चावल-मोतीहारी तम्बाकू के सस्यक्रम ने अत्याधिक शुद्ध प्रतिफल दिया। उसके बाद बोरो चावल-अमन चावल-तम्बाकू, मक्का-अमन चावल-तम्बाकू, जूट-धैनचा (जी.एम.)-तम्बाकू एवं जूट-पड़ती-तम्बाकू आते हैं।

फसल संरक्षण

लनटाना कमरा, थिविटा नेरिफोलिआ एवं निकटनथस एस.पी. के अरकों का 10 म्यू.एल. सांद्रता ने माहूँ को करीब 90 प्रतिशत तक नियंत्रण किया। सी.टी.आर.आई., अनुसंधान केन्द्र, हुण्सूर में एफ.सी.एच. 221 एवं एफ.सी.एच. 222 वंशावलियों को, आशाजनक फ्यूजेरियम विल्ट प्रतिरोधी अग्रिम प्रजनन वंशावलियों के रूप में पहचान गया। 108 सी.एफ.यु. प्रति मि.ली. की दर से जिवाण्विक दवाई का टीका लगाने, 560 कि.ग्रा. प्रति हेक्टेयर की दर से मृदा में चूना मिलाने, 30 दिनों तक पड़ती छोडने एवं धैनचा से स्वस्थाने हरा खाद देने के द्वारा मोतिहारी तम्बाकू में जीवाण्विक मुरझान को महत्वपूर्ण रूप से कम किया गया।

फसल रसायन एवं मृदा विज्ञान

1. तम्बाकू बीज उत्पादन पर परिक्रामी निधि योजना

वर्ष 1990 में, भारतीय कृषि अनुसंधान परिषद ने उत्पादन एवं गुणवत्ता को सुधारने के लिए एवं तम्बाकू की खेती करने वाले किसानों को मान्यता प्राप्त किस्मों के शुद्ध बीजों एवं स्वस्थ पौधों के आपूर्ति के लक्ष्यसे केन्द्रीय तम्बाकू अनुसंधान संस्थान को परिक्रामी निधि योजना की मंजीरी दी । इस योजना के अंतर्गत, आंध्र प्रदेश में नियमित रुप से तंबाकू की खेती करने वाले किसानों को 18,000 से 20,000 कि.ग्रा. एफ.सी.वी. तम्बाकू बीज एवं 400 से 600 कि.ग्रा. लंका तम्बाकू बीजों (एफ.सी.वी. रहित तम्बाकू) का उत्पादन कर वितरित किया जा रहा है। किसी भी मौसम में, 90 प्रतिशत से भी अधिक, केन्द्रीय तम्बाकू अनुसंधान संस्थान से आपूर्ती की गई तम्बाकू बीजों से ही तम्बाकू फसल क्षेत्र का रोपण किया जा रहा है। हालाँकि सन् 1990 में परिक्रामी निधि योजना 3,00,000 रुपये की राशि से प्रारंभ की गई, वर्ष 2007 के दौरान इस योजना की आय बढ़कर 75,00,000 रुपए हो गई।

2. तिलहन फसल के रुप में तम्बाकू

तम्बाकू बीज में बीज तेल की मात्रा 35-39 प्रतिशत है, जो निकोटिन रहित, मूंगफली, सरसों एवं कपास के बीज के तेल से बेहतर तथा वसा अम्ल सम्मिश्रण की दृष्टि से सूरजमुखी तेल के समान है। संसाधित पत्ता उत्पादन के अतिरिक्त संशोधित कृषि तकनीकों से चबाऊ तम्बाकू किस्म ए-145 से 1171 कि.ग्रा. प्रति हेक्टेयर बीज के उत्पादन से 433 कि.ग्रा. प्रति हेक्टेयर तेल की प्राप्त क्षमता से तिलहन फसल के रुप में तम्बाकू की क्षमता स्थापित हो गई।

EXECUTIVE SUMMARY

The Institute has identified 10 major research programmes and the significant achievements made under these programmes and All India Network Research Project on Tobacco (AINRPT) during 2007-08 are summarized as under.

1. Germplasm Resource Management

A total of 2383 germplasm lines including 55 wild species are currently maintained at CTRI, Rajahmundry. Screening germplasm against various diseases and insect pests, under artificial inoculation has resulted in identification of reliable sources of resistance to TMV, aphid, bud worm and stem borer. Wild species viz., *N. repanda, N. stocktonii, N. undulata* and *N. trigonophylla* were confirmed as sources for resistance to root parasite, *Orobanche*. Wild *Nicotiana* species belonging to sub-genera Tabacum and Petunioides were observed to show high variability for solanesol content. Wild *Nicotiana* species such as *N. suaveolens*, *N. kawakamii*, *N. hesperis*, *N. tomentosiformis* and one *N. tabacum* accession No. EC 554900 were confirmed as potential sources of high solanesol content (up to 3.15%).

2. Tobacco Cultivar Development

In Vertisols, two CMS hybrids, TBSH-1 and TBSH-2, which were identified as promising are undergoing multi-location trials under AINRP (T) and new CMS hybrids that showed 22 to 24% increase in leaf yield over best check, Siri besides possessing acceptable leaf quality are undergoing Station replicated yield trials. In NLS, promising CMS hybrid, NLSH-1 which showed significant superiority in productivity over check variety 'Kanchan' is undergoing multi-location test under AINRP(T). The hybrid also recorded lower tar content (18.18 mg/cigarette) than parent JS-78 (19.00 mg/cigarette) and check variety Kanchan (21.32 mg/cigarette) in Station bulk trial. In KLS, five advanced breeding lines, FCH 196, FCH 197, FCH 201 were contributed for multi-location testing under AINRP (T) and the lines FCH 221 and Line FCH 222 were identified as promising *Fusarium* wilt resistant advanced breeding lines.

In Burley tobacco, advanced breeding lines viz., YB-10 and YB-4 recorded 2,510 kg/ha and 2,324 kg/ha cured leaf with an improvement of 86 and 81%, respectively over the control Banket A1. One caterpillar resistant Chewing tobacco variety, Meenakshi CR was released for commercial cultivation in the inland tobacco zone of Tamil Nadu as a replacement for Meenakshi by the Tamil Nadu Tobacco Varietal Release Committee.

The release proposal of a *Bidi* tobacco variety, NBD 43 from Nipani centre was submitted to the Karnataka State Variety Release Committee. Initial varietal trials on FCV tobacco hybrids, FCV tobacco, *Bidi* tobacco and *rustica* tobacco lines were conducted and the promising entries were promoted to AVT in the respective centres. Four more FCV tobacco hybrids and three Chewing tobacco hybrids entered IVT during 2007-08. Bulk trials indicated the superiority of N 98 at Kandukur, Cy 149 at Rajahmundry and ABD 90 at Nandyal. FCV tobacco entries, V 4230 and V 4219 at Rajahmundry, KST 27 and KST 28 at Shimoga, CH 3 at Hunsur & Shimoga and CH 1 at Jeelugumilli and *Bidi* tobacco entries, NBD 159 and ABD 99 at Nandyal entered bulk trials in view of their superior performance in AVT.

3. Biotechnology for Tobacco Improvement

Coat protein gene of tobacco leaf curl virus isolated from tobacco plants collected from Khammam and Nellore districts of Andhra Pradesh was amplified and sequenced. Presence of Cry1A(b) and kanamycin genes in *B.t* transgenics was confirmed by using specific primers. *B.t* transgenics were found to produce 2.75 – 14.5 ng/g Cry1A(b) protein under tissue culture condition. Seventy five simple sequence repeat (SSR) markers specific to tobacco were developed and validated in

Nicotiana sp. and tobacco types. These SSR sequences were deposited in NCBI public domain. Genetic diversity in all flue-cured tobacco cultivars (24) was evaluated by using SSR markers and specific markers were developed.

4. Crop Production Technology

Combined inoculation of *Rhizobium* and PSB to blackgram seed increased the grain yield significantly as compared to single inoculation of either *Rhizobium* or PSB or no inoculation in NLS. Tobacco (with N=115 kg/ha) grown after sunnhemp (*in situ* green manuring) recorded significantly higher green leaf, cured leaf and grade index as compared to tobacco grown after other preceding crops. New suckericides, Flumetralin and Pendimethalin significantly reduced sucker number, sucker fresh weight and sucker dry weight as compared to control (Decanol@4%). Potassium nitrate was at par with potassium sulfate as a source of potassium as top dresser for flue-cured tobacco in NLS.

Application of FYM @ 7.5 t/ha + 22.4 kg N/ha produced significantly higher yields of green, cured, bright and grade index with an increased yield of 34, 34, 15 and 23 %, respectively over no FYM and no nitrogen in CBS. FYM at 15 t/ha and FYM + Neem cake (7.5 t/ha + 30 Kg N/ha) in combination with inorganic sources of nitrogen, P_2O_5 and K_2O improved the yields over their respective controls. In SLS, application of different organics, FYM, NADEP compost, vermicompost etc. improved cured leaf yields by 5.0 to 8.8% over control. Vermicompost (1.5 t/ha) proved superior followed by NADEP compost (3 t/ha) and FYM (3 t/ha) when applied in plant row plough furrows. One life saving irrigation at 30 mm depth utilizing water from farm ponds improved yields by 11.5% and additional net return was Rs. 3,785/ ha due to improved yield.

In KLS, confirmatory trial on efficacy of vermicompost application in FCV tobacco field crop revealed that vermicompost application @ 4 t/ha (at the time of planting) along with recommended NPK dose was optimum for getting maximum productivity and bright grade outturn. Integrated management practice involving 25% organic and 75% inorganic (25:75 ratio) was found more effective in increasing both cured leaf yield and top grade equivalent, compared to 50:50 or 75:25 ratios. Vermicompost was found to have better influence on growth and productivity than other organic manures like FYM or press mud. Application of 75% recommended N + 2.5 kg *Azotobacter* + 2.5 kg *Azospirillum* + 2.5 t FYM/ ha to FCV tobacco is recommended for higher yields and net returns to the farmers of Shimoga region in Karnataka.

In Tamil Nadu, application of 50% P + PSB in the first year and application of 75% P alone in the second year recorded higher whole leaf yield (2,669 kg/ha) in the second year. The total leaf yield was higher (3,444 kg/ha) in the second year when 100% P + PSB was applied in the first year and 100% P alone in the second year. Application of 50 kg K_2O/ha to chewing tobacco is recommend for adoption by the farmers in Tamil Nadu for higher net returns.

Application of recommended dose of fertilizer (220 kg N/ha) along with bio-fertilizer, *Azotobacter* @ 4.0 kg /ha (10^8 cfu^{-1}) to *Bidi* tobacco is recommended for maximizing yield and net returns to *Bidi* tobacco farmers of middle Gujarat Agro-climatic zone III. Planting of *Bidi* tobacco hybrid, GTH 1 in second fortnight of August with 45 to 60 days old seedlings is recommended to the farmers in middle Gujarat agro-climatic zone for maximizing yield and net returns. Green manuring with sunnhemp or FYM @ 12.5 t/ha was found effective in increasing the productivity of *Bidi* tobacco at Anand. A seed rate of 8 kg/ha is recommended for *Rustica* tobacco nurseries.

One furrow-irrigation during grand growth period (50-60 days after planting) to *Pikka* tobacco variety, Gajapati is recommended to the farmers of Orissa for improved productivity and quality of tobacco and for higher net returns.

5. Cropping Systems and Alternative Crops for Sustainable Production

Maize – Tobacco system can be recommended to the farmers in NBS as an alternative cropping system to sole tobacco and Soybean – Chickpea cropping system is a profitable alternative to FCV tobacco grown in the region.

6. Bio-ecological and Pathological Studies on Pests and Diseases

Incorporation of TMV resistance in Kanchan, Siri and Pyruvittanam is in an advanced stage.

7. Integrated Pest and Disease Management

Tobacco crop planted during the first week of October recorded the lowest incidence of major insect pests. The crop planted during the third week of October suffered from heavy damage by the aphid, *M. nicotianae*. During the early planting (20th September), the per cent infestation of *M. nicotianae* and *H. armigera* showed a significant negative correlation with minimum temperature. Maximum temperature and rain fall exhibited significant negative association with the incidence of *S. litura* during the late (20th October) planting in NLS.

Stem application of imidacloprid @ 1:30 and thiamethoxam @1:20 were able to check aphid infestation on FCV tobacco and supported higher natural enemy activity as compared to foliar spray of the insecticides. Proclaim (Emamectin benzoate) @ 11 g a.i./ha is highly effective against *S. litura* in tobacco seed beds and it was effective against *H. armigera* @ 22 g a.i./ha in the field crop. Clothianidin (Dantop) 50 WDG @ 22.5 g a.i./ha effectively checked aphids on FCV tobacco.

In KLS, copper hydroxide 77% schedule, either alone or in combination with metalaxyl MZ 72 WP was effective in controlling major soil-borne fungal diseases in FCV tobacco nursery viz., damping-off, blight, black shank, anthracnose and frog-eye spot. Combined application of *Pseudomonas fluorescens* @ 1 g/plant with *Aspergillus niger* enriched FYM @ 100 g/plant at the time of planting caused 61.4% reduction in wilt disease and 48% reduction in RKI under field conditions. Resultant increase in total cured leaf yield was 25.8% over untreated check. Integration of Carbofuran @ 10 g/m^2 with *Pseudomonas fluorescens* application @ 10 g/m^2 in neem cake (400 g/m^2) amended solarized nursery beds caused 48.3% reduction in soil nematode population and reduced the RKI to 2.10 compared to 3.72 in check. It also caused 52.7% increase in root- knot free healthy transplants yield compared to untreated check.

There was 16.25% increase in the yield of soybean in BIPM over farmer's practice. The parsitization of *H. armigera* and *S. litura* improved in tobacco to about 78% and 68%, respectively with trap crops (*Tagetes* for *H. armigera* and castor for *S. litura*) than without trap crops. Planting of marigold (single whorl) and *rustica* tobacco as border along with foliar spray of NSKS 0.5% on FCV tobacco proved effective in reducing the infestation of *H.armigera* in FCV tobacco and increased the trapping of budworm population. In SLS, the IPM Module containing the need based 'Bio and Chemical Control' was successfully demonstrated in 1 acre area under farmer's field condition.

In West Bengal, following bacterial drench inoculation (10^8 cfu/ml), the incidence of bacterial wilt of *Motihari* tobacco was significantly lower in the treatment : soil liming (@ 560 kg/ha) + Fallow for 30 days + Green manuring with *dhaincha*.

Sorghum as a barrier crop against aphid played a major role in obstructing the movement of aphid into the main field of *Bidi* tobacco at Nandyal. Frog-eye spot disease in *Bidi* tobacco can be managed by spraying of 0.05% carbendazim @ 600 l spray fluid/ha twice at an interval of 15 days starting from initiation of the disease. Next best is spraying of 0.1% propiconazole 25 EC @ 600 l spray fluid/ha twice at an interval of 15 days starting from initiation of the disease. Root-knot disease in *Bidi* tobacco can be managed by spot application of poultry manure @ 1 t/ha + carbofuron 3G @ 5 kg/ha at the time of

planting in Nipani area. These technologies are recommended to the farmers of Nipani area in Karnataka.

8. Soil Fertility, Water Quality and Nutrient Management

FCV tobacco growing soils of Chikkamagalur and Davanagere districts were moderately acidic, low in soluble salts and chlorides. Lime requirement of acid soils of Hassan district, Karnataka was between 1.2 to 1.7 t/ha. Chewing tobacco growing areas of Hiriyur taluk in Chitradurga district were alkaline, medium in soluble salts, high in chlorides, low in organic carbon, high in available phosphorus and medium in available potassium in surface as well as sub soils. Among all the P fractions, occluded Fe-P was maximum followed by Ca-P, Al-P and Fe-P. Southern black soils have higher amounts of each fraction compared to southern light soils of Andhra Pradesh.

9. Alternative Uses of Tobacco and Reduction of Harmful Substances

Foliar application of manganese sulphate significantly reduced TSNA (50.2%) in Burley tobacco, while exogenous application of ascorbic acid resulted in significant reduction (46.5%) in TSNA.

The maximum seed yield in *rustica* type SH - 30 was 1,384 kg/ha with 31.45% oil content and the oil yield was 435 kg/ha. *Bidi* tobacco genotype, ABD 36 recorded highest leaf protein yield (1,147 kg /ha) followed by *Bidi* tobacco variety, A 119 with 1090 kg/ha. *Bidi* tobacco variety, A 119 recorded highest seed yield (677 kg/ha) and seed oil (255 kg/ha) at Anand. However, oil content was higher in the genotype, 103-9-101 at 39.4% as against 37.64% in A 119. Significant improvement in seed yield, oil content and oil yield of chewing tobacco variety, A 145 was observed due to S application at Shimoga.

A number of O- alkylated xanthone, carbazoles and coumarins have been synthesized and screened for their *in vitro* anti-diabetic activity and compounds showing significant inhibition were identified. A patent (No. 211204) was granted for the invention "Process for purification of solanesol (95+%) from crude/enriched extracts of tobacco green leaf/tobacco cured leaf/tobacco waste"

10. Agricultural Extension and Information Technology

The Front Line Demonstrations conducted in NBS Zone indicated that the newly released variety, Siri performed better than the check, VT 1158. The Variety Siri yielded 300 kg more cured leaf per ha with 66.5% bright grades. The following programmes were conducted during the period: Training programmes (61), *Rytu sadassu*/Field day (4), Radio talks (21) and TV shows (2).

Databases of PERMISNET and Meteorological Database Management System were updated. New hyperlinks were created in CTRI website, www.ctri.org.in with 256 MB web space, as per the ICAR specifications, hosted in the internet and updated periodically.

INTRODUCTION

India is the 3rd largest producer and exporter of tobacco in the world. The country accounts for 10% of the area and 9% of the world's total tobacco production. Tobacco is cultivated in about 0.4 m hectares, i.e. 0.27% of the land area but accounts for about 4% of total Indian agri-exports. Tobacco crop also earns about Rs. 9,500 crores excise revenue to the national exchequer on the sale of tobacco products in the domestic market.

Tobacco production in India

The total tobacco production in India stands at 700 m kg out of which FCV tobacco constitutes 260 m kg. About 1,00,000 farmers raise the crop of FCV on an area of nearly 2.2 lakh hectares (Table 1). FCV tobacco productivity in India continues to be around 1,220 kg/ha, as compared to 1,950 kg/ha in Brazil and 2,400 kg in USA. However, when combined productivity of all types of tobaccos is considered, the average productivity of 1,800 kg/ha in India is more than the world average of 1,650 kg/ha.

Global tobacco situation

World flue-cured leaf production in 2008 is projected to decrease by 1.3% on the estimated production of 3,975 million kg. Reduction in production in some countries viz., Brazil, Canada, Philippines and South Africa and average weather conditions in most of African countries and USA are responsible for this reduction. Production increased in USA, China, India and Tanzania while it is almost constant in European Union, Indonesia, Uganda and Thailand. In Brazil, Argentina, Bangladesh, Malawi, Canada, Zambia, Philippines, South Africa and Zimbabwe FCV production has declined. It is predicted that Brazil will continue to dominate FCV production and USA will mostly meet its domestic needs. It is expected that India and Bangladesh will be benefited by the reduction in production in European Union after 2013 and African countries like Tanzania, Zambia, Malawi and Uganda will become potential producers. In this context, price/quality factors will continue to govern the tobacco trade. In most of the major flue-cured tobacco exporting countries, average farm prices, in U.S. $ terms, have increased in 2007, mostly due to the weakness of the US $ against the local currency and it is predicted that the increasing trend will continue.

Table 1: Soil region-wise area, production and productivity of FCV tobacco (2007)

Region	Area (ha)	Production (million kg)	Productivity (kg/ha)	Average price* (Rs/kg)
Andhra Pradesh				
NLS	24,838	47.72	1,921	54.13
SLS	63,873	57.75	904	44.86
SBS	32,364	54.85	1,695	45.38
CBS & NBS	5,814	11.63	2,000	43.08
Total for AP	**1,26,889**	**171.95**	**1,355**	**47.47**
Karnataka				
KLS	85,755	87.66	1,022	59.23
Grand Total	**2,12,644**	**259.61**	**1,220**	**51.44**

* 2007 AP auctions concluded on 27.07.2007

Exports

India exports unmanufactured tobacco and tobacco products to over 80 countries in the world. Since 2002-03, there is an upward trend in the exports of tobacco and tobacco products. Exports of unmanufactured tobacco during 2007-08 reached a new peak of 1,74,261 tonnes valued at Rs. 1,475 crores. Total exports of unmanufactured tobacco and tobacco products during the period recorded an all time high of 2,03,399 tonnes at a value of Rs. 2,021 crores (502 million US $). Exports of tobacco and tobacco products increased by about 13% in quantity terms and 17 % in rupee terms compared to 2006-07. In dollar terms, the increase is about 32%, surpassing the notional target fixed by the Government.

Unmanufactured tobacco: Apart from flue-cured tobacco, Burley, *Natu*, Oriental and Fire-cured tobacco are also exported. During 2007-08, exports increased by 14.5% in quantity terms and 19% in value terms compared to 2006-07. Unmanufactured tobacco exports from India accounted for about 85% of total exports in quantity terms and 73% in value terms. Of the total unmanufactured tobacco exports, FCV tobacco exports constituted 79% in quantity terms and 84% in value terms. FCV tobacco exports during 2007-08 totalled 1,37,779 tonnes valued at Rs. 1,242.14 crores as against 1,20,300 tonnes valued at Rs. 1,060.57 crores in 2006-07.

- Belgium and Russia are the major traditional markets for Indian tobacco, despite a significant decline in exports to Russia
- Philippines, Germany, Korea, Netherlands, South Africa, UK, Vietnam, Egypt and Nepal are the other important markets
- Exports to Western Europe increased by 20% in quantity terms and 19% in value terms

Tobacco products: The country exports tobacco products like cigarettes, *Bidi*s, branded chewing tobacco and hookah paste etc. These exports account for about 15% (in quantity terms) of total exports and in value terms, the share is about 27%. During 2007-08, exports of tobacco products increased by 8 % in quantity terms and 13% in value terms compared to last year, mostly due to the increase in exports of cut tobacco and chewing tobacco, by about 4% and 27% in value terms, respectively (Table 2).

Future

Since, Indian tobacco is acknowledged as a good filler tobacco, efforts must be made to project its image so as to find customers on permanent basis. As India is a signatory to the World Health Organization (WHO) - Framework Convention on Tobacco Control (FCTC), it is required to considerably reduce tobacco production by the year 2020. Thus, there is a need to reorient the research programmes keeping in view the obligations and government policies.

Mission

Developing economically viable and eco-friendly agro-technologies for enhancing productivity and quality, reducing harmful substances, developing value-added products for promoting exports and generating revenue and employment on a sustainable basis.

Vision

Enhancing productivity and quality of Indian tobacco to make it more remunerative, globally competitive and promoting alternative uses to sustain the crop in the country.

Mandate

- To conduct research on different types of tobacco, with greater emphasis on exportable types, on all phases of production management with a view of

Table 2: Trends in exports of tobacco products (2007-08)

Product	Export status in 2007-08 compared to 2006-07	Important markets and quantity exported in Tonnes
Cigarettes	9% decline in volume	USA, UAE, Saudi Arabia, Philippines and Singapore
Cut tobacco	11% increase	UAE:1,685, Yemen: 481, Iraq: 492, Cyprus: 490 and Cambodia 463
Chewing tobacco	40% increase in quantity terms and 27% in value terms (Significant increase in exports to Afghanistan, UAE and Malaysia)	UAE: 5,004, Afghanistan: 1,293, Yemen: 623, USA: 207, Nepal: 185, Saudi Arabia: 281 and Malaysia: 333
Hookah tobacco paste	1% increase in quantity terms and 8% in value terms (Brazil and South Africa are emerging as potential customers)	Saudi Arabia: 10,020, France: 103 and UAE: 181
Bidis	7% decline in quantity terms and 13% increase in value terms	UAE: 704, Afghanistan: 110, USA: 51, Iran: 47 and Singapore: 35
Snuff	~ 70% increase	China: 46 (31% of total exports), Saudi Arabia, UAE, Yemen and USA

attaining economic advantage/ benefit to the tobacco growers through improvement in quality and quantity of tobacco

- To collect tobacco germplasm from world over and to maintain and operate tobacco genetic resources which will be made available to scientists and National/ International Institutions
- To conduct research on economically viable and sustainable cropping systems
- To conduct research on diversified uses of tobacco and development of value-added products (phytochemicals)
- To produce and distribute quality seeds of notified varieties of tobacco
- To publish and disseminate research findings and recommendations of latest technology for the benefit of the tobacco growers, scientific community, policy makers and development agencies

Major Research Programmes

1. Germplasm Resource Management
2. Tobacco Cultivar Development
3. Biotechnology in Tobacco Improvement
4. Crop Production Technology
5. Cropping Systems for Sustainable Production
6. Bio-ecological and Pathological Studies on Pests and Diseases
7. Integrated Pest and Disease Management
8. Soil Fertility, Water Quality and Nutrient Management
9. Alternative Uses of Tobacco and Reduction of Harmful Substances
10. Agricultural Extension and Information Technology

Thrust areas and milestones identified for Tobacco Research in XI Plan

1. Improving the productivity, quality and profitability of tobacco

- Development of high yielding varieties through hybrid/ conventional breeding technologies
- Producing flavourful and superior quality filler FCV tobacco to meet the export demands
- Development of pest and disease resistant cultivars through conventional/ Biotechnological approaches
- Gene pyramiding for developing durable resistance to biotic stresses and for stabilizing productivity
- Reducing the cost of production through mechanization in tobacco cultivation and fuel efficient technologies for flue-curing and identification of alternate fuels for curing in lieu of coal/ wood
- Production and distribution of pure seeds and seedlings of high yielding varieties of tobacco to the farming community
- Developing molecular markers for selection and maintaining varietal integrity

2. Nutrient, water and IPM strategies for resource-use-efficiency

- Improving the nutrient-use-efficiency through INM approach
- Improving the water-use-efficiency through micro-irrigation systems and watershed management technologies
- Development of IPM modules for different pests and diseases to produce pesticide residue-free tobaccos for increasing the tobacco exports
- Transfer of proven agro-technologies to farming community for maximizing the profitability

3. Remunerative cropping systems for different agro-climatic zones

- Development of profitable cropping systems for different tobacco growing areas
- Development of profitable alternative crops for unsuitable and uneconomical tobacco growing zones
- Nutrient and water management strategies in different cropping sequences

4. Reduction of harmful substances in tobacco and tobacco products

- Development of suitable agro-techniques for reduction of TSNA in tobacco and tar, nicotine, carbon monoxide in tobacco smoke
- Reduction of harmful constituents in tobacco through exogenous application of chemicals like potassium salts.
- Reduction of harmful constituents through modification of manufacturing technologies of tobacco products

5. Alternative uses of tobacco and their commercialization

- Extraction, purification and enrichment of value-added phytochemicals viz. nicotine, solanesol and solanesol derivatives from tobacco/ tobacco waste
- Development of technologies for extraction of quality protein, vaccines, enzymes, flavour chemicals etc. from tobacco
- Development of technologies for utilization of tobacco seed oil for edible purposes
- Commercialization of the above technologies for sustainable tobacco production and exports

Keeping in view the research priorities, the following new projects have been approved by the Institute Research Committee (IRC) in 2007.

1. Screening for higher seed yield and oil recovery in *Jat*i *N. tabacum* (L.) tobacco accessions in North Bengal
2. Response of Burley tobacco (var. Banket A1) to varying levels of vermicompost and nitrogen
3. Nutrient budgeting for FCV tobacco variety Kanchan in irrigated Alfisols
4. Effect of different chemicals on sucker control in FCV tobacco under SLS
5. Agro-techniques for productivity enhancement in FCV tobacco under SLS conditions
6. Agronomic evaluation of promising FCV tobacco pipeline varieties (FCH 196 and FCH 201) in KLS
7. Feasibility of producing organic tobacco under KLS situation
8. Spacing cum nitrogen requirement for the early maturing *Motihari* tobacco pipeline
9. Fertigation system for tobacco nurseries to reduce labour and to improve water and nutrient use-efficiency
10. Bale pressing and packing machine for marketing of FCV tobacco
11. Bio-ecology and management of tobacco aphid under SLS conditions
12. Evaluation of FCV tobacco germplasm for the tobacco caterpillar/aphid tolerance under SLS conditions
13. Evaluation of organics enriched with bio-agents in integration with soil solarisation against root-knot nematodes in FCV tobacco nursery
14. Influence of curing on chemical composition of chewing tobacco
15. Characterization of soil phosphorus and potassium in FCV tobacco growing soils of Karnataka
16. Nitrogen nutrition of FCV tobacco
17. Effect of K mobilizing bacteria and VAM on the growth, yield and quality of NLS tobacco
18. Prospects biofertilizers in tobacco nursery management

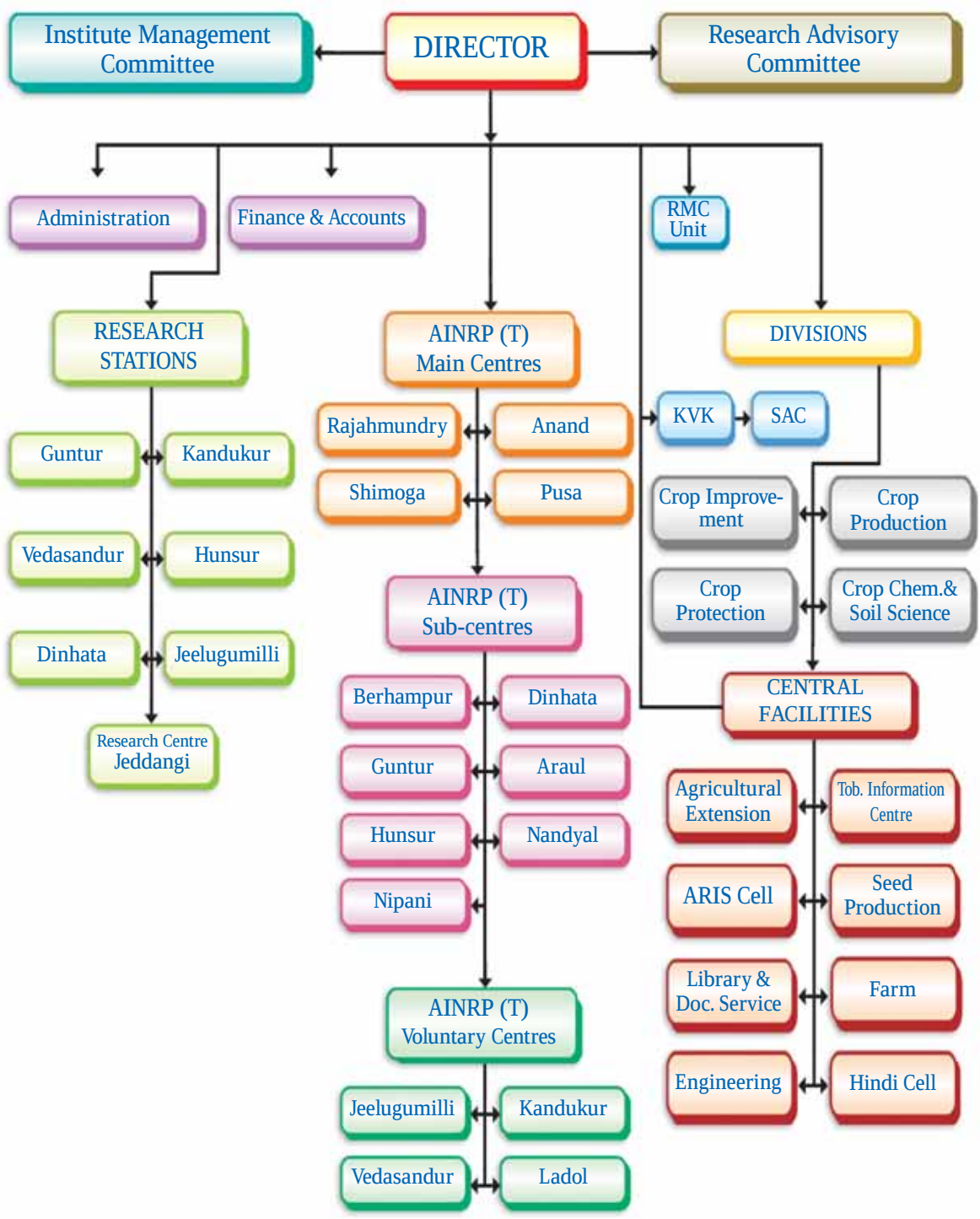
STAFF POSITION AS ON 31.03.2008

Sl. No	Category	Sanctioned Strength	In Position	Vacancies
1.	Scientific	78+1	39+1	39
2.	Technical Category III (T-6 to T-9) Category II (T-II-3 to T-5) Category I (T-1 to T-1-3)	 05 54 93	 4 49 90	 1 5 3
3.	Ministerial	77	70	7
4.	Supporting S.S.Gr.IV S.S.Gr.III S.S.Gr.II S.S.Gr.I	 19 40 65 57	 19 36 59 45	 Nil 4 6 12
5.	Casual workers on Temporary Status in position		136	

FINANCIAL STATEMENT FOR THE YEAR 2007-08

Head of Accounts	Rupees in lakhs	
	Budget Grant	Expenditure
Non-Plan	1,227.00	1,227.00
Plan	125.00	125.00
KVK	53.77	53.27
AP Cess Fund Schemes	3.53	0.35
Pension & Retirement Benefits	300.01	299.76
'P' Loans & Advances	18.00	18.00
'R' Deposit Schemes	26.71	8.15
Revolving Fund Scheme	148.76	82.03
Internal Resource Generation	38.58	16.34
Total	1,941.36	1,829.90
Revenue Receipts	125.00	127.16

ORGANISATIONAL STRUCTURE



Research Achievements

PROGRAMME 1 GERMPLASM RESOURCE MANAGEMENT

CTRI, Rajahmundry

Germplasm acquisition, maintenance, evaluation and utilization

(R.V.S. Rao and T.G.K. Murthy)

Acquisition

Seventeen tobacco germplasm accessions were acquired from USA. Out of which, TC-540 (Samsun NN), TC 551 (Xanthi NN), TC 553 (Xanthi NC), TI -1407, TI 1459, TI-1462, TI-1463, TI-1473,TI -1492, TI-1500, TI-1501, TI-1504, TI-1507 (Sirogo), TI-1508 (Sirone) and Bel.61-10 are resistant to Tobacco Mosaic Virus (TMV) and two lines, TW 36 (*N. debeneyi*) and TW 67 *(N. goodspeedi)* are resistant to *Perenospora tabacina*. Also, 3 Burley hybrids viz., ITB-221, ITB - 573 and ITB-574 were imported from France and 4 indigenous lines (two each of *N. tabacum* and *N. rustica*) were collected from Assam.

Maintenance

Out of 2,383 total genetic stocks, 973 genetic stocks comprising 451 FCV varieties and 522 non-FCV varieties were rejuvenated. Fifty two CMS lines of different sources were maintained.

Conservation

All the new germplasm accessions acquired during past five years were sent to NBPGR along with feed back information for long term conservation.

Seed supply

About 280 germplasm accessions were supplied to 19 indenters for research purpose.

Screening against Tobacco Mosaic Virus Disease (in collaboration with the Division of Crop Protection)

New Germplasm Accessions (2006): The following nine exotic CMS hybrids were resistant: GL 26 H, NC 297, PVH O3, PVH-09, NC -100, PVH-20, PVH-50, PVH 51 and RGH 04.

Trial VT-13: Out of 9 advanced breeding lines screened for resistance to TMV under artificial inoculation, five lines viz., R2-3, R10-1, R 23-1, R 48-1 and R 85-1 were resistant.

Screening against insect pests (in collaboration with the Division of Crop Protection)

Stem Borer	:	Exotic germplasm, lines NC 71 and Candel recorded least (33.5%) infest of stem borer. Indigenous lines **Putcha** and Karedu recorded the least (37.5%) infestation.
Aphids	:	C 110, CU 1097 (no infestation).
Whitefly	:	V.373, CU 1097s (no infestation).
Budworm	:	C110, CU 1097, V 373; advanced derivatives of crosses, Hema x CU1097, VT 1158 X V 373 (no infestation).
Caterpillar	:	C 110, CU 1097, V 373 (showed 0.28, 0.2 & 0.8 infestation score); advanced derivatives of cross Hema x CU1097 (1.00)

Evaluation

1. Seed oil content (in collaboration with the Division of Crop Chemistry and Soil Science)

The oil content in 104 non-FCV germplasm accessions varied from 19.61- 39.01%, the highest being recorded by *Bidi* cultivars.

Type	Oil content (%)
Non- FCV (104)	
Exotic air-cured (52)	20.88-38.15
Japanese air-Cured (13)	19.61-33.33
Turkish - Chemical Mutant (1)	30.43
Chewing (TN) - PV-7 (1)	25.48
Bidi (24)	27.11-39.01
Burley (13)	25.12-32.37

2. Leaf yield and quality

(a) Trial VT- 13

Nine advanced cross derivatives along with three standard checks Siri, VT 1158 and Hema were evaluated for leaf yield characteristics during 2006-07 in a RBD with 3 replications. Line R 2-3 (green leaf : 15,600 kg/ha; cured leaf: 2,294 kg/ha; bright leaf: 1,267 kg and grade index: 1,890) was found to be significantly superior to best check Siri with an increase of 30% green leaf yield, 28% for cured leaf, 32% for bright leaf and 27% for grade index. Also, lines R 48-1 and R-55 -1 recorded significant superiority over Siri for bright leaf yield. Chemical quality parameters like nicotine, reducing sugars and chlorides were mostly within acceptable limits in the test entries.

(b) Trial HRET -2 (Hybrid Replicated Evaluation Trial)

Eight CMS hybrids were evaluated for yield and chemical quality of cured leaf along with three checks during 2006-07 in a RBD with 3 replications. The hybrid HR-1, with 15,401 kg/ha green leaf yield, 2,306 kg cured leaf, 1,158 kg bright leaf and 1,878 grade index, was significantly superior to check Siri and showed 22%, 28%, 18% and 21% increase, respectively for these traits. The hybrids had acceptable levels of nicotine, reducing sugars and chlorides in the cured leaf.

Documentation

Catalogue on FCV and Non-FCV tobacco germplasm was documented.

Maintenance of the genus *Nicotiana*

(T.G.K. Murthy and R.V.S. Rao)

Under the Genetic Resources Management Programme, the Division has been maintaining germplasm of all types of tobacco including wild species of the genus *Nicotiana*.

Maintenance

During the season, 137 accessions of 53 *Nicotiana* species and two sub-species were maintained in pots or experimental micro-plots. Four non-flowering species were rescued through *in-vitro* micropropagation. Fifty eight accessions were rejuvenated at Katheru farm. Two accessions of wild *Nicotiana* species viz., TW 36 and TW 67 were newly added to the list of wild germplasm. Also, one autotetraploid of *N. longiflora* and two species hybrids viz., *N. excelsior x N. glutinosa* and *N. gossei x N. glauca* and four stabilized derivatives of interspecific crosses, *N. x umbratica-nesophila, N. x benthamiana-repanda, N. x repanda-sylvestris* and *N. x excelsior-plumbaginifolia* were maintained.

Evaluation

a. Seed oil content

Seed samples of 44 species, including earlier identified high (about 42-43%) and low (~ 21%) oil containing species were processed for analysis of seed oil content and fatty acid profile in collaboration with Division of Crop Chemistry and Soil Science.

b. Solanesol content

During 2006-07 season, air-cured leaf samples of 102 accessions belonging to 50 species were used for estimation of solanesol content in collaboration with Division of Chemistry.

Nicotiana species exhibited wide variability for solanesol content in cured leaf. The content varied from non-detectable levels in *N. arentsii* and *N. obtusifolia* to 3.15% % in *N. tomentosiformis*. Also, pronounced intraspecific variation was observed. Following species showed high solanesol content.

	2006-07	2005-06
N. hesperis TW 69	0.85-2.10	2.55
N. kawakamii TW 72	1.95	3.20
N. suaveolens TW 133	0.75-1.25	2.70
N. tabacum EC554900	0.75-2.25	4.70
N. suaveolens EC554943	0.80-1.95	3.90
N. tomentosiformis TW 142	3.15	0.10

Seasonal and growth variations appear to play a major role in solanesol content in a given genotype. The solanesol content in wild species during 2005-06 season was, in general,

higher than that observed during 2006-07, while lowest values were recorded during 2004-05 season. As compared to sub-genus *Rustica*, the other two sub-genera viz., Tabacum and Petunioides showed more variability for solanesol content. Also, most of the high solanesol species belong to these two sub-genera. Among taxonomic sections, Tomentosae, Genuinae and Suaveolentes showed wide variability for solanesol content.

Sub-genus	Section	Solanesol content (%)
Rustica	Rusticae	0.05-0.20
	Paniculatae	0.05-1.35
	Thyrsiflorae	0.25-0.55
Tabacum	Tomentosae	0.10-3.20
	Genuinae	0.20-4.70
Petunioides	Undulatae	ND - 0.15
	Trigonophyllae	ND - 0.15
	Alatae	0.05-1.15
	Repandae	0.10-0.95
	Noctiflorae	0.45-1.00
	Acuminatae	0.05-0.25
	Bigelovianae	0.05-0.60
	Nudicaules	0.10-0.30
	Suaveolentes	ND - 3.90

Identification of sources for high solanesol content among wild *Nicotiana* species in this study indicates the scope for their exploitation for phytochemical production.

c. Reaction to *Orobanche* infestation

During the 2006-07 season, 60 germplasm accessions including 13 lines of *N. tabacum*, two cultivars (Hema and VT 1158) and 44 wild species were screened for extent of *Orobanche* infestation under severe natural infestation condition facilitated by irrigating the plots at 40 and 55 days after transplantation.

Level of infestation: The infestation was 85% in variety Hema and 100% in released variety, VT 1158. Among the thirteen *N. tabacum* germplasm lines, the infestation varied from nil in EC 554929 to 100% in EC 554884. In general, the extent of infestation in wild *Nicotiana* germplasm was less as compared to *N. tabacum* lines. It was nil in species viz., *N. repanda* (3 accessions), *N. stocktonii* (2 accessions), *N. trigonophylla, N. undulata* and *N. occidentalis* (TW91) in addition to seven others (Table 1), while *N. gossei recorded* 85% infestation. Autotetraploid *N. longiflora* (ITB 520) was observed to be free from *Orobanche* infestation, whereas its diploid counterpart showed 43% infestation.

Number of spikes per plant: In the susceptible cultivars, the mean number of spikes per plant

Table 1: Overall reaction of species of different subgenera and sections to *Orobanche*

Subgenus	2005-06	2006-07	Mean
Rustica	**14*** Ru-14, Pa-14	**40** Ru-21, Pa-46	**30** *Ru-19*, Pa-33
Tabacum	**66** To-11, Ge-81	**51** To-71, Ge-48	**55** To-48, Ge-57
Petunioides	**15** Un-0, Tr-4, Al-12, Bi-3, Re-0, Nu-6, Su-25	**16** Un-0, Tr-45, Al-18, Re-2, Nu-10, Su-19	**17** *Un-0*, *Tr-28*, Al-15, Bi-3, *Re-1*, Nu-7, *Su-22*

Ru- Section Rusticae, Pa- Paniculatae, To-Tomentosiformae, Ge- Genuinae, Un- Undulatae, Tr- Trigonophyllae, Al- Alatae, Bi- Bigelovianae, Re- Repandae, Un- Nudicaules, Su- Suaveolentes; * Mean infection

was 6.7 for Hema and 17.0 for VT 1158, while in *N. tabacum* germplasm accessions, the number varied from 0 (EC554929) to 7.7 (EC554884). The wild *Nicotiana* species in general, supported less number of spikes and the mean values varied from 0 in 15 accessions to 9.1 in *N. glauca*.

Results of studies made under natural and artificial inoculation conditions during 2005-06 also revealed that species viz., *N. repanda, N. stocktonii, N. trigonophylla, N. bigelovii, N. rotundifolia* and *N. occidentalis* among others were resistant to *Orobanche* infestation. Therefore, these species can be considered as promising against *Orobanche* infestation. Intensive screening under artificial inoculation is required to be undertaken in collaboration with Plant Pathology for identifying a reliable and cross compatible *Nicotiana* species for immediate use in tobacco cultivar improvement programmes.

Among the three sub-genera of genus *Nicotiana*, Petunioides seems to be a good source of resistance to *Orobanche*. Within the sub-genus, Petunioides, taxonomic sections such as Undulatae and Repandae appeared to be more promising than others.

Germplasm enhancement

Morphological variants were identified in *N. excelsior* and *N. gossei*. There was no chromosomal variation in these variants. Also, natural hybrid of cross, *N. excelsior x N. glutinosa* was identified. The hybrid was completely sterile and produced flowers which were intermediate in morphology between the parents. The nature of branching leaf shape and size were also intermediate between the parents. The hybrid was micropropagated for increasing the population size and inducing fertility.

Seed distribution

Seed samples of 32 wild species were supplied to 8 researchers from various universities/ institutes during the year.

CTRI Research Station, Hunsur

Germplasm maintenance of *Nicotiana tabacum* varieties/lines

(K.N. Subrahmanya and M.M. Shenoi)

Nine new genotypes were added to the gene bank during the year. Active stock of 613 germplasm accessions is maintained. Under the periodical seed multiplication programme, 230 germplasm accessions were regenerated.

CTRI Research Station, Vedasandur

Evaluation and maintenance of germplasm

(K. Palanichamy)

Maintenance of germplasm

As a regular programme, 85 chewing and 60 cigar and cheroot germplasm accessions were raised, self pollinated and seed collected for maintenance at CTRI Research Station, Vedasandur.

Maintenance of male sterile lines

Cytoplasmic male sterile lines of sun-cured, smoke-cured and pit-cured chewing tobacco varieties viz., Bhagyalakshmi, Meenakshi, Abirami, Vairam, Maragadam, PV.7, I 115, VTK 1 and VR 2 were crossed with their respective fertile counterparts and seeds collected for maintenance of the male sterile lines.

Response of varieties to curing methods

The objective of the study is to assess the differential influence of curing methods on the chemical attributes of the cured leaves of different varieties in respect of nicotine, chlorides, solanesol , TSNA etc. Harvested leaf produce of 12 commercial varieties and 4 traditional cultivars (Thatyan, Karuvanikkarai, T.N.Palayam and Sekandimonnai) was subjected to three different methods of curing viz., Sun, Pit and Smoke curing. There was a significant reduction in nicotine on smoke-curing and to a lesser extent on pit-curing. The reducing sugars also showed appreciable

reduction on pit-curing as compared to sun-curing. There was a slight increase in chloride levels on smoke-curing. Differential varietal response was evident (Table 2).

Evaluation of smoking quality of cigar wrapper leaves

Smoking quality evaluation of cigar wrapper leaves of four cigar wrapper varieties viz., Corojo Special, Havana PR, Dixie Shade and RG raised under three cultural conditions viz., Hessian cloth enclosure, 75% shade net (HDPE) and open at Thandikudi hill (Elevation 1150 m) in Dindigul district, and aged for one year was carried out as per standard score card system with the help of an experienced tester.

The highest mean smoking quality score of 35.0 (33.3 last year) out of 40 was recorded in the leaf from the crop raised under Hessian cloth followed by 29 in shade net compared to 26.5 in the open grown crop. Differential varietal response was also noticed. While Dixie shade recorded the maximum score of 35 under shade net followed by Habana Giant with 31, these varieties were on par with a score of 37 out of 40 under Hessian cloth tent. Ageing thus, appeared to improve the smoking quality of cigar wrapper leaves.

Evaluation of Black shank resistant lines

Three chewing tobacco lines viz., BC.5 S1, BC.5 S2 and BC.5 S3 developed through back cross breeding involving the coastal chewing tobacco variety VR.2 as the susceptible recurrent parent and Beinhart 1000- 1 as the resistant donor by raising the segregating progenies over 6 seasons under sick plot conditions were evaluated for productivity along with the checks VR.2 and Kaviri in RBD with 4 replications at CTRI Research Station, Vedasandur and bulk plots at Ayyakkaranpulam in coastal Vedaranyam area in 2006-07.

At CTRI Research Station, Vedasandur, the yield differences were found significant for both whole and total leaf yields. Line BC.5 S1 and BC.5 S3 were significantly superior to VR.2 recording 3,194 and 3,361 kg/ha of whole leaf respectively but were on par with the check Kaviri. In total leaf also the trend was same with the two lines recording 4,398 kg/ha and 4,463 kg/ha respectively compared to 3,843 kg/ha of the best check Kaviri.

In the bulk trial at Vedaranyam both BC.5 S1 and BC.5 S2 recorded higher cured leaf yield of 3,323 and 3,100 kg/ha, respectively compared to 3,000 kg/ha of VR.2 and 3,350 kg/ha of Kaviri.

CTRI Research Station, Dinhata

Maintenance of *Jati*, *Motihari* and other types of tobacco germplasm

(S. Amarnath)

Ten plants of each of the following 229 lines of *N. tabacum* (*Jati*, Cigar Wrapper and Cigar Filler) and 175 lines of *N. rustica* (*Motihari*) tobacco were grown and 3 healthy plants in each line were selfed. Selfed seeds of each line were collected separately for use in the ensuing season.

Table 2: Influence of curing method on chemical composition of chewing tobacco

Constituent (%)		Sun-curing	Smoke-curing	Pit-curing
Nicotine	Mean Range	3.79 3.02 - 4.42	1.75 1.62 - 1.90	2.98 2.23 - 3.58
Reducing sugars	Mean Range	0.46 0.05 - 0.90	0.54 0.22 - 0.82	0.21 0.07 - 0.38
Chlorides	Mean Range	4.52 4.01 - 5.16	5.48 5.28 - 5.67	4.67 4.37 - 5.23

Evaluation of *Jati* tobacco germplasm

Thirty entries of *Jati* tobacco from genetic stock available at this Research Station were evaluated for their growth, yield and quality. Results of statistical analysis of results indicated that cultivar J-1(36.1 cm) with desirable height, HDJ-**2** with maximum leaf length (64.3 cm), breadth (46.7 cm) and area (2005 cm^2); HDJ-3 with highest number of leaves (11.4), Chhotamani with highest cured leaf yield (1,728 kg/ha), first grade leaf (879 kg) and maturity score (3.17) appeared promising for use in hybridization programme aimed to evolve superior *Jati* tobacco varieties for North Bengal region.

Demonstration trials in Assam

In order to popularize the high yielding tobacco varieties viz., Manasi and Dharla in Assam, demonstration trials were conducted in several farmers' fields in five districts (Kokrajhar, Bongaigaon, Goalpara, Kamrup and Borpeta). The cured leaf yield obtained in nine farmers' fields of three districts viz. Kamrup, Goalpara and Bongaigoan ranged from 960 to 1,875 kg/ha.

Evaluation of new cultivar

Seed from fifty plants of a new *Hookah* tobacco cultivar C-304 was collected from Bawal Research Station, Haryana and evaluated under topped and untopped conditions for growth, morphological characters and cured leaf yield. Morphologically, the plant appeared to be of *N. tabacum* type. The data indicated that height, leaf length, leaf breadth, leaf area, number of leaves and internodal length decreased due to topping whereas green leaf, cured leaf and first grade leaf yields increased due to topping. The cured leaf and first grade leaf yields were 699 and 176 kg/ha, respectively under topped condition.

Exploration for land races in Assam

In order to collect the seeds of tobacco varieties grown locally in different villages/ areas of Assam, few villages in the districts of Goalpara and Bongaigaon were surveyed. Seeds of the following three local cultivars of *N. tabacum* and two cultivars of *N. rustica* were collected for their characterization of morphology and yield and quality evaluation.

N. tabacum
Cultivar-1-Tambaku collected from Vaayada and Hudakhona villages in Goalpara district , Assam
Cultivar-2-Rangpur local collected from Hudakhona village in Goalpara district, Assam
Cultivar-3- Saada collected from Nabang village in Goalpara district, Assam
N. rustica
Cultivar-4-Bengtuli Saada collected from East Ankorbari village in Chirang district, Assam
Cultivar-5-Bengtuli Saada collected from East Ankorbari village in Bongaigaon district, Assam.

PROGRAMME 2

TOBACCO CULTIVAR DEVELOPMENT

BREEDING FOR YIELD IMPROVEMENT

CTRI, Rajahmundry

Evolving superior varieties of FCV tobacco through hybridization

(P.V. Venugopala Rao)

Sub-project Br. 2 (a) VII: Evaluation of advanced breeding lines for yield and quality

Yield parameters

A replicated trial was conducted for the second year with seven advanced breeding lines viz., V-4262, V-4263, V-4269, V-4270, V-4272, V-4278 and V-4280 along with the check varieties VT 1158 and Hema. The leaf yield was significantly higher in lines viz., V-4270 and V-4280. Line V-4270 recorded 1,873 kg/ha cured leaf yield, followed by V-4280 (1,764 kg/ha). The yield improvement, over the better control VT 1158 (1,431 kg/ha) was 31% in V-4270 and 23% in V-4280. In bright leaf yield and grade index also, the two lines showed 32 & 22% and 29 & 22% increase over VT 1158, respectively. Chemical quality parameters like nicotine, reducing sugars and chlorides were within acceptable range in the test entries.

Sub project Br. 2 (a) VIII: Evaluation of advanced breeding lines for yield and quality

Yield parameters

Nine advanced breeding lines viz., V-4339, V-4340, V-4343, V-4344, V-4350, V-4351, V-4361, V-4362 and V-4267 were evaluated against three controls viz., VT 1158, Hema and Siri in a replicated trial and following lines were promising with significant yield improvement over best check Siri.

Green leaf: V-4343 (10,804 kg/ha; 21% increase), V-4367 (10,567 kg; 18% increase)
Cured leaf: V 4347 (1,609 kg/ha; 13% increase), V-4343 (1,604 kg/ha; 12.6% increase)
Bright leaf: V-4367 (1,098 kg/ha; with 21% increase)
Grade index: V-4367 (1,379 kg/ha; 17% increase over Siri)

Chemical quality parameters like nicotine (1.22 - 3.47%), reducing sugars (10.1 – 17.6%) and chlorides (0.46-1.13%) were within the acceptable limits.

Preliminary evaluation of advanced breeding lines

Forty six advanced breeding lines, V-4368 to V-4410, were evaluated in a row trial along with the control VT 1158, Hema and Siri to identify the potential lines with higher yield. Based on the results, the lines V-4377, V-4379, V-4380, V-4388, V-4391, V-4392, V-4393, V-4404 and V-4405 (which produced more than 200 kg cured leaf yield over Siri and with a bright grade out turn of 60% and above) were selected for further evaluation during 2007-08.

Evaluation of advanced breeding lines for yield and quality

(K. Sarala, R.V.S. Rao, P.V. Venugopala Rao and T.G.K. Murthy)

Replicated trial (1st year)

Two low tar lines, two somaclones, six advanced breeding lines and one interspecific hybrid were tested in a replicated trial along with three controls, Hema, VT 1158 and Siri. Except for grade index, which was significant, all the other leaf yields were non-significant. RS-6 recorded maximum cured leaf yield of 2,530 kg/ha. None of the lines were found to

be significantly superior to Siri in grade index. Maximum number of curable leaves was recorded by RS 8 (28), leaf length by RS 5 (61 cm) and leaf width by JS 131 (31 cm). Chemical quality parameters like nicotine, reducing sugars and chlorides were within the acceptable limits. Among the 19 breeding lines tested for TMV resistance, Cy 159, Cy 161, Cy 163, Cy 164 and Cy 165 were found to be resistant.

CTRI Research Station, Jeelugumilli

Evolving FCV tobacco varieties having high yield and better quality suitable for NLS area of Andhra Pradesh

(T.G.K. Murthy)

Preliminary evaluation of advanced breeding lines

A single plant progeny-row trial was conducted with 58 selections (F_6-F_9) along with the check variety Kanchan to identify selections suitable to NLS area. Twenty five of the selections were found to be morphologically uniform. Cured leaf yield varied from 1,430 to 3,160 kg/ha among the advanced lines and the most promising were: M31N5VT, 323K, 170-4-1 and 56-12-1. Twenty one single plant selections showing good plant type and leaf characteristics suitable for NLS besides high yield potential, were advanced for further evaluation. Also, four semi-dwarf selections (RT 9 to RT 12) with compact plant type and very short internodal length, suitable for close spacing, were also identified.

Generation advancement and selection

F_3, F_4 and F_5 progenies of 38 crosses involving Kanchan as one of the parents were raised and eight single plant selections showing plant type suitable to NLS besides having high leaf number were advanced. Also, F_4 progeny crosses involving Kanchan and aromatic lines, Soluky and Izmir were grown. Three selections with suitable plant habit, small leaf size and yield were made and advanced for further studies.

Evaluation of advanced breeding lines in replicated yield trials

a. Trial RYT-6 (3rd year): Combined statistical analysis of the yield data collected on ten medium cast advanced breeding lines evaluated over three seasons (2004-07) along with check, Kanchan revealed significant differences between entries for all the yield traits. Five of the ten advanced breeding lines out yielded the best check, Kanchan for all the yield traits. The increase in yield traits was 12-28% in green leaf, 7-25% in cured leaf and 12-29% in grade index in these lines. Based on overall performance, lines RT86-1, RT48-2 and RT100-1 were identified as most promising for further testing. The lines showed increase of 14-28% in green leaf yield, 12-25% in cured leaf and 14-29% in grade index over Kanchan (GLY: 11,400 kg/ha, CLY: 2,050 kg/ha, GI: 1,110 kg/ha). Seasonal differences were significant and yield levels during the 2006-07 season were higher compared to other two seasons. Season x entry interaction was significant for all the four yield traits.

b. Trial RYT-7 (1st year): Eight stabilized intra- and interspecific cross derivatives were evaluated along with checks Kanchan and CM-12 in a RBD with three replications for yield and leaf quality traits. Although six lines showed significant increase in yield over Kanchan with 16-30% in green leaf and 17-30% in cured leaf, only three lines (99-13-18, H-60 and H-17) exhibited improvement in overall grades. Cured leaf colour, size and weight were good in lines 99-13-18, 78-21-11, H48-1, Kanchan and 7-20 -12 in that order. Advanced line 99-13-18 showed desirable cured leaf chemical quality parameters (nicotine: 2.3%, reducing sugars: 12.9%, chlorides: 1.0%) as compared to all other entries in the experiment.

c. Trial RYT-8 (1st year): Another set of eight advanced intra- and interspecific cross derivatives were evaluated along with checks Kanchan and CM-12 in a RBD with three

replications for yield and leaf quality traits. Only one line, 323K-31-1 showed significant increase in yield over Kanchan with 38% in green leaf (15,222 kg/ha), 39% in cured leaf (2,690 kg/ha) and 36% in grade index (1,721 kg/ha). Therefore, the line 323K-31-1 will be further advanced in a new replicated trial along with lines 99-13-18 and H48-1 which were identified as promising in the trial RYT-7. Advanced lines, 323K-31-1 and RT35-1 possessed desirable chemical quality parameters as compared to the other test entries in the experiment.

d. Trial RYT-9 (1st year): A third set of nine medium green cast advanced breeding lines (intra- and interspecific cross derivatives) were evaluated along with check Kanchan for yield and leaf quality traits in a RBD with three replications. Three lines viz., 312MC-1, JL130-3 and 325X1-5D showed vigor for vegetative growth and leaf size. The three lines also showed significant increase for green and cured leaf yields and grade index over check, Kanchan. The increase was 21-41% for green leaf, 22-41% for cured leaf and 26-42% for grade index in these lines. In general, the test entries along with check, Kanchan showed desirable physical attributes such as size, body and colour of cured leaf. The trial will be repeated during 2007-08 season. The contents of nicotine, reducing sugars and chlorides were, in general, within prescribed limits in the test entries.

Evaluation of pure line selections in variety Kanchan (3rd year)

In the variety Kanchan, a few distinct morphological selections were made. Some of these selections were found to be true breeding for plant type and morphology. Combined statistical analysis of the 3 year (2004-07) yield data revealed that line N-7 recorded significant superiority over check, Kanchan for all the three yield traits with 17% increase in green leaf yield (12,783 kg/ha), 19% in cured leaf yield (2,323 kg/ha) and 19% in grade index (1,413 kg/ha). Seasonal differences were significant and yield levels during 2006-07 were in general higher than other two seasons. Season x entry interaction was also significant for all the four yield traits. The colour, body and size of cured leaf were good in codes N-2, N-4, N-5, N6, N-7 and N-9 along with Kanchan. Levels of nicotine, reducing sugars were within the prescribed limits in most of the entries in the trial.

Bulk evaluation of advanced lines

Advanced breeding lines 54-30-21, 56-3 and RT-13 that had shown significant increase in yield over Kanchan in station replicated yield trials were grown in experimental plots along with check, Kanchan. Results indicated superiority of the advanced lines over check cultivars. The lines showed 9, 8 & 21% increase in cured leaf yield and 2, 14 & 24% increase in grade index, respectively over Kanchan. The three lines are undergoing multi-location trials under AINRP(T).

Developing new varieties of irrigated *Natu* tobacco for Andhra Pradesh

(T.G.K. Murthy)

Bulk evaluation

Seven advanced breeding lines, identified as superior to checks in previous bulk assessment trials, were grown in progeny bulks, each comprising 250-300 plants. Sel. 46 (1,520 kg/ha total cured leaf yield) and Sel. 47 (1,390 kg/ha) were more promising than check Kommugudem (1,210 kg/ha).

Fresh crosses

Crosses were made between Kommugudem, Sel.45 and 9-14 for developing a superior irrigated *Natu* line.

Confirmation of black shank resistance

The three black shank resistant irrigated *Natu* lines viz., Peddavithanam SR, Rangapuram SR and Singarajupalem SR were submitted to Plant Breeder at CTRI, Rajahmundry for confirmation of black shank resistance in collaboration with Plant Pathologist. The screening will be done for one more season to confirm the resistance.

CTRI Research Station, Guntur

Development of FCV tobacco varieties suitable for cultivation in CBS and SBS of Andhra Pradesh

(A.V.S.R. Swamy)

Generation advancement

About 120 F_3 selections of the crosses, GH-9 (V-3703 X KST-26), GH-10(V3703X Cy-79) and GH-14(V-3703 X Hema) were raised at Medarametla and selections with cured leaf yield ranging from 2,806 to 3,494 kg/ha were made.

Bulk trial with advanced FCV lines

Two new pipe line entries promoted from AVT-II i.e., KST-28, V-4064 were evaluated for yield potential and quality along with released varieties in a bulk trial. Line KST-28 was found to be superior in giving comparable or higher cured, bright and grade index yields of 2,412; 1,440 and 2,110 kg/ha, respectively, to high yielding check Siri (2,350, 1,405 and 2,169 kg/ha)

Natu bulk trial

Among the *Natu* entries, the advanced high yielding selection II-1873 gave maximum cured leaf yield of 2,490 kg/ha, which is 10.9 and 10.4% higher over Bhairavi and WAF, respectively. In the two on-farm trials conducted in the Mehaboobnagar district, the line II-1873 showed its superiority over checks, WAF and Bhairavi.

Maintenance of *Natu* germplasm

About 151 *Natu*/Oriental/HDBRG/Burley/*Motihari* tobacco germplasm were maintained and nucleus seed was collected for the next year.

CTRI Research Station, Kandukur

Breeding FCV tobacco varieties for yield and quality characters under SLS conditions

(A.R. Panda, C.V. Rao, V. Venkateswarlu, K.C. Chenchaiah, P.V.V.G. Rao, T.G.K. Murthy, K.N. Subrahmanya, A.V.S.R. Swamy and C.V. Narasimha Rao)

About 385 accessions of FCV germplasm were maintained. Also, six high potassium lines viz., Cor-3, Cor-13, Cor-14, Cor-15, Cor-16, Cor-17 were maintained.

BTRC, Jeddangi

Evaluation of advanced Burley breeding lines for productivity and quality

(P.V. Venugopala Rao and T.G.K. Murthy)

Fourteen advanced breeding lines (YB-1 to YB-14), developed from cross 324C x Banket A-1, were evaluated in three replications in RBD along with three controls viz., Banket A1, Burley-21 and BSRB-2. Advanced breeding line, YB-10 recorded the significantly higher green leaf yield of 16,178 kg/ha followed by YB-4 (15,766 kg/ha). The maximum cured leaf yield was also recorded by YB-10 (2,510 kg/ha) and YB-4 (2,324 kg/ha). The yield improvement in these cultures over the better control Banket A1 (1,378 kg/ha) was 86 and 81%, respectively.

Generation advancement and selection

Out of 39 F_3 progenies studied, 53 selections were made based on the morphological characters like leaf size, shape, colour of leaf, stem and veins, number of leaves, internodal length, spotting etc. F_1 generation of crosses viz., Banket A1 X Ky-42 and SM13 X Ky-42 was raised and selfed seed collected with the objective to combine the typical creamy white Burley nature of the Ky-42 with the high yield potential of new advanced breeding lines.

Hybrid seed production

Hybrid seed of BA1 X 324C was produced and the seedlings will be supplied for the Agronomy trial on the hybrid and also for the bulk evaluation trial in the farmer's field.

Incorporation of Male sterility (CMS) in Burley varieties

The BC_2 of crosses involving the male sterile hybrids BRK-1, BRK-2, TN-97, NCBH-127 and NC-3 were raised and back crossed with the respective male fertile recurrent parents viz., Banket A1, Burley-21, VA-510 and Banket-127.

Maintenance of Burley germplasm

One hundred and two lines of Burley germplasm were maintained and the seed collected.

CTRI Research Station, Vedasandur

Pedigree selection in chewing tobacco (*N. tabacum* L.) population with a broad genetic base

(K. Palanichamy)

From 52 selections made from the broad based composite population, 52 families were raised along with Bhagyalakshmi, Meenakshi, Vairam and Abirami planted at regular intervals as checks during 2006-07. Based on the desired level of expression for yield component characters, 35 selections were made from 20 families and self pollinated for generation advancement and further selection. It was observed that the selections showed higher values than the checks in one or more yield component attributes such as leaf length, leaf width and stem girth.

Similarly, whole and total leaf yields were also recorded in the selected families as well as checks. Ten out of the 20 families recorded higher total leaf yield ranging from 3,626 kg/ha (BSB.27) to 4,080 kg/ha (BSB.21), indicating an appreciable increase in the frequency of desirable genes for productivity in the selected families arising from diallel selective mating (DMS).

CTRI Research Station, Dinhata

Locational trial of early maturing *Motihari* tobacco (*N. rustica*) cultivars

(S. Amarnath, S. Roy and R.L. Arya)

Two early maturing *Motihari* tobacco cultivars viz., Tangua Manda and RT-Bulk were evaluated in three farmers' fields and at CTRI RS, Dinhata for the second year. On an average, cultivar Tangua Manda recorded 25.8 and 47.3% higher total cured leaf and first grade leaf yields, respectively over check, Bitri (2,129 kg/ha). Whereas cultivar RT-Bulk recorded 11.4% higher total cured leaf yield and 3.5% higher first grade leaf yield. The increase in quality leaf outturn over Bitri (1,243 kg/ha) was higher in Tangua Manda (68.3%) than in RT-Bulk. Tangua Manda recorded highest number of leaves and maturity score, higher leaf length, leaf breadth, leaf area than control Bitri. Cultivar RT Bulk recorded highest plant height, leaf length, leaf breadth and leaf area and maturity score was the least. Less incidence of brown spot and hollow stalk was recorded in cultivar Tangua Manda as compared to RT Bulk and check Bitri. High nicotine, reducing sugars and chlorides and low total N, P and K were recorded in cultivar Tangua Manda than control Bitri. Thickness of leaf in Tangua Manda was found to be 0.60 mm as compared to 0.44 mm in RT Bulk and 0.48 mm in control Bitri.

Pooled analysis indicated that cultivar Tangua Manda exhibited 26.0 and 35.4% higher total cured leaf and first grade leaf yield over control Bitri. The average quality leaf outturn in this cultivar was 68.0% as compared to only 56.3% in RT-Bulk and 63.4% in control Bitri. Tangua Manda also recorded highest number of leaves/plant and maturity score (3.79) and higher leaf length and leaf area than control Bitri with lowest plant height and leaf breadth. Besides higher leaf yield and quality, Tangua Manda recorded less incidence of brown spot and hollow stalk disease than Bitri.

Diallel analysis in *Motihari* (*N. rustica*) tobacco

(S. Amarnath, S. Roy and R.L. Arya)

Eight parents and 28 crosses amongst them of *Motihari* tobacco (*N. rustica*) were evaluated for their yield and quality for the second year. Significant differences were observed for all the seven characters. It was observed that the range for different characters in parents was low to that of the crosses.

Mean squares due to gca were significant for plant height (PH) and maturity score (MS) indicating additive gene action for the inheritance of these characters. It further revealed significant mean squares due to sca for leaf length (LL) and first grade leaf yield

(FGLY) indicating the role of non-additive genes for these characters. For characters viz., leaf breadth (LB), leaf area (LA), number of leaves (NL), green leaf yield (GLY) and cured leaf yield (CLY), the mean squares due to both gca and sca were significant pointing out the importance of both additive and non-additive gene effects for this type.

Significant positive gca values were obtained in parent Black Queen for plant height, parent DD 437, Bitri and Tangua for maturity score, parent Bulk-2 for green leaf yield and parent Bitri for first grade leaf yield. Other significant estimates of gca for different characters in different parents were negative. Also, cross combinations with significantly positive sca values were identified for different traits.

On the basis overall results, it is concluded that the cross Black queen x Bitri with highest BP heterosis for leaf length (24.3%) and green leaf yield (41.9%), cross Black queen x Snuff-2 (40.4%) and cross Black queen x DD-437 (11.3%) for cured leaf yield and number of leaves, respectively as well as cross Black queen x DD-437 with highest SP heterosis of 30.7, 24.5, 49.0 and 58.5% for leaf length, number of leaves, green leaf yield and cured leaf yield, respectively hold promise. Therefore, cross Black queen x Bitri, Black queen x DD-437 and Black queen x C-25 can be taken up for further breeding programme to improve yield and its related traits in *Rustica* tobacco.

HYBRID TOBACCO

CTRI, Rajahmundry

Developing hybrid tobacco suitable for Traditional black soils of Andhra Pradesh

(T.G.K. Murthy, R.V.S. Rao, P.V. Venugopala Rao and K. Sarala)

During the year, one bulk evaluation trial and two replicated yield trials with CMS hybrids and one with fertile hybrids were conducted.

Bulk evaluation of hybrids

Three CMS and two fertile F_1 fertile hybrids which showed significant standard heterosis in the Station replicated yield trials were grown in bulk plots along with check varieties for evaluation of yield traits. Among the CMS hybrids, TBSH-1 and TBSH-2 showed superiority with 10-28% increase in yield characters over best check cultivar, Siri (green leaf: 13,190 kg/ha, cured leaf: 1,969 kg/ha, bright leaf: 962 kg/ha and grade index 1,525 kg/ha). Both the fertile hybrids, 312-1 x VT 1158 and VT 1158 x Cy 142 recorded 10-31 % more leaf yield than best check, Siri. All the hybrids showed desirable colour, body and weight of cured leaf. The two promising CMS hybrids, TBSH-1 and TBSH-2 were included in multi-location trials under AINRP (T). The content of nicotine, reducing sugars and chlorides in cured leaf of all the genotypes evaluated in the bulk trial were within the prescribed limits.

Replicated yield trials

During the year, two replicated yield trials with CMS hybrids and one with fertile hybrids were conducted.

Trial 1 with CMS hybrids: The trial was repeated for the third successive year with eight hybrids produced by crossing two CMS lines, 75-30 MS and MS 19 with four improved genotypes viz., Cy 79, Cy 139, Cy 142 and L 1358. The eight hybrids were evaluated for leaf yield and quality along with the checks, VT 1158 and Hema in a RBD with three replications. Three hybrids, 75-30 MS x Cy 79, MS 19 x Cy 79 and MS 19 x Cy 139 showed significant standard heterosis, bright leaf and grade index only. The extent of standard heterosis varied from 28 to 39% in different hybrids. The nicotine and reducing sugars content in cured leaves of most of the entries in the experiment were within acceptable limits.

Pooled analysis

Combined statistical analysis of the data on yield traits collected in the experiment over three seasons (2004-07) was done for identifying promising hybrids, if any. Following hybrids exhibited significantly superior performance over best check, VT 1158 for different yield traits.

Green leaf:	75-30 MS x CY 79, MS 19 x CY 79 (Standard heterosis 12 & 10%)
Cured leaf:	75-30 MS x CY 79, MS 19 X CY 139, MS 19 X CY 79 (Standard heterosis 14, 12 & 10%)
Bright leaf:	75-30 MS x CY 79, MS 19 X CY 139, MS 19 X CY 79 (Standard heterosis 24, 22, & 20%)
Grade index:	MS 19 X CY 139, 75-30 MS x CY 79, MS 19 X CY 79 (Standard heterosis 23, 20 & 20%)

Yield traits of best check VT 1158: 12,669 kg/ha green leaf, 1,949 kg/ha cured leaf, 904 kg/ha bright leaf and 1,372 kg/ha grade index).

Seasonal differences were significant and yield levels during 2006-07 were higher than other two seasons. Season x hybrid interaction was also significant for all the four yield traits. Based on the performance over three years, two hybrids viz., MS 19 x Cy 79 and MS 19 x Cy 139 were identified as promising and suitable among the eight hybrids evaluated.

Trial 2 with CMS hybrids (First year): The trial was conducted for the first year with eight new hybrids that showed promise in progeny row trials during the previous years. The CMS hybrids were produced by using four CMS lines (6-6RMS, AP1-8, 72-21MSVT and MST29) and six promising advanced breeding lines (Cy 79, Cy 139, Cy 142, Cy 149, R-77 and 312-1S4) as parents. All the hybrids were evaluated for yield potential and leaf quality along with three checks viz., Hema, VT 1158 and Siri in a RBD with 3 replications.

Three hybrids viz., AP1-8 x 312-1S4, 6-6RMS x 312-1S4 and 6-6RMS x Cy 139 showed significantly higher standard heterosis than high yielding check, Siri for all the four yield traits, besides having good leaf physical qualities. The heterosis varied from 17 to 21% for different traits. The trial will be repeated during 2007-08 season also. The nicotine and reducing sugar content in cured leaves of all the entries in the experiment were within acceptable limits.

Trial 3 with fertile hybrids (First year): Ten fertile hybrids produced by crossing identified high yielding cultivars and improved stabilized advanced breeding lines were evaluated along with checks Siri, VT 1158 and Hema for yield potential and leaf quality in a RBD with 3 replications. Three hybrids viz., VT 1158 x 312-1S4, R 79 x 312-1S4 and 312-1S4 x VT 1158 showed significantly positive standard heterosis over the high yielding check, Siri for all the four traits. The standard heterosis in different hybrids varied from 16 to 21% for green leaf, 17 to 23% for cured leaf, 16 to 41% for bright leaf and 11 to 26% for grade index, respectively. The nicotine, reducing sugars and chloride contents in cured leaves of all the entries in this experiment were within the acceptable limits.

Maintenance of CMS lines

A total of 20 CMS lines with varying cytoplasm sources (*N. undulata*, N. *plumbaginifolia*, *N. tabacum, N. gossei, N. suaveolens, N. megalosiphon* etc.) were maintained. The stabilized CMS lines viz., AP-1-8, 6-6, MST-29, MS-19, MS-20, CR 73 were involved in crosses with different recurrent parents including VT 1158, Gauthami, Siri, Kanchan, 312-1S4, Rathna, JS-62, 324C, Cy-142, Cy-79, L-1358 for developing high yielding /resistant CMS lines for use in hybrid breeding programme. Crosses were also made for conducting various RYTs with CMS hybrids and also to submit the seed for multi-location testing under AINRP (T). Also, four crosses viz., MS58 x HDBRG, MS58 x VT 1158, MS58 x A 145 and MS58 x TI-163 were made to develop CMS parental lines with high biomass potential and the hybrid seed was submitted to Head, Crop Production for raising CMS hybrids.

CTRI Research Station, Jeelugumilli

Developing hybrid FCV tobacco suitable for NLS area of Andhra Pradesh

(T.G.K. Murthy, R.V.S. Rao, P.V. Venugopala Rao and K. Sarala)

Maintenance of CMS lines

Seventeen CMS lines in the genetic background of Kanchan and other improved lines were maintained and back crossed to recurrent parent. High yielding CMS hybrid NC 71 was crossed with Kanchan and JS 62 (BC_3) for developing high yielding CMS parental lines.

During 2006-07, one bulk evaluation trial with promising CMS hybrid NLSH-1 and one replicated yield trial with 15 CMS hybrids were conducted.

Bulk evaluation

The promising CMS hybrid, NLSH-1 which showed significant superiority to check variety, Kanchan in station replicated yield trials, was evaluated in a bulk plot along with check, Kanchan. Results confirmed superiority of the hybrid NLSH-1 which showed 10% increase in green leaf yield (12,142 kg/ha), 12% in cured leaf (2,065 kg) and 14% increase in grade index (1,559 kg/ha) over Kanchan.

Content of nicotine (2.68%), reducing sugars (9%) and chlorides (0.9%) in cured leaf of the CMS hybrid NLSH-1 were similar to Kanchan. The hybrid also showed lower tar content than Kanchan as indicated below.

Genotype	Tar (mg/cigarette)	Tar (mg/g dry tobacco)
NLSH-1	18.18	34.28
JS 78	19.00	36.11
Kanchan	21.32	41.87

Evaluation of CMS hybrids in replicated yield trial

Fifteen CMS hybrids, produced by crossing five identified promising CMS lines with three fertile high yielding genotypes viz., JS 62, JS 78 and Kanchan in a line x tester design, were evaluated along with the eight parents in a RBD with 3 replications. Three hybrids were found to show significantly higher heterobeltiosis than the best parent, Kanchan for all the three yield traits.

MS-VT x JS-78: 12% heterobeltiosis for green leaf, 20% for cured leaf and 37% for grade index

AP1-8-K x Kanchan: 13% heterobeltiosis for GL, 18% for CL and 24% for GI

MS58-VT x Kanchan: 10% heterobeltiosis for GL, 23% for CL and 30% for GI

Among the female parents, AP1-8K and MS58VT were better combiners while among the male parents, JS 62 and JS 78 were good combiners.

Evaluation of exotic CMS hybrids

A preliminary progeny row trial was conducted with 18 exotic hybrid accessions received from Head, Division of Crop Improvement, CTRI, Rajahmundry. Forty plants (4 x 10) of all the lines along with the check, Kanchan were raised in experimental plots. Results indicated more promise of hybrids, RGH 4, PVH 51, NC 55, GL 26H and PVH 03 than others for yield traits. The hybrids recorded 2,600 to 2,800 kg/ha cured leaf yield and 1,530 to 1,920 kg/ha grade index. Cured leaf colour, size and body were good in most of the CMS hybrids. Nicotine (1.6 -2.5%), reducing sugars (9 - 14%) and chlorides (0.7 - 1.1%) in cured leaf were within the prescribed limits in the exotic hybrids.

CTRI Research Station, Kandukur

Evaluation of FCV hybrids of tobacco for yield and quality under SLS conditions

(A.R. Panda)

On the basis of results obtained during 2004-05 and 2005-06 seasons, 12 fertile hybrids were evaluated for yield potential and leaf quality in a RBD with 3 replications along with checks, VT 1158, Kanthi and Hema. Three hybrids viz., SH-1, SH-12 and SH-6 were most promising with significantly higher heterosis than all the checks. Standard heterosis ranged between 4 and 37% for different yield traits in the three hybrids.

CTRI Research Station, Hunsur

Development and evaluation of F_1 hybrids suitable to Karnataka Light Soil region

(K.N. Subrahmanya, M.M. Shenoi, M. Mahadevaswamy and S. Ramakrishnan)

Seventeen hybrids were evaluated in a RBD along with 3 checks for yield and leaf quality. The standard heterosis (up to 14% for green leaf yield, 39% in cured leaf, 25% in bright leaf and 27% in top grade equivalent) observed for yield parameters in eight of the hybrids was, however, non-significant. The cured leaf quality assessment indicated that the hybrids involving Coker 48 and Newdel with either Rathna or Kanchan produced riper leaves having desired physical characteristics. In addition to the above, the cross combinations of Kanchan with Rathna, Golden Cure as well as Yellow Special also showed desired physical qualities. Performance of hybrids varied with seasonal variations during the two years of study. Kanchan x Yellow Special, Rathna x Kanchan, Rathna x Newdel and Rathna x NC 12 have performed well in both the seasons in cured leaf yield as well as bright grade out turn.

Feeler trial on evaluation of exotic hybrids

Eleven exotic cultivars viz., PVH 03, PVH 09, NC 100, PVH 20, PVH 50, PVH 51, RGH 04, GL 350, GL 26 H, NC 55 & NC 297 were grown in observational plots for studying the plant behaviour and their reaction to pests and diseases. All the cultivars were found to be male sterile. They resembled the variety Kanchan in plant habit, having shorter internodes, medium to dark cast, long & narrow leaves with wavy surface and thick body. Cured leaf obtained from these varieties showed medium to thick body, deep lemon to orange colour. Cultivars PVH 09, PVH 20, PVH 50, PVH 51, GL 26H & NC 55 were found promising in cured leaf quality characteristics. All the entries were found susceptible to root-knot nematode disease recording more than 2.5 root knot index (RKI) in 0 to 5 scale in the observational plots. They were also found susceptible to brown spot disease. Average disease index (PDI) ranged from 20 to 59% in the standing crop and 45 to 68% in the harvested leaves.

CTRI Research Station, Vedasandur

Studies on heterosis in chewing tobacco

(K. Palanichamy)

Replicated evaluation of hybrids (2nd year)

Eleven hybrids were evaluated along with checks, Bhagyalakshmi, Vairam and Abirami for yield potential and leaf quality. Differences among the entries were significant for total leaf yield and non-significant for whole leaf yield. Four of the hybrids viz., F1.2, (PV.7 X Abirami), F.1-3 (VD1 x Abirami), F1-5 (Vairam x Abirami) and F1-6 (Abirami x KV.1) recorded significantly higher total leaf yields ranging from 3,726 to 3,990 kg/ha., with standard heterosis values of 12.4 to 20.4% over the check, Abirami.

In the combined analysis of the data over two seasons, differences among hybrids and entries were significant in respect of both whole leaf and total leaf yields. Seven of the hybrids F1-1 to F1-7 and F1-11 recorded significantly higher whole leaf yields ranging from 2,514 kg/ha (F1-9) to 2,977 kg/ha (F1-5) over 2,412 kg/ha of the best check Bhagyalakshmi. Five of the hybrids viz., F1-2, F1-3, F1-5, F1-6 and F1-11 recorded significantly higher total leaf yields ranging from 3,590 kg/ha to 3,914 kg/ha compared to 3,269 kg/ha of the best check Abirami, the standard heterosis ranging from 9.81 to 19.73%.

Seasons x variety interaction effects were also significant for both whole and total leaf yields. The chewing quality of hybrids tested as per the standard score card system was found to be comparable to that of the current commercial cultivars/checks. Variability in respect of yield component attributes such as leaf length, leaf width, stem girth etc. were also significant. It is interesting to note that four out of the five hybrids, showing appreciable standard heterosis, had the high yielding chewing tobacco variety Abirami as one of the parents

Bulk evaluation

Two bulk trials were laid out in two locations (Allukkuli and Kosavapatty) with 3 hybrids F1-5, F1-6 and F1-7 along with relevant checks. F1-5 and F1-6 recorded 14.31 and 20.00% increase in yield over KV.1 in Allukkuli. However, at Kosavapatty only F1-9 (Bhagyalakshmi x KV.1) recorded 25% higher (4,237 kg/ha) total leaf yield as compared to 3,378 kg/ha of Abirami. Location differences are thus evident.

BREEDING FOR DISEASE RESISTANCE

Incorporation of disease resistance for Tobacco Mosaic Virus

(P.V. Venugopala Rao and C.A. Raju)

The BC2 generation plants of the crosses V-4294, V-4297, V-4298 (involving Cy-135 as recurrent parent), V-4299, V-4304 and V-4307 (involving N-98 as recurrent parent) were raised and artificial inoculation was made with TMV. The resistant plants were back crossed with the respective recurrent parent and seed collected to raise the BC3 during 2006-07.

TMV resistance in F3 progenies of Siri, Cy-142 and N-98

F3 progenies of Siri X VT 1158 (32 progenies) Cy-142 X HMR (3 progenies) and N-98 X VT 1158 (13 progenies) were raised in a row trial. All the plants in each row were artificially inoculated with TMV and the plot-wise yield was also recorded. Among the lines evaluated for TMV resistance, all the plants inoculated in V-4419 and V-4427 recorded resistance. Seed of the individual resistant plants in these lines was collected. The individual plant seed of these two lines will be studied during 2007-08. The plant type in these lines was also very much similar to the Siri. Highest cured leaf yield (2,767 kg/ha) was recorded in V-4419.

Incorporation of TMV resistance in Pyruvittanam of *Natu* tobacco

BC1S2 progenies of twenty three progenies of PVM x JMR/VT 1158 were raised and artificially inoculated with TMV. The results showed that all the plants in the lines PVM- 2, 3, 5, 6, 10, 11, 16, 17, 18 and 19 were resistant to TMV. These lines will be evaluated finally for the stability in a row trial during 2007-08.

Incorporation of black shank resistance in FCV varieties/advanced breeding lines

Black shank resistance incorporation in the recently released variety Siri and the advanced breeding lines N-98 and Cy-142 are in progress. These lines were crossed with the resistant donors, Beinhart 1000-1 and 1129SR. The resistant lines thus obtained will be screened further during 2007-08.

CTRI Research Station, Hunsur

Imparting resistance to brown spot in the high yielding FCV tobacco varieties/ advanced breeding lines suitable for Karnataka light soils

(K.N. Subrahmanya and M.M. Shenoi)

Breeding for resistance to brown spot

Twelve promising advanced breeding lines viz., FCH 205 to FCH 216 derived from the crosses involving Beinhart 1000-1 and L.1128 (SR) as brown spot disease resistance donors were assessed for yield and quality in a replicated trial. Although, the two lines viz., FCH 209 and FCH 210 registered higher yields over standard check Kanchan, the increase was non-significant. Five lines including FCH 209 and FCH 210 produced cured leaf having desired physical quality characters as well. All the twelve lines showed low incidence of brown spot disease (<15 PDI), comparable to that of resistance donors, while the susceptible check Bhavya recorded disease index (PDI) as high as 88% in 'hot spot' area for the disease.

Breeding for quality improvement

Among the nine advanced breeding lines viz., FCH 196 to FCH 204 assessed for yield and quality under a replicated trial, the differences in cured leaf yield were not significant. In bright grade out turn, FCH 197 (60% increase over Kanchan) and FCH 201 (43%) registered significant superiority over Kanchan (896 kg/ha). In top grade equivalent yield, FCH 197 alone recorded significantly higher (20%) value over Kanchan (1770). Based on the

overall performance, FCH 196, FCH 197 & FCH 201 have been contributed for multi-location testing under AINRP (T).

Breeding for resistance to *Fusarium* wilt disease in flue-cured Virginia tobacco for Karnataka Light Soils

(K.N. Subrahmanya and M.M. Shenoi)

Twelve advanced breeding lines (FCH 217 to FCH 228) derived from the crosses involving Dixie Bright 101 and Speight G.33 as *Fusarium* wilt disease resistance donors have been assessed for yield and quality under replicated trial. Ten lines registered significant superiority in all yield attributes over standard check Kanchan. High incidence (to an extent of 23%) and faster rate of spread of *Fusarium* wilt disease has reduced the yields in Kanchan. Eight lines recorded > 1,900 kg/ha cured leaf yield and six among them have produced cured leaf having desired physical quality parameters. FCH 221 and FCH 222 have overall superiority in terms of yield, disease resistance and cured leaf quality parameters.

CTRI Research Station, Vedasandur

Breeding for insect resistance against caterpillar attack in chewing tobacco

(K. Palanichamy)

Variety release

One caterpillar resistant chewing tobacco variety viz., Meenakshi CR developed through backcross breeding involving the popular sun-cured chewing tobacco variety, Meenakshi as the recurrent parent and exotic fire-cured type viz., DWFC as the donor for the simply inherited dominant gene for resistance to tobacco caterpillar *Spodoptera litura*, was released by the Tamil Nadu Tobacco Varietal Release Committee Meeting held at CTRI Research Station, Vedasandur on 9th March, 2007 for commercial cultivation in Tamil Nadu. The variety Meenakshi CR has leaf yield potential of 3,433 as compared to 3,316 kg/ha of the parent Meenakshi, besides having good chemical and chewing quality and resistance to caterpillar. In terms of chemical quality attributes also, this line is considered desirable with a slightly less nicotine content of 3.20% compared to 3.81% of Meenakshi.

CTRI Research Station, Dinhata

Screening for resistance against brown spot and hollow stalk in germplasm accessions of *Jati* (*N. tabacum*) and *Motihari* (*N. rustica*) tobacco in North Bengal

(S. Amarnath and S. Roy)

A total of 60 and 179 germplasm accessions for *Jati* and *Motihari* tobacco, respectively were screened for resistance to brown spot under field conditions. Based on the area under disease progress curve (AUDPC) score between 1st and 3rd observation dates, the germplasm accessions were ranked in four different categories viz., resistant (R) having AUDPC range between 0 - 250; moderately resistant (MR) from 250.1 - 500; moderately susceptible (MS) from 500.1 - 750 and highly susceptible (HS) > 750.

Sources of resistance (R)/ moderate resistance (MR) to brown spot

***Jati* tobacco**

Resistant: GT 6-1, Gandak Bahar, AC-5, GTH-1, Vaishali Spl., PT-76, II-68-79, AVT-65
MR: Manasi, Lichchavi, II-3A-7-85, II-1A-7-80, II-1A-6-69, GT-6, II-1A-7-81, Sona, J-2

***Motihari* tobacco**

MR: GC-1, M-9, I-104, Tangua Manda, HAR-1, HDN-1, Jaunpur Local, Hirawata, Harpur Sadi, III-281, Labu, M-2, C-21, NPS-219, Bhowal, Manda, Daiya Kharwar, Khaga Damadaha Range, Tangua, NP-220, M-3, Gosaigaon-2, Aligarh Local, SK-404, Hemti, I-191, *Motihari*, BVM-5, Saraiya Range, Chatwar, HD-65-40, Bulk-2, Rustica-6, S-22, Jhuripara, Goramma, Kursaila, Kharagpur, Kanpur Local, NP-222, RT-Bulk

INTERSPECIFIC HYBRIDIZATION

Interspecific hybridization: Breeding tobacco varieties resistant to pests and diseases utilizing relevant donor species. Incorporation of aphid resistance from *N. gossei, N. repanda, N. umbratica - nesophila* and N. *benthamiana - repanda*

(T.G.K. Murthy, R.V.S. Rao, U. Sreedhar and K. Siva Raju)

Maintenance of interspecific cross derivatives

About 200 single plant-to-row progenies in F_9-F_{10} and different back cross generations derived from crosses involving *N. tabacum* as one parent and aphid resistance donors viz., *N. gossei, N. excelsior, N. x benthamiana-repanda,* and *N. umbratica as* the other parents were grown in experimental plots along with susceptible cultivars.

Screening for resistance to tobacco aphid

The experimental plots were irrigated at about 40 and 55 days after planting (DAP) for increasing aphid development. At 60-65 DAP, all the plants were artificially inoculated with tobacco aphids (@ 500 per plant) that were developed and collected from susceptible cultivar, Lanka Special. Aphid infestation was recorded at 15 - 20 days after inoculation on 0-5 scale (0: immune and 5: highly susceptible).

In general, aphid infestation was high during the 2006-07 season as compared to previous four seasons. Under artificial inoculation, the mean aphid infestation score in susceptible checks/cultivars varied from 4.1 to 5.0. In the advanced interspecific cross derivatives, the score varied from 1.0 to 5.0. Eleven families scored a mean of less than 1.0 while in 53 families the mean score was below 2.0. Selected single resistant plants in families with low aphid infestation score were selfed for further studies. Also, 50 more interspecific cross derivatives were submitted to the Entomologist, CTRI RS, Guntur for screening under artificial inoculation during the 2006-07 season.

Characterization for morphology and other traits

The derivatives exhibited variability for plant type (FCV, Burley, *Natu*, Chewing, *Lanka* and very light coloured leaf mutants), biomass, plant height, canopy type, internodal length, phyllotaxy, earliness, leaf colour, number of leaves, size and shape of auricle & petiole, curability, flower colour, fertility, etc. Following cross derivatives were promising for various traits: high yield potential (39 lines), leaf weight (3), short internodal length (14), big leaf size (36), high seed bearing (1), high biomass (7), earliness (1), Burley type (5), Lanka (4) and TMV resistance (14). A CMS line, 6-6 developed from this project is found to be a good parent for synthesis of tobacco hybrids with high leaf yield and quality. The CMS line, in VT 1158 and Rathna genetic back grounds, is used in the hybrid breeding programmes in NBS, NLS and KLS zones.

Screening cross derivatives against leaf curl damage

Twenty one derivatives of crosses, *N. gossei x N. tabacum* and *N. umbratica x N. tabacum*, were screened for leaf curl symptoms in collaboration with the Entomologist in a pot culture experiment under high whitefly infestation pressure. At 110 DAP all the plants of susceptible check variety, VT 1158 showed extreme type of leaf curl symptoms. The following interspecific cross derivatives were either leaf curl free or showed mild infection on calyx only: 7-9LCR-1, 16-1LCR-2, 39-11LCR-3, 44-26LCR-1,2 & 3, 133-31LCR-2, & 5. The leaf curl tolerant lines will be submitted to the Entomologist at CTRI RS, Kandukur for screening under artificial inoculation.

Screening cross derivatives against caterpillar damage

Twenty two advanced interspecific cross derivatives along with checks Hema, Kanchan and VT 1158 were subjected to screening in micro-plots under artificial inoculation in RBD with two replications in collaboration with the

Entomologist. The damage in susceptible checks varied from 85 to 100% while in resistant check *N. gossei*, it was 5%. The infestation in interspecific cross derivatives varied from 20 to 100%. The following five interspecific derivatives showed infestation level comparable with the resistant parent: 53MX1-14 CR (20%), 144MX1-CR (27%), 178-3-5CR#1 (22%), 137MX1-1CR#3 (27%) and 144MX1-9 CR (35%). These lines showed low caterpillar infestation during the previous two seasons also. The resistant and moderately resistant lines will be subjected to intensive screening in collaboration with the Entomologist during 2007-08 season.

Evaluation of cross derivatives for yield and leaf quality

a. Trial TBL-1 (3rd year): A replicated yield trial was conducted with six aphid resistant morphologically stable interspecific cross derivatives, one resistant derivative of intraspecific cross, 1099/2/4 x Cu-1097, and one high yielding interspecific cross derivative 312-1S4, along with checks Hema and VT 1158. Two interspecific cross derivatives viz., 312-1S4 and 55MX1-2-11 showed significant superiority over VT 1158 for green leaf yield (17 & 38%), cured leaf yield (18 & 35%) and grade index (25 & 54%) while the line 55MX1-2-11 showed significant superiority in case of bright leaf yield also (57%) (VT 1158; green leaf: 11,491 kg/ha, cured leaf: 2,202 kg/ha, bright leaf: 997 kg/ha, grade index: 1,535 kg/ha). In general, the levels of nicotine and reducing sugars were within the prescribed limits in the advanced cross derivatives.

Pooled analysis

Combined statistical analysis of the data collected on the yield trial over three seasons (2004-07) was done for identifying promising lines. Two advanced cross derivatives, 55MX1-2-11 and 312-1S4 exhibited significantly superior performance over the best check, VT 1158 for different yield traits with 26 and 16% increase in green leaf, 24 and 15% for cured leaf, 38 and 25% for bright leaf and 30 and 14% for grade index, respectively. Also, another derivative, 55MX1-22-3 showed significant increase (9, 16 & 8%) for cured and bright leaf and grade index over the better check, VT 1158 (green leaf: 13,024 kg/ha, cured leaf: 2,034 kg/ha, bright leaf: 861 kg/ha, grade index: 1433 kg/ha). Seasonal differences were significant and yield levels were higher during 2006-07 than other two seasons. Season x entry interaction was also significant for all the four yield traits. Based on overall performance, two entries 312-1S4 and 55MX1-2-11 were identified for further studies.

b. Trial TBL-2 (1st year): Another replicated yield trial was conducted with ten selected morphologically stable advanced intra- and interspecific cross derivatives along with three checks in a RBD with three replications for evaluating their yield potential and leaf quality. The following derivatives were found promising:

Green leaf	: M31-324C-1 (31% increase over best check, Siri), M31N5VT-2 (26%), R28-1 (23%), R43-2 (18%)
Cured leaf	: R43-2 (27%), M31-324C-1 (24) M31N5VT-2 (23%), B2-2 (21%)
Bright leaf	: R43-2 (32%), B2-2 (31%), M31N5VT-2 (27%), M31-324C-1 (24%)
Grade index	: M31-324C-1 (33%), R43-2 (32%), B2-2 (32%), M31N5VT-2 (23%)

(Siri – green leaf: 16,300 kg/ha, cured leaf: 2,475 kg/ha, bright leaf: 1,215 kg/ha, grade index: 1,790 kg/ha)

Colour, body and size of cured leaf were good in the entries, M31N5VT-2, M31-324C-1, R43-2 and B2-2, besides the checks. In general, nicotine (1.25-2.48%), reducing sugars (8.1-15.5%) and chloride contents (0.8 – 1.0%) were within the prescribed limits in the advanced cross derivatives.

c. Trial VT-13 (1st year): Out of the 9 advanced interspecific cross derivatives (*N. tabacum x N. gossei*, *N. umbratica x N. tabacum*) evaluated for yield potential and leaf quality, line 312-1S4 was found significantly superior to the best check cultivar, Siri and recorded about 30% increase in green leaf yield, 28% in cured leaf, 32% in bright leaf and 27% in grade index, respectively. Two other lines RT 31-1-1-3 and M31N5VT-1-1 (TMV resistant), showed significant increase over Siri (15 and 12%) for bright leaf yield only. Four of the derivatives were also observed to be TMV resistant.

d. Progeny row trial: A number of aphid resistant advanced interspecific cross derivatives having plant type and leaf colour (light, medium or dark cast) comparable to standard checks were grown in progeny rows and after evaluation of the plant type, leaf colour and body, leaf number, plant height, floral and fertility traits and seed bearing nature, the most promising morphologically uniform lines are retained for further agronomic evaluation. During 2006-07, the cured leaf yield potential of 120 such progenies varied from 1,420 kg/ha to 3,950 kg/ha. Seven selections with yield potential of over 3000 kg/ha besides leaf quality suitable for black soils were identified for further studies.

Maintenance of other important genotypes

In addition to the above, the following genetic stocks/lines were also isolated and maintained for future use.

- Autotetraploids induced in lines VT 1158 and CM-12 and their selfed derivatives
- Cytoplasmic male steriles including eu- and alloplasmic sources
- Corolla-split variants
- 'Asynaptic line'
- 'Translocation heterozygotes'
- Variegated mutants
- Cream coloured seed variant

PROGRAMME 3 BIOTECHNOLOGY FOR TOBACCO IMPROVEMENT

CTRI, Rajahmundry

Micropropagation of elite lines and other selections

(K. Sarala)

Micropropagation of elite lines

Seven *Nicotiana* species (*N. noctiflora*, *N-excelsier-plumbaginifolia*, *N. undulata*, *N. tomentosiformis*, *N. gossei*, *N. nesophilia*, TW-75), one *B.t* transgenic line (J20-6(R_0)), two *B.t* transplastomic lines (pskc-84 19 CA (Sh), pskc-85 5 BA (Sh)), three haploids of tobacco lines (JS-62, GT 7 and Hema), eleven haploids from crosses and two varieties (Hema and Jayasri) were micropropagated under *in vitro*.

Development of virus tolerant tobacco lines under *in vitro*

(K. Sarala, C.A. Raju, P. Venkateswarlu and K. Siva Raju)

Characterization of promising VT 1158 somaclones

Thirteen somaclones of VT 1158 were tested in a replicated trial at Katheru for their leaf yielding capacities along with three controls viz., Hema, VT 1158 and Siri. Somaclone VLCR-25-12 recorded significantly higher green leaf yield (18,698 kg/ha) over Siri. Clones, VLCR-12-5, VLCR-25-12 and VTCMV-1-15-14 recorded higher cured leaf (2,505 to 2,748 kg/ha), bright leaf (1,250 to 1,360 kg/ha) and grade index (1,978 to 2,170 kg/ha) values than better control Siri and were significantly superior to VT 1158. Among these lines, VLCR 25-12 was found to be promising, though not significantly superior to Siri, with 12, 11 and 12% increase in cured leaf, bright leaf and grade index, respectively over Siri. Somaclones VLCR-25-12 recorded maximum leaf length (65 cm), leaf width (33 cm) and curable leaves (28) compared to controls and other clones (Fig.1). Leaf nicotine and reducing sugars in somaclones were found to be in the desirable range.

Molecular diversity of VT 1158 somaclones

Thirteen somaclones of VT 1158 along with control varieties viz., VT 1158, Hema and Siri were studied to know their RAPD diversity. Clones 1-9 are leaf curl tolerant ones and 10-13 are CMV tolerant ones. Thirty one single arbitrary decanucleotide random primers and eleven SSR primers were tested for their ability to produce polymorphic bands in the above tobacco lines. Of the thirty-one primers used in this study, 21 produced amplification products. A total of 814 bands were scored from the amplification with 21 primers from 16 tobacco lines. An average of 4 bands scored per primer and 80 different bands were detected, of which 60 were polymorphic (75.0%). Out of 11 STMS used, only 8 gave response. A total of 298 bands were scored in 13 VT1158 tobacco lines with 8 primers.

Cytology of VT 1158 somaclones

Meiosis was found to be normal in clones VLCR 9-25, VLCR 11-5, VLCR 6-5, VLCR 12-32, VTCMV 1-15, VTCMV 1-6 and VT 1158 and abnormal in VLCR 12-5 and VLCR 1-12. Abnormalities like laggards at metaphase and laggards at anaphase were observed. This may be due to rearrangement of chromosomes in tissue culture. Studying the cytology of other clones is in progress.

Characterization of promising Kanchan somaclones

Six somaclones of Kanchan, a field selection (NM) and two low tar advanced breeding lines (JS 116-1 and JS 124) were tested in a replicated trial along with Kanchan (control). Significant yield differences recorded among somaclones, breeding lines and control. All the somaclones and NM recorded significantly superior yields of all types than Kanchan. The cured leaf yield in somaclones ranged from 3,061 kg/ha in NLCR-4 to 2,857 kg/ha in NLCR-7 (k) as against 2,373

kg/ha in Kanchan. The cured leaf increase in somaclones ranged from 22 to 30% and grade index from 38 to 57%. Most of the somaclones recorded higher leaf number, leaf length and leaf width values. NLCR-7 recorded maximum leaf length (67 cm) and leaf width values (28 cm). NLCR-7(k) recorded maximum number of leaves (33) after topping (Fig.1). Chemical quality characteristics of somaclones and advanced breeding lines were in the desirable range.

Fig.1: Promising Somaclones of VT 1158 & Kanchan

Molecular diversity of Kanchan somaclones

Six Kanchan somaclones along with a variant and a field selection NM were studied using seventeen single arbitrary decanucleotide random primers and seven SSR primers. Seventeen primers produced amplified products and were scored. A total of 459 bands were scored from the amplification with 17 primers from 9 tobacco lines. An average of 4.2 bands scored per primer. 72 different bands were detected, of which 41 were polymorphic (56.9%). Out of seven SSR primers used, only 6 have given response. An average of 3.2 bands scored per primer.

Cytology of Kanchan somaclones

Meiosis was found to be normal in clones NLCR, NLCR-4, NLCR-5, NLCR-7, NLCR-7 (K*), NLS-4, NLCR-10, NM. Prophase-I, Metaphase-I and Telophase-I were observed in NLCR, NLCR-4, NLCR-5, NLCR-7, NLS4 NLCR-10 and NM. Chromosomes were counted in NLCR-7, NLCR-7 (K*), NLCR-10 which are found to be normal to that of parent i.e. 24 pairs.

Screening of somaclones

Nineteen S_6 generation somaclones and 34 S_5 generation somaclones were tested in a row trial at Katheru Farm. Ten S_5 and 5 S_6 somaclones were found to be promising. Out of 16 clones, three were found promising under NLS condition.

Fifty five somaclones were tested for leaf curl resistance under artificial conditions at Rajahmundry. Forty five clones were found to be free from leaf curl incidence. Fifty two somaclones were screened for CMV resistance under artificial conditions at Rajahmundry. All the plants in 44 clones found to be free from CMV.

Viral genome sequencing

PCR primers specific to coat protein gene (cp) of tobacco leaf curl virus were designed based on the sequences of tobacco leaf curl virus-Karnataka1 (TbLCV-Kar1) and tobacco leaf curl virus-Karnataka2 (TbLCV-Kar2) genes available in the NCBI data base. The designed primers were used to specifically amplify a sequence of 725 bp from the total DNA isolated from the tobacco plants, collected from Khammam and Nellore districts of Andhra Pradesh, showing leaf curl symptoms. This confirmed the presence of leaf curl virus in plants showing leaf curl symptoms. The amplified DNA was eluted, purified and sequenced. Through NCBI and BLAST tools, it was found that the DNA sequence was aligned with sequences of different begomoviruses that infected croton, tomato, tobacco, *Phyllanthus*, mesta etc.

Maintenance, evaluation and characterization of tobacco transgenics

(K. Sarala and K. Siva Raju)

B.t tobacco transgenics

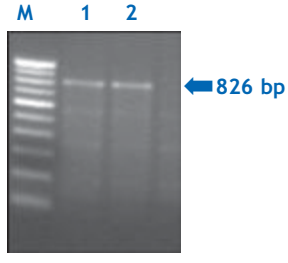
Two transgenics, each of Hema and Jayasri were raised in transgenic screen house and screened against *Spodoptera litura*, *Helicoverpa armigera*. These transgenics contain Cry1 A (b) and Cry 1 C genes and Cry 1 A (*b*) confirms resistance to *H. armigera* and Cry 1 C to *S. litura*.

Due to lack of sequence information of B.t. genes inserted in the transgenic lines, *B.t* primers available in the public domain were utilized for detection of the transgene presence. Kanamycin specific primers amplified a 612 bp fragment in transgenics. Public domain primers did not work for Cry 1 A (b) and Cry 1 C. Using the Cry 1 A (b) sequences available in NCBI database, primers were designed for conserved regions. As expected these primers amplified region of 247 bps in transgenics (Figs.2 & 2a). These results clearly indicated the presence of Cry 1 A (b) and Kanamycine genes.

ENVIROLOGIX quantiplate kits were used to quantify *B.t* proteins in the *in vivo* grown plants. The Cry 1A (b) protein quantities ranged from 1.06 to 1.84 ng/g green tissue.

NOTE: M- 100 bp Marker, H-Hema, JS-Jayasri, HT 1-Hema transgenic 1, HT 2-Hema transgenic 2, JT 1- Jayasri transgenic 1, JT 2 -Jayasri transgenic 2

Fig.2: Confirmation of *B.t* transgenics with Cry 1 A (b) specific primers



Note: M-100 bp Marker 1-pSKC85-5BA(R) 2-pSKC85-5BA(Sh)

Fig.2a: Confirmation of *B.t* transplastomic lines with Cry 9 Aa2 specific primers

Biological assays

Transgenic lines were screened against tobacco caterpillar and budworm. Leaf area consumed by *Spodoptera litura* in transgenic (41 – 125 cm^2) was less than controls (135 & 1365 cm^2). Weight of the line larvae was more in controls (832 & 857 mg) than transgenic (72 – 391 mg).

Tissue culture

B.t transgenics were raised in tissue culture in MS basal and half-basal media, with or without Kanamycin. The transgenic plantlets were green and showed vigorous growth on Kanamycin medium compared to MS (b) medium. Estimation of Cry 1 A (b) protein in tissue culture indicated that sufficient protein is being synthesized in tissue culture when Kanamycin is added to MS (b) (3.5-12.5 ng/g) and ½ MS (b) (2.75-14.5 ng/g) media.

Transplastomics

Cry 9 Aa2 specific primers were amplified a region of 826 bps in pSKC 85-5BA transplastomics. This indicates presence of Cry 9Aa2 gene. Another transplastomic line pSKC 84-19C could not be grown in *vivo* and hence not much difference observed between transplastomic line, Pskc85-5BA and control with regards to leaf area consumed by *Spodoptera* and larval mortality maintained in tissue culture laboratory.

Molecular mapping of important tobacco traits

(K. Sarala, T.G.K. Murthy, C.V. Narasimha Rao, K. Siva Raju and P.V. Venugopala Rao)

Selection of parents for mapping populations and studying their molecular diversities

TSNA: Assessment of molecular diversity among 11 selected Burley lines was made using 34 single arbitrary decanucleotide random primers, 11 tobacco specific SSR primers (Fig.3). Of the thirty-four primers used in this study, 20 produced amplification products. A total of 884 bands were scored with 20 primers from 11 Burley tobacco lines and 60 % of the bands were found to be polymorphic. Out of 11 SSR used for the study, 6 gave response. A total of 163 bands were scored with 6 primers in 11 Burley tobacco lines. An average of 3 bands scored per primer. Genetic similarity coefficients were calculated based on the

RAPD data of 20 primers. Maximum genetic similarity value (0.88) was found between By-64 and BySota 51 and minimum (0.61) between Banket-A1 and By-21. Among the high and low TSNA lines, minimum similarity was found between Banket A-1 and Burley Resistance.

Solanesol: In order to select parents for developing mapping population, selected lines were assessed for their solanesol content during 2005-06 season in air-cured middle picks. Among the selected high and low solanesol lines, HDBRG recorded higher solanesol (3.45%). Among the five selected solanesol lines, VA 510 recorded low solanesol (2.05%). In order to confirm the solanesol content of the parental lines, during 2006-07 season, solanesol content was estimated in HDBRG, Gauthami, By 53, TI-117 and Siri. As the lines recorded low solanesol values, confirmation could not be done.

Nicotine: In order to select parents for developing molecular mapping population for nicotine trait, 6 high nicotine lines and 4 low nicotine lines were tested for their leaf nicotine in air-cured middle picks during 2005-06 season. NC 55 recorded highest nicotine (3.62%) and Nisnicotinony-121 lowest (0.90%). During 2006-07, four high nicotine lines viz., Kumkumathri, GT9, Candel, and NC 55, and a low nicotine line, Nisnicotinony-121 were tested for nicotine content for confirmation. Nisnicotinony-121 recorded low (0.9%) and others higher nicotine values (3.2 – 3.8%).

Phytochemicals: Five tobacco lines (GT-8, TI 163, HDBRG, GT 7 and A 145) and two crosses (A 145 x GT 7 and GT 7 x A 145) were assessed for their molecular diversity using 16 single arbitrary decanucleotide random primers and 12 tobacco specific SSR primers and two chromosome specific SSR primers (Figs. 4-6). Of the sixteen RAPD primers used, fourteen produced amplification products. A total of 284 bands were scored with 14 primers from 7 tobacco lines. On an average, four bands were scored per primer and 54% bands were found to be polymorphic. Out of 12 tobacco SSR primers used, eight primers showed amplification. The total number of scorable bands amplified using the 8 SSR primers was 126. On an average, three bands were scored per primer and 27% bands were found to be polymorphic. One SSR primer was found to be polymorphic among A145 and GT 7. One SSR primer each, specific to chromosome 22 and chromosome 23 were found to be polymorphic and putative markers were identified.

Genetics of important tobacco traits

Higher leaf biomass was found to be dominant over lower leaf biomass as F_1 and reciprocal crosses recorded leaf biomass comparable to high biomass parent, GT 7. Low solanesol was found to be dominant over high solanesol and fertilizer did not show major influence on solanesol content. Solanesol yield was higher in hybrids with GT 7 as a female parent. Solanesol yield was found to have maternal influence. A single gene difference was found for nicotine between A 145 and GT 7. F_1 was intermediate between both the parents and the reciprocal was slightly higher than the mid parental value indicating the maternal influence of GT 7. F_1: F_2 recorded 3:1 ratio and RP: F_2 recorded 5:1 ratio. The distorted ratio in RP: F_2 may be due to maternal effects. Higher seed yield was found to be dominant and also showed nuclear and cytoplasm interactions. Low seed oil content was found to be dominant over high seed oil content. Oil recovery also showed complimentary effect of cytoplasm and nuclear genes. Leaf protein content was found to be polygenic in nature.

Development of mapping populations

F_1 and F_2 generations of crosses involving high and low parents for developing mapping populations for TSNA, solanesol, nicotine and other phytochemicals were raised and single plants were advanced to next generation.

Development of Doubled Haploid (DH) lines

Flower buds from six tobacco hybrids and their reciprocals were collected and anthers were excised and inoculated in tissue culture for the production of haploid lines necessary

for the molecular mapping of phytochemicals. Anthers from two Burley hybrids were inoculated for TSNA mapping. Except for two hybrids all the anthers responded by production of either callus or shoots in 12-20 days.

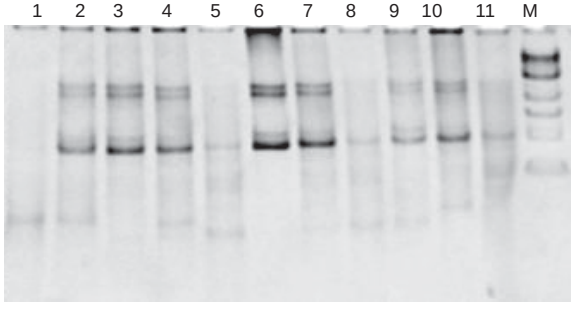
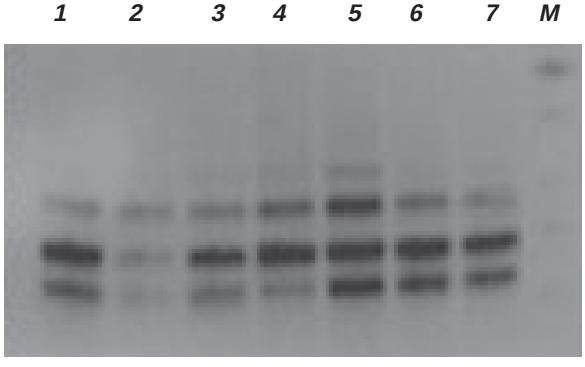


Fig.3: SSR Profile showing the genetic polymorphism among the Burley lines detected using SSR Primer-31 on PAGE
Lines: 1.Banket A1, 2.Sota-6506, 3.Apia, 4.Burley Resistant, 5.By-64, 6.By Sota-51, 7.Ky-10, 8.T-117, 9.VA-510, 10.BSRB-II, 11.By-21, M-Marker



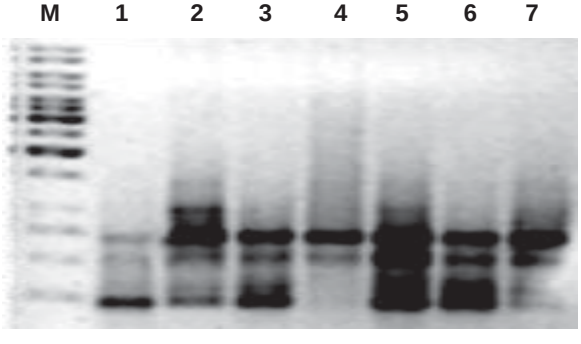


Fig.4: RAPD profile of tobacco lines

1:GT-8, 2:TI 163, 3:HDBRG,4:GT 7, 5:A 145, 6:A 145 x GT 7, 7:GT 7xA 145, M: 1 kb marker

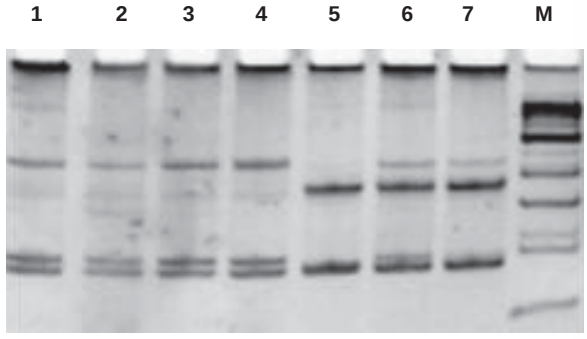
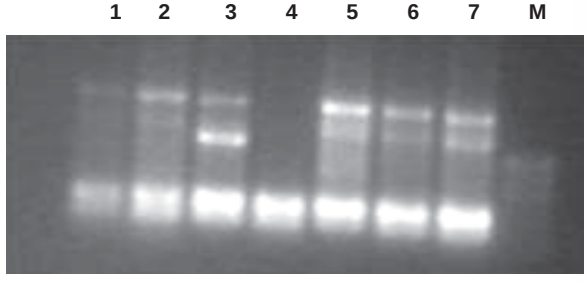
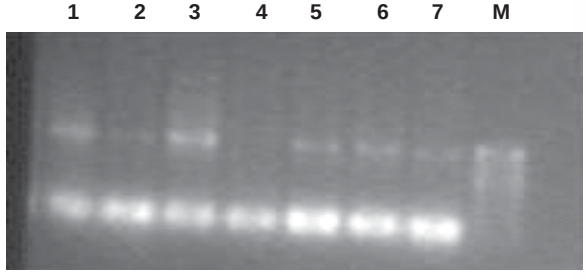


Fig.5: SSR profile of tobacco lines

x1-GT-8, 2-TI 163, 3-HDBRG, 4-GT 7, 5-A 145, 6-GT 7xA 145, 7-GT 7xA 145,M-MARKER



Chromosome 22 SSR



Chromosome 23 SSR

Fig.6: SSR profile of tobacco lines

1-GT-8, 2-TI 163, 3-HDBRG, 4-GT 7, 5-A 145, 6-GT 7xA 145,7-GT 7xA 145,M-MARKER

Electrophoretic characterization of tobacco (K. Siva Raju and K. Nageswara Rao)

Simple sequence repeats (SSRs) markers were used to study the genetic variability among the flue-cured tobacco varieties grown in India. The genetic similarity among the varieties varied between 45 and 91% with an average genetic similarity of 68%. The varieties FCV Special and Dhanadayi showed minimum genetic similarity (45%) whereas the varieties Rathna and FCV Special and Jayasri and Jayasri

MR showed maximum (91%) genetic similarity (Fig.7).

Unweighted group method on arithmetic averages (UPGMA) method of clustering analysis, the 24 varieties were separated into two main clusters (A and B). Cluster A was formed by 14 cultivars with two sub-clusters and one variety Gauthami was independently linked to this sub-cluster. In the sub-cluster 1, the varieties were formed into 3 groups. Group I was formed by the varieties Virginia-Gold, CTRI Special, CTRI Special MR and VT 1158. CTRI Special was one of the parents to the varieties CTRI Special and VT 1158. The variety CTRI Special showed 88 and 80% genetic similarity with the varieties CTRI Special MR and VT 1158. The second group was formed by the varieties Dhanadayi, Kanakaprabha, Swarna and Kanthi. The varieties Dhanadayi and Kanakaprabha had a line Delcrest as one of the parents and the variety Kanakaprabha showed 85 and 88% of genetic similarity with the varieties Swarna and Dhanadayi, respectively. The third group was formed by the varieties Jayasri, Jayasri MR and Siri. The variety Siri was placed away from one of its parents Gauthami. The position of the variety Kanthi above the variety Jayasri was justified as the variety Jayasri was one of the parents to it. The variety Hema, a local selection and the variety, Godavari Special with different parentage were grouped together with 79% of genetic similarity.

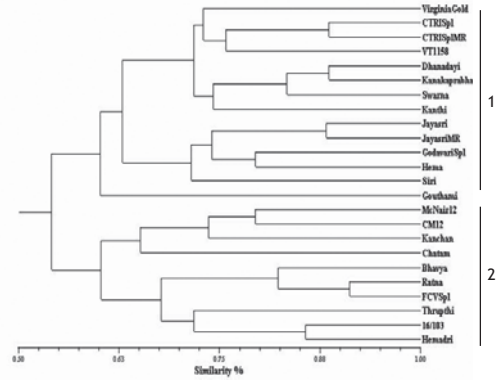


Fig.7: Dendrogram constructed using an UPGMA and SAHN algorithm from the Jaccard's similarity matrix data from all the SSR markers

The sub-cluster 2 was formed by 10 varieties with two main groups. The variety 16/103 was one of the parents to the variety Hemadri and both were grouped together with 85% of genetic similarity. The variety Thrupthi having different parentage was linked to this group with 65% genetic similarity. The varieties Bhavya, Rathna and FCV Special, were grouped together. The varieties McNair 12, CM 12, Kanchan and Chatam were grouped together, where the variety CM 12 was a chemical mutant of McNair 12 and the other two varieties were exotic introductions. The parentage of the varieties played an important role in the grouping of the varieties. In the sub-cluster 1, many of the varieties were interconnected with ancestral background. In the sub-cluster 2, except the variety Thrupthi, all other varieties have no ancestral pedigree with the varieties of sub-cluster 1. The specific marker identified in the present study will be helpful in identifying the variety FCV Special. More number of primers have to be screened to develop specific markers for the varieties.

Development of molecular markers for *Fusarium* wilt

(K. Siva Raju and K. Subrahmanya)

Two *Fusarium* wilt susceptible parents (Kanchan and Rathna), resistant line (SG 33) and one breeding line (Rathna x Kanchan) x SG 33(F4) were screened with RAPD and SSR primers for selection of primers that detect polymorphism between the parental lines. A total of 18 random decamer primers were used, out of which 3 primers were chosen for analysis based on the variation of reproducible bands produced in the parental lines. A total

of 48 fragments are common to all the parental lines. The primers OPL 14, OPAB 8, OPAB10 and OPL 3 which showed variation in the parental lines were used for amplification in 12 breeding lines including parents. The primer OPL 3 only showed variation in the breeding population and it will be tested in the large population for confirmation.

A total of 18 SSR primers were used, out of which 2 primers were chosen for analysis based on the variation of reproducible bands produced in the parental lines. A total of 31 fragments were amplified by 18 primers in four lines of which 7 were polymorphic with 22.5% of polymorphism. The primers except TbM41 and TBM 59 gave monomorphic pattern. The primers TbM 12, 36, 41, 45, 46, and 47 were used for amplification in 12 breeding lines including parents. The primers TbM 41, 45 and 59 produced polymorphism among the population. The primer TbM 41, TbM45 and TbM 59 will be used in large population of breeding lines showing different response to resistance for *Fusarium* wilt. A low rate of genetic polymorphism was detected between the parental lines.

Development of tobacco specific microsatellite markers

(K. Siva Raju and K. Palanichamy)

To standardize the PCR amplification conditions for newly synthesized SSR primers, factors like annealing temperature, concentration of primer and concentration of $MgCl_2$ were studied (Fig.8 & Table 3). The primer concentration was kept at 30 ng per reaction in all amplifications. Initially for all the primers the annealing temperature was kept at 55 °C and the $MgCl_2$ concentration was 1.5 mM. Many of the primers were not amplified and a few primers were amplified but the bands were in diffused state and very light in intensity. Then keeping the concentration of primer constant and annealing temperature was increased from 55 °C to 58 °C and $MgCl_2$ concentration was changed from 1.5 mM to 2.5 mM. Some of the primers gave very good amplification. The primers, which were not amplified at 58 °C, were tried at 60 °C of annealing temperature where a few primers were amplified. The primers which were not amplified with 2.5 mM $MgCl_2$ at 58 °C annealing temperature were tested with 3.5 mM $MgCl_2$.

Recently developed tobacco specific simple sequence repeats (SSRs) were used for the validation and to study the genetic diversity among the tobacco types. A total of nine primers were used, out of which 6 primers were chosen for analysis based on reproducible amplification pattern. The varieties included in the present study were 1. Hema, 2. Kanchan (FCV), 3. Banket A1 (Burley), 4. HDBRG (Burley) 5. Lanka special (*Natu*), 6. Sendarapatty special (cheroot), 7. S-5 (cigar wrapper), 8. Abirami (chewing), 9. Lichchavi (chewing), 10. Bhagyasri (*Bidi*) 11. GC-2 (chewing) and 12. Dharla (*Hookah*).

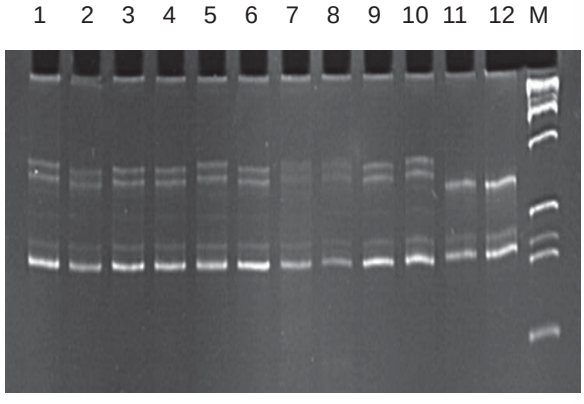


Fig.8: SSR amplification by TbM 31. Lane 1. Hema, 2. Kanchan, 3. Banket A1, 4. HDBRG, 5. Lanka Spl, 6. Sendarapatty Spl, 7. S-5, 8. Abirami, 9. Lichavi, 10. Bhagyasri, 11. GC-2 and 12. Dharla. M-DNA ladder.

Table 3: Standardization of SSR primer amplification

Conditions	Primers amplified
55 °C, 1.5 mM $MgCl_2$	A few primers were amplified with diffused bands
58 °C, 2.5 mM $MgCl_2$	TbM- 1, 5,10,16, 24, 39, 40, 41, 45, 46, 47, 62, 64, 65, 68, 70, 71, 72, 73 and 74
60 °C, 2.5 mM $MgCl_2$	TbM- 48, 61 and 66
58 °C, 3.5 mM $MgCl_2$	TbM- 3, 4, 4-1, 7, 8, 9, 11, 14, 43, 51 and 71

The genetic similarity among the cultivars of both the species varied between 37 and 85%. Between the species, the variety Lanka Special of *N. tabacum* L. and the cultivar GC-2 of *N. rustica* L. showed minimum genetic similarity (37%); whereas, the cultivars Hema of *N. tabacum* and the cultivar Dharla of *N. rustica* showed maximum genetic similarity (60%). Among the cultivars of *N. tabacum*, the genetic similarity varied between 40 and 88% with an average genetic similarity of 64%; whereas, the genetic similarity between the two cultivars of *N. rustica* was 75%. The genetic similarity between the FCV and non-FCV tobacco types of *N. tabacum* varied between 62 and 76%.

Unweighed pair group method on arithmetic averages (UPGMA) method of clustering analysis, the 12 varieties separated into two main clusters based on species specificity. The 10 varieties of *N. tabacum* formed cluster 1 with four sub-clusters. Sub-cluster1 was formed by two FCV cultivars, sub-cluster 2 was formed by 4 non-FCV cultivars, sub-cluster 3 included one chewing and *Bidi* type and the fourth sub-cluster was formed by cheroot and cigar wrapper types. The sub-cluster 2 was formed by Burley, chewing and Lanka Special in SSR grouping whereas in RAPD study, the Burley varieties and chewing varieties grouped separately. The cluster 2 was formed by two cultivars of *N. rustica* with genetic similarity of 75%. Thus, the genetic similarities and clustering patterns between RAPD and SSR analysis gave nearly 80% similar results. Some of the specific markers developed in the present study can be used in the varietal identification.

PROGRAMME 4

CROP PRODUCTION TECHNOLOGY

CTRI, Rajahmundry

Permanent manurial trial: Long term manurial and fertilizer experiments on FCV tobacco in Vertisols (Variety: VT 1158)

(R. Subba Rao, P. Harishu Kumar and J.A.V. Prasad Rao)

Application of farm yard manure @ 7.5 tonnes/ha recorded significantly higher yield of cured leaf, bright leaf and grade index with an increased yield of 8.7, 28.5 and 20.1%, respectively over no farm yard manure. Among the various inorganic fertilizers tested (N, P and K), application of nitrogen @ 22.4 kg/ha recorded significantly higher yields of cured leaf, bright leaf and grade index with an increased yield of 26.7, 21.6 and 15.5%, respectively over no nitrogen. Potassium @ 56 kg/ha showed its significant increase in leaf yield production of all kinds over no application of potassium. Application of phosphorus did not exhibit variation in production of FCV tobacco.

Permanent manurial trial

(J.A.V. Prasad Rao)

Tobacco leaf lamina samples of 2005-06 season were analysed for N, P, K, reducing sugars, nicotine, total ash, insoluble residue and leaf burn. Tobacco composite samples (stalk, root, midrib and inflorescence) were analyzed for N, P & K and their uptake was computed. Application of FYM increased the leaf nitrogen and nicotine and decreased the reducing sugars and leaf burn as compared to no-FYM application. FYM application increased the uptake of all the major nutrients compared to no-FYM application. Among the inorganic sources, N-application showed a profound effect on the uptake of major nutrients when compared to the control and all the other combinations without N in both No FYM and FYM treatments.

Iron - Manganese interactions in FCV tobacco in Vertisols

(J.A.V. Prasad Rao)

A feeler trial was conducted with the variety VT 1158 to improve the leaf manganese content in turn lowering the Fe/Mn ratio, through soil and foliar applications of Mn and see its effect on flavourful quality. Application Mn either to soil or foliage had no effect on the yield characters. However, an increase in reducing sugars and a slight decrease in nicotine was noticed with the foliar application of Mn, when compared to control and water spray treatments.

Effect of foliar nutrition of Boron on quality leaf production in FCV tobacco under different organic manures

(P. Harishu Kumar, S. Kasturi Krishna and C. Chandrasekhararao)

Maximum cured leaf of 2,330 kg/ha was recorded due to application of 2.5 t vermicompost/ha followed by 0.2% B as foliar spray at 20, 40, 60 DAT and at par with all the treatments except no FYM and no B spray and no FYM with 0.2% B spray. It is therefore, inferred that under FYM or vermicompost application, foliar nutrition of B @ 0.1% or 0.2% showed a non-significant improvement in cured leaf yield and grade index but followed the same trend as that of cured leaf. Potassium content in the lamina indicated an increase due to B foliar application in all the treatments. However, the increase was conspicuous at 0.2% B foliar spray of 20, 40, 60 DAT under FYM and vermicompost only. The correlation coefficient between midrib K and leaf K is negative (-0.2982) and the soil K with leaf K is -0.3719.

Response of light intensity in relation to nitrogen fertilization in flue-cured Virginia tobacco

(M. Anuradha, K. Nageswara Rao, K. Siva Raju and V. Krishnamurthy)

Pot culture experiments were conducted with three levels of sunlight (100%, 75% and 50% sunlight) and three levels of nitrogen (4.95, 6.60 and 8.25 g N/plant) using recommended package of practices. During the crop growth period, leaf samples were analysed for total chlorophyll content, *in vivo* nitrate reductase activity and total soluble protein content. Yield components, leaf area and specific leaf weight were measured at harvest. Cured leaf samples were analysed for quality parameters. The total chlorophyll content increased with increased concentration of nitrogen under normal sunlight and decreased in 75% and 50% sunlight. *In vivo* nitrate reductase activity increased and soluble protein content decreased due to low sunlight. More leaf expansion was observed under 75 and 50% sunlight and specific leaf weight decreased with decrease in sunlight at X, L and T positions. Green leaf yield, cured leaf yield and grade index decreased due to low sunlight. Increased nicotine content and decreased reducing sugars were recorded with decrease in sunlight (75% and 50%) and increased concentration of applied nitrogen. Total nitrogen content and starch content were reduced with increasing nitrogen application and reduced sunlight. With reduced sunlight chlorogenic acid and rutin content were reduced and applied nitrogen did not show significant affect.

Chloride nutrition in flue-cured tobacco

(M. Anuradha, K. Nageswara Rao, C. Chandrasekhararao and V. Krishnamurthy)

Experiment 1

Pot culture experiment was conducted with six levels of chloride (0, 5, 10, 15, 20, 25, 30 g Cl/plant) in light soil using recommended package of practices. Harvested leaf was cured in an electric barn (Fig.9). Cured leaf samples collected from X, L and T positions were analysed for leaf burn, chlorides, nicotine and reducing sugars. Results showed that chloride levels did not influence the yield characters significantly. Leaf chloride content increased with increased level of applied chloride and leaf burn reduced with increased leaf chloride concentration and there is a negative correlation between lamina chloride and leaf burn (Fig.10).

T1 T2 T3 T4 T5 T6

T1 - 0 g Cl /plant, T2 - 5 g Cl /plant T3 - 10 g Cl / plant T4 - 15 g Cl /plant T5 - 20 g Cl /plant T6 - 25 g Cl /plant

Fig.9: Influence of applied chloride on cured leaf of flue-cured tobacco

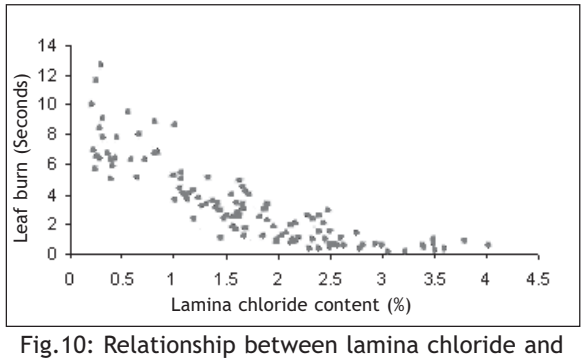
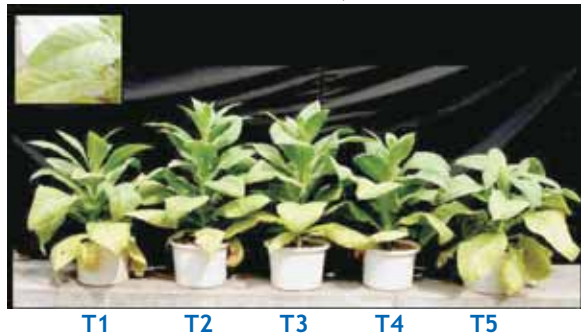


Fig.10: Relationship between lamina chloride and leaf burn

Experiment 2

Sand culture experiment was conducted with five levels of chloride (0, 0.99, 1.98, 3.96,



T1 T2 T3 T4 T5

T1-0 g Cl/plant, T2-0.99 g Cl/plant, T3-1.98 g Cl/ plant, T4-3.96 g Cl/plant, T5 - 7.92 g Cl/plant

Fig.11: Symptoms of excess chloride

7.92 g Cl/plant) in river sand using Mc Murtay nutrient medium. The plants were allowed to grow for 60 days. The plants fed with higher levels of chloride showed toxicity symptoms (Fig.11). At 60 days after planting, the plants were pulled from the pots and fresh and dry weight of all plant parts were recorded. The applied chloride content did not influence the dry weight of the plant. With increase in the supply of chloride, the leaf chloride content increased in all the positions of the plant. In the leaf, the chloride content was more in the midrib than in the lamina.

Feeler trial

Curing studies in flue-cured tobacco

Leaves of three maturity levels (Immature, Mature and Over mature) from 4th pick were selected from the harvested leaf of varieties Hema and VT 1158 from the bulk plots at CTRI Katheru farm and the leaf samples were drawn periodically from the bottom and top portion of the barns to estimate leaf moisture, nicotine and sugars. Prevailing temperatures in the barn were recorded from the curometer fixed in the barn and also the leaf temperatures of leaves loaded in bottom and upper tiers of barn were also recorded using infra-red thermometer. The leaf moisture content was higher in over mature leaves than mature and immature leaves of both the varieties Hema and VT 1158. Nitrogen and nicotine concentrations were higher in immature leaf as compared to over mature leaves; whereas, sugars were higher in over mature leaves.

- The curing schedules differed depending on the variety
- Yellowing and colour fixing stages were completed in the variety Hema, within 36 hours and then the lamina drying stage was initiated. In the variety VT 1158, yellowing and colour fixing stages continued beyond 48 hours and lamina drying temperatures were reached after 54 hours.
- The moisture removal pattern from the leaves loaded in bottom and upper portion of the barn and also the moisture removal from lamina and midrib varied significantly
- In the variety Hema, lamina and midrib drying was completed in the bottom tier leaves in 48 and 96 hours, respectively and in the variety VT 1158, in 66 and 78 hours, respectively.
- Moisture removal from the leaves loaded in upper tiers was 96 and 110 for lamina and midrib in the variety Hema and in VT 1158 the lamina and midrib was dry by 120 hours for the leaves loaded in upper tiers.
- Leaf temperatures recorded with infrared thermometer showed that there is considerable difference between the barn temperature and leaf temperature.
- Maximum leaf temperatures were reached in upper tier leaves in 110 hours in Hema and 120 hours in VT 1158.

QUALITY EVALUATION LABORATORY

During the period under report, 10,284 tobacco leaf lamina samples pertaining to different crop years of various projects of the main Institute and its research stations including AINRP(T) and traders were analyzed for various chemical quality parameters viz., nicotine, reducing sugars, chlorides and total nitrogen (Tables 4 & 5).

Plant growth promoting rhizobacteria (PGPR) in tobacco-based cropping systems

(D.V. Subhashini and C. Chandrasekhararao)

Dynamics of plant growth promoting rhizobacteria in KLS

The isolates of PGPR including *Bacillus, Pseudomonas, Azospirillum* and *Rhizobium* and *Streptomyces* apart from VAM, *Streptomyces* spp. were isolated from the rhizosphere of KLS tobacco during the grand growth period. Isolates *Streptomyces* isolated from tobacco soils were screened *in vitro* for antagonistic activity against plant fungal pathogens, including *Fusarium*, *Pythium*, *Colletotrichum* and *Rhizoctonia*. Isolates having significant antifungal activity have been identified. Micro pot trials with selected isolates are being conducted. Some isolates also showed anti-nematode hatching *in vitro*.

Table 4: Chemical quality parameters of FCV tobacco (%)

Soil Type	Variety	Nicotine	Reducingsugars	Chlorides
NBS	Hema VT 1158 Siri	0.97 - 2.71 1.17 - 2.83 2.62 - 3.42	10.83 - 16.85 10.13 - 14.60 9.40 - 13.62	0.76 - 1.27 0.58 - 1.31 0.82 - 1.51
CBS	Siri VT 1158 Hema	1.76 - 2.70 2.28 - 3.14 2.61 - 2.89	15.24 - 18.25 12.55 - 15.82 9.82 - 13.46	0.17 - 0.57 0.22 - 0.47 0.20 - 0.41
SBS	Siri	3.13	15.12	1.94
NLS	Kanchan	1.61 - 2.88	6.30 - 14.34	0.43 - 1.25
SLS	Hema	1.87 - 2.78	7.76 - 9.97	0.16 - 0.30
KLS	Kanchan (X) (L) Rathna (X) (L) Thrupti (X) (L)	1.14 - 2.29 1.85 - 3.14 1.04 - 1.44 1.98 - 2.75 1.38 - 1.66 1.29 - 1.81	12.84 - 16.80 15.94 - 18.42 13.75 - 17.34 13.30 - 17.76 11.19 - 12.50 11.00 - 13.78	0.11 - 0.25 0.16 - 0.56 0.16 - 0.29 0.13 - 0.18 0.13 - 0.16 0.12 - 0.15

Table 5: Chemical quality parameters of non - FCV tobacco (%)

Centre	Varieties	Nicotine	Reducing sugars	Chlorides
Berhampur	Pyruvittanam	3.91	1.50	0.25
Nandyal (*Bidi*)	A-119 GT-5	3.98 3.69	1.97 1.71	1.60 2.45
Nandyal (Rainfed *Natu*)	Bhairavi WAF	3.18 2.13	2.18 2.72	2.47 1.93
Guntur (Rainfed *Natu*)	HDBRG Bhairavi	3.54 2.99	0.44 0.84	0.43 0.24
Jeelugumilli (Irrigated *Natu*)	Kommugudem (Melimi) Kommugudem (Gulla)	2.58 2.47	0.33 0.25	1.42 1.19
Nipani (*Bidi*)	Bhavyasree	2.85	8.16	0.54
Vedasandur	Bhagyalakshmi	3.89	0.68	4.39
(Chewing)	(Sun-cured) Bhagyalakshmi (Pit-cured) Bhagyalakshmi (Smoke-cured)	 2.75 1.85	 0.39 0.82	 4.56 5.61

VAM infestation was found to be maximum in KLS rhizosphere with 188 spores followed by NLS 144 spores, CBS 110 spores and SLS recorded the least 39 spores/100 g of soil.

Fluorescent pseudomonads in tobacco disease management

(D.V. Subhashini)

An experiment was laid out in 2 different locations at CTRI, main building complex to study the effect of *Pseudomonas fluorescens* in controlling damping-off disease caused by *Pythium aphanidermatum* in tobacco nurseries. There was no significant difference among treatments in case of fresh and dry weight of seedlings. Significant reduction of *Pythium* affected seedlings in the treatment *Pseudomonas* 3 lt/3 kg seed (one ml contains 9 x 10^7 CFU) was observed and it was on par with Ridomil, Phytolan and Bordeaux mixture. Significant increase in transplantable healthy seedlings was recorded in all the treatments as compared to control. Establishment of *Pseudomonas fluorescens* in the rhizosphere of tobacco seedlings was observed in all the inoculated treatments.

Feeler trial

Effect of K mobilizing bacteria and VAM on the growth, yield and quality of NLS tobacco (Pot culture)

Pot culture experiment was conducted to study the interaction of VAM and FA (*Frateuria aurantia*) and their utility as biofertilizers in NLS tobacco soils. The experiment was conducted with 8 treatments and 4 replications in pots filled with 50 kg of NLS soil. The seedlings of Kanchan were inoculated with *Frateuria aurantia*, which was obtained from Gokulum Biotech, Pondicherry.

The observations on FA & VAM infestation taken 45 days after planting showed significant improvement in the colonization of both FA & VAM alone. The colonization was more when both the microorganisms were co-inoculated. Fresh and dry weight of tobacco leaves, stem weight, seed weight and inflorescence weight were influenced by either single or as co-inoculation. There were no significant differences among treatments with respect to plant height and number of leaves. The dual inoculation of FA and VAM in the presence of recommended dose of NPK fertilizer recorded significantly higher dry matter, followed by FA+ RD and VAM + RD. The plants treated with VAM and FA alone were on par with absolute control.

CTRI Research Station, Jeelugumilli

Effect of level and time of potassium application on yield and quality of tobacco in NLS of Andhra Pradesh

(S.V. Krishna Reddy, S. Kasturi Krishna, P. Harishu Kumar and J.A.V. Prasad Rao)

The experiment was designed to raise the leaf potassium level under field conditions by modifying the rate and time of potassium application in top dressings and to study the effect on yield and quality of tobacco. The experiment consisted of 115 kg N/ha nitrogen, and six N and K ratios (0.5, 1.0, 1.5, 2.0, 2.5 and 3.0) with two splits of K application in 50: 50 proportions at 10 and 30 DAP and three splits in 25:50:25 proportion at 10, 30 and 45 DAP.

Results of three years pooled analysis showed progressive and significant increase in green leaf yield, cured leaf yield and grade index with increased N: K ratio up to 1.0:2.0. GLY, CLY and GI decreased beyond N: K ratio of 1.0:2.0. Application of potassium in three splits in 25:50:25 ratios recorded significantly higher GLY, CLY and GI compared to application of potassium in two splits in 50:50 proportions.

In general, there was a gradual increase of nicotine, total N, chlorides and potassium content and decrease of reducing sugars in leaf with increasing level of potassium application. No significant differences were observed in nicotine, total N, chlorides and potassium due to number of splits, while application of N & K in two splits showed significantly higher reducing sugars compared to three splits.

Seasonal variations were significant for all the quality parameters. In general, 2005-06 season gave higher nicotine, total nitrogen and

lower sugars while 2004-05 season showed higher potassium in leaf.

Effect of foliar spray of Zn, Mg and topping level on yield and quality of cv. Kanchan in irrigated Alfisols of Andhra Pradesh

(S.V. Krishna Reddy, S. Kasturi Krishna, P. Harishu Kumar and P.R.S. Reddy)

The experiment was conducted for two consecutive seasons during 2004-05 and 2005-06 to study the influence of Zn and Mg foliar spray and topping level on yield and quality of FCV tobacco cv. Kanchan in a factorial randomized block design replicated three times with four foliar sprays (water spray at 35 and 45 days after planting (DAP), Zn SO_4 0.5% spray at 35 and 45 DAP, Mg SO_4 0.5% spray at 35 and 45 DAP and Zn SO_4 0.5% + Mg SO_4 0.5% spray at 35 and 45 DAP) and four topping levels (16 leaves, 20 leaves, 24 leaves and 28 leaves) at old farm.

Results of two years pooled analysis indicated that two foliar sprays of 0.5% $ZnSO_4$ + 0.5% $MgSO_4$ at 35 and 45 days after planting and topping at 24 leaves recorded higher GLY, CLY and GI. Cured leaf yield and grade index were significantly higher in 2004-05 season than in 2005-06 season.

A perusal of quality parameters indicated that foliar spray of 0.5% Zn SO_4 + 0.5% Mg SO_4 sprays recorded significantly higher nicotine in P, X and L positions. Significant differences in nicotine content were not noticed in T position due to different foliar sprays tried. Reducing sugars were higher with foliar spray of 0.5% Zn SO_4 + 0.5% Mg SO_4 as compared to other sprays. Topping at 16 leaves level recorded significantly higher nicotine and reducing sugars content and there was a significant reduction in nicotine and reducing sugars content as the topping level increased from 16-28 leaves level. Chlorides were well within the acceptable limits.

Moisture and nutrient depletion/utilization pattern under NLS conditions

(S. Kasturi Krishna, S.V. Krishna Reddy, V. Krishnamurthy C. Chandrasekhararao, and M. Anuradha)

The experiment was conducted to study the moisture and nutrient utilization/depletion pattern under NLS conditions with three levels of N (90, 115, 140 kg/ha) and two levels of K_2O (120, 140 kg/ha) and replicated four times.

In the first year, significant differences were observed in the cured leaf and grade index of tobacco due to N and K levels. Application of 115 and 140 kg N/ha being on par recorded significantly higher cured leaf and grade index as compared to 90 kg N/ha at 120 kg N/ha. Nitrogen content decreased from 30 to 90 days. Dry weights of stem and root continued to show increased growth up to 125 days after planting (Figs. 12, 12a & 13).

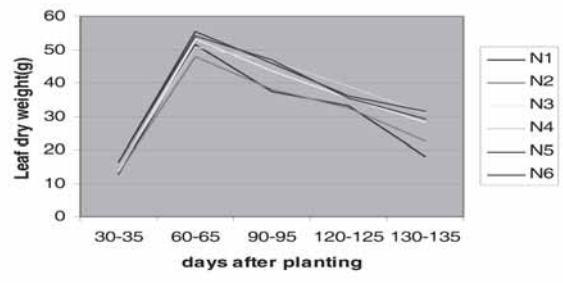


Fig. 12: Leaf dry weight of tobacco plant at different stages of crop growth

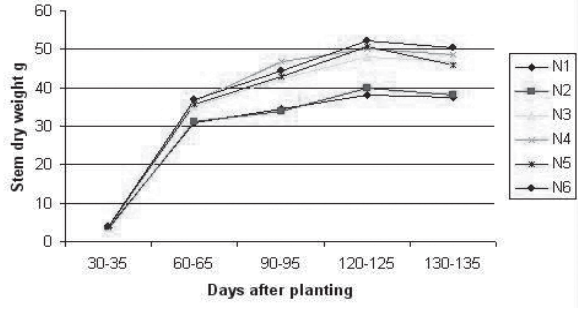


Fig. 12a: Stem dry weight of tobacco plant at different stages of crop growth

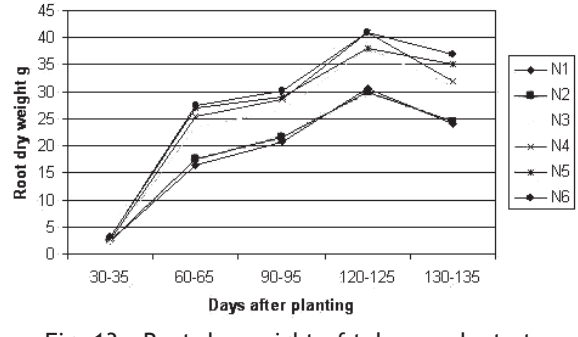


Fig. 13: Root dry weight of tobacco plant at different stages of crop growth

Integrated approach in flue-curing barn to economize energy and improve leaf quality

(M. Sannibabu)

Trials conducted for two years (2004-05 and 2005-06) with various curing manipulations to supply oxygen during yellowing period and quick removal of moist air from the barn revealed that the Turbofan showed encouraging results. The results of on-farm trials conducted in four locations in the NLS area of Andhra Pradesh also revealed that a saving of 20 hours curing time and 400 kg fuel was achieved by using the Turbofan.

Quantification of aroma in tobacco in terms carbonyls and other gases by anemometric method

(M. Sannibabu and K. Siva Raju)

An innovative anemometric technique was developed for the estimation of aroma in terms of carbonyls content in tobacco leaf. It is a non-destructive method. The specifications of chemicals, leaf chamber, sample quantity, amount of air to be passed were quantified.

The efficacy of different micro irrigation nozzles in wetting tobacco nursery beds with appropriate soil aeration techniques

(M. Sannibabu)

The experiment was laid out in a replicated random block design in tobacco nursery for two years. The mini water emitters tested were half jet, full jet and mini sprinklers along with control hand watering by rose can. The schedule of watering was as per the need of climatic demand. Irrigations were given as per the treatments whenever needed. The micro jet emitters were adjusted to 1.5 lit/ hour till the bed gets wetted.

Results of pooled data revealed that the treatments, mini sprinkler and hand watering were on par in seedling production. The same two treatments are highly significant when compared to mini full and half jets. Regarding irrigation water, mini emitters saved 50% irrigation water when compared to hand watering. It can be concluded that, 5 mini sprinklers staged in between the 2 tobacco nursery beds made easy in irrigating the tobacco nurseries. It saved 50% irrigation water and 80% labor and created a very congenial micro climate in the nursery site.

Crop growth modeling for FCV tobacco in Northern Light Soils

(C. Chandrasekhararao, M. Anuradha, K. Siva Raju, S. KasturiKrishna and H. Ravishankar)

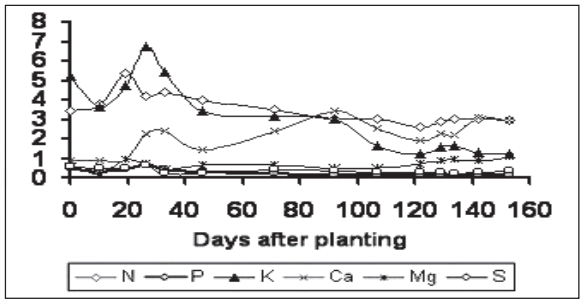
Field experiments were conducted at CTRI Research Station, Jeelugumilli during 2006-07 season with three dates of planting (Early, Normal and Late). During the crop growth period observations were taken on leaf length, breadth, plant height, root length, root volume and dry matter at different stages. Crop growth rate, net assimilation rate, leaf area index (LAI) and specific leaf weight (SLW) were computed. The yield parameters were at par in early and normal planting and were reduced in late planting.

Crop growth parameters

Higher crop growth rate was observed in 42-72 days in early planting, 56-75 days in normal planting and between 43-49 days and 74-84 days in late planting. Higher net assimilation rates were observed between 12-52 days in early planting, 28-62 days in normal planting and 14-49 days in late planting. Leaf area index increased up to 91 days in early planting, 98 days in normal planting and 84 days in late planting. Specific leaf weights were higher in later part of the crop growth compared to early stages.

Nutrient concentrations and uptake

Analysis of lamina samples of 2005-06 season for different nutrients at different stages revealed that the concentration of nitrogen, phosphorus and potassium were higher in the initial stages and were reduced in the later stages whereas calcium content was low in the early stages and high in the later stages. Higher lamina uptake was observed during 67-125 days after transplanting. In late planting crop, the duration of higher uptake was low. Uptake of different nutrients by lamina was in the order of N>K>Ca>Mg>S>P. Nutrient uptake was more in the new farm where soils are slightly heavier textured compared to the old farm (Figs. 14 & 15).



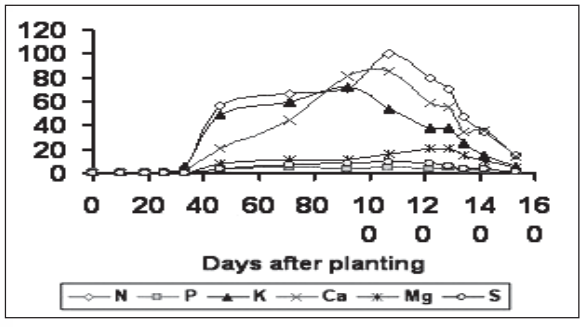
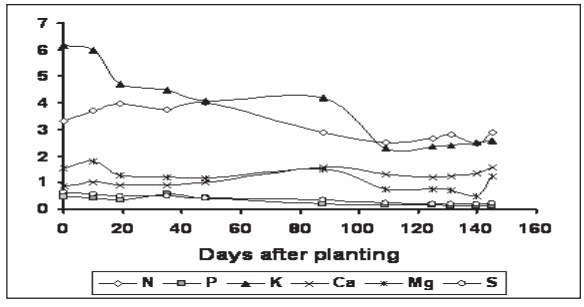


Fig. 14: Nutrient concentration and uptake by leaf at different stages of crop growth (Normal planting, New farm)



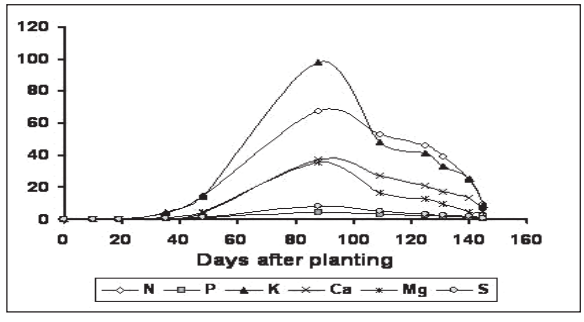


Fig. 15: Nutrient concentration and uptake by leaf at different stages of crop growth (Normal planting, Old farm)

Regression equations

Total dry matter can be predicted with leaf area index (LAI) and specific leaf weight (SLW) alone or in combination. The regression values can be improved by addition of climatic parameters.

Total DM = -6.56+107.65 LAI R^2 = 0.932 **

Total DM=-195.96+4.903SLW R^2= 0.676 **

Total DM= 189.76+5.193NAR R^2 = 0.017

Total DM = 284.55 -20.48 CGR R^2 = 0.316 **

Total DM = -70.38 + 90.62 LAI + 1.188 SLW R^2 = 0.949 **

Total DM = -50.51 +87.27 LAI + 1.14 SLW -2.50 CGR R^2 = 0.952 **

Total DM = -67.47 + 91.34 LAI + 1.254 SLW -3.037 NAR R^2 = 0.954 **

Total DM = - 62.40 + 90.32 LAI + 1.23SLW – 2.58 NAR – 69.14 CGR R^2 = 0.932 **

Total DM = 369.100815 -20.693 Min T + 60.371 Max T + 2.2641 RF + 4.5913 SS -59.940 Evap. -4.8603 RH Min -11.052 RH Max. R^2 = 0.681 **

Total DM = -92.874220 + 91.842 LAI + 15654 Min T + 17.391 Max T +0. 59869 RF + 6.4776 SS -22.995 Evap. -1.5536 RH Min -2.9929 RH Max. R^2 = 0.953 **

Total DM = -169.964997 + 87.591 LAI + 0.89841 SLW + 1.8500 MinT+ 14.166 MaxT +18.592 RF+ 2.9262 SS -20.053 Evap -0.88534 RHMin -2.2279 RH Max. R^2 = 0.958 **

Total DM = -143.865436 + 88.531 LAI + 1.0323 SLW -1.7376 NAR +1.3431 MinT +12.452 MaxT -0.053803 RF +2.4095 SS -20.013 Evap -0.83919 RHMin -1.8997 RH Max. R^2 = 0.959 **

Total DM = -148.464030 + 87.721 LAI +1.0078 SLW -1.3912 NAR -56.394 CGR +1.4338 MinT +12.330 MaxT -0.17199 RF +2.3811 SS -19.637 Evap -0.86167 RHMin -1.7736 RH Max. R^2 = 0.959 **

Bulk trial

Evaluation of Potassium nitrate as a top dresser for FCV tobacco in Northern Light Soils of Andhra Pradesh

Field experiment (bulk trial) was conducted at CTRI RS, Jeelugumilli during 2006-07 season to evaluate potassium nitrate as top dresser in comparison to potassium sulphate for FCV tobacco in Northern Light Soils. Soil properties of the experimental site are slightly acidic, low in soluble salts, chlorides and organic carbon, high in available P and K. Recommended package of practices were followed in raising the crop. Potassium nitrate was at par with sulphate of potash in terms of yield and chemical quality parameters. All the chemical quality parameters were within the acceptable limits in both the treatments. Hence, potassium nitrate can be used as a top dresser for FCV tobacco in Northern Light soils of Andhra Pradesh.

Carbohydrate metabolism as influenced by nitrogen and potassium nutrition in flue-cured tobacco grown in NLS

(K. Nageswara Rao, M. Anuradha, C.V. Narasimha Rao and V. Krishnamurthy)

Field experiment with four levels of nitrogen (80, 100,120 and 140 kg N/ha) and four levels of potash (120,150,180 and 210 kg K_2O/ha) were conducted at CTRI RS, Jeelugumilli to study the effect of levels of nitrogen and potash on the yield and chemical composition of flue-cured tobacco variety Kanchan. Higher levels of nitrogen (120 and 140 kg N/ha) gave significantly higher green leaf, cured leaf and grade index. Potash levels did not affect the yield characters and the interaction between nitrogen and potash was non-significant. Leaf area of top leaves was measured and it was found that there was increase in leaf area of top leaves with higher levels of nitrogen as well as potassium. Leaf samples were collected from T position and nitrogen and potassium were estimated in green leaf and harvestable leaves. Harvestable leaves contained lower levels of nitrogen and potassium as compared to green leaf.

Sucker control in flue-cured tobacco grown in NLS

(K. Nageswara Rao and M. Anuradha)

A field experiment with four suckericide treatments along with control (Decanol@4%) was conducted at CTRI RS, Jeelugumilli. The semi-systemic suckericides, Flumetralin and Pendimethalin@2% were tried at concentration alone and along with Decanol@3% application. The differences in yield characters viz., green leaf, cured leaf and grade index were non-significant due to sucker control with new suckericides as compared to control. To measure the extent of sucker control, observations were recorded on sucker number, sucker fresh weight and sucker dry weight. The results showed that the number of suckers was low in Decanol@3% + Flumetralin@2% applied plots in the counts taken at 15 and 30 days after suckericide application. Sucker count, sucker fresh weight and sucker dry weight were higher in Decanol@4% as compared to all the other treatments.

BTRC, Jeddangi

Effect of spacing and nitrogen levels on yield and quality on Burley tobacco hybrid, YBH-1

(R. Subba Rao and P. Harishu Kumar)

The experiment was conducted with three spacings (0.80 x 0.45 m, 0.90 x 0.45 m and 1.00 x 0.45 m) in main plots and four nitrogen levels (100, 120, 140 and 160 kg N/ha) in sub-plots, in a split plot design with three replications to study the effect of various spacings and nitrogen levels on yield and quality of Burley tobacco hybrid, YBH – 1 and to find out optimum spacing and N level to the hybrid. Closer spacing of 0.80 x 0.45 m (27,777 plants/ha) while not differing statistically with the standard spacing of 0.90 x 0.45 m (24,691 plants/ha) recorded significantly higher cured leaf yield when compared to wider spacing of 1.00 x 0.45 m (22,222 plants/ha). Among the levels of nitrogen, the lower level of 100 kg N/ha recorded significantly lower Burley tobacco leaf yield when compared to the other levels of 120, 140 and 160 kg N/ha which were at par. The interaction of spacing x nitrogen levels

did not show any statistical variation in production of Burley tobacco.

Studies on the influence of plant population and nitrogen levels on yield and quality of Oriental tobacco (Variety: Izmir)

(R. Subba Rao and P. Harishu Kumar)

The experiment on Oriental tobacco cv. Izmir, was conducted with four spacings (0.30 x 0.12 m, 0.30 x 0.15 m, 0.40 x 0.12 m and 0.40 x 0.15 m) in main plots and four nitrogen levels (0,5, 10 and 15 kg N/ha) in sub-plots in a split plot design replicating three times to develop the crop management practices for Oriental tobacco. Closer spacing of 0.30 x 0.12 m (2,77,777 plants/ha) recorded comparatively higher cured leaf yield compared to other spacings, though there was no significant variation between spacings. Among the levels of nitrogen tested, application of no nitrogen (0 kg N/ha) recorded significantly lower yield of Oriental tobacco compared to application of 5, 10 and 15kg N/ha. The interaction of spacing x nitrogen levels was not significant.

Studies on N and K interaction effects on Oriental tobacco (Variety: Izmir)

(P. Harishu Kumar, R. Subba Rao and C. Chandrasekhararao)

The experiment was laid out in a factorial design with the variety Izmir, at a spacing of 30 x 15 cm as test crop to N (0,5,10 and 15 kg N/ha) and K (10, 20, 30 kg K_2O/ha) requirements.The green leaf production was significantly influenced by N and K fertilizer levels and their interactions. Highest green leaf of 3,139 kg/ha was recorded at N_{15} x K_{10} level only and was significantly superior to all other levels. Similarly N_{15} x K_{10} recorded the highest cured leaf of 625 kg/ha and significantly superior to all other combinations of N and K fertilizers. It is inferred that the variety Izmir showed significant response by recording maximum green and cured leaf due to application of 15 kg N + 10 kg K_2O per hectare.

Effect of Mg, Zn, B and biofertilizers (*Trichoderma* + *Azospirillum* + PSB + VAM) on Burley tobacco (Variety Banket - 1) leaf yields in bulk plots

(P. Harishu Kumar and R. Subba Rao)

A bulk testing plot was managed with 200 plants each {Biofertilizers (BF), BF + $MgSo_4$ 0.4% foliar spray, BF + $ZnSo_4$ 0.4% foliar spray, BF + Boron 0.2% foliar spray, BF + water spray, BF + Vermicompost (1 t/ha) and Control} to see the effects of above micronutrients and biofertilizers on cured leaf yields in the light soil tract of Burley tobacco. The crop received normal fertilization and spacing with all the usual plant protection measures. It is inferred that Mg exerted maximum impact on increasing cured leaf yield followed by Zn and B. The biofertilizers, alone or with vermicompost recorded 17.75 and 13.86% increase in cured leaf yield, respectively over the control.

Feeler experiments

Effect of organic manures on cured leaf production of Oriental tobacco

(P. Harishu Kumar and R. Subba Rao)

Preliminary work on Oriental tobacco revealed that the variety Izmir planted at 30 x 15 cm spacing and fertilized at 10:20:10 kg NPK per hectare required 1 t vermicompost per hectare to produce 516 kg/ha cured leaf and 2,706 kg/ha green leaf. The differences due to application of FYM or FYM + vermicompost or goat dropping to give an amount of 1 t organic manure were non-significant over vermicompost.

Effect of different sources of fertilizer N on Oriental tobacco leaf yield

The Oriental tobacco variety Izmir recorded a maximum of 523 kg cured leaf when fertilizer N was supplied 50% through urea + 50% through ammonium sulphate. Correspondingly, the green leaf weight was also maximum and significantly superior to CAN, ammonium sulphate, urea or 50% N as CAN with 50% N as urea or ammonium sulphate at

fertilizer N dose of 10 kg/ha and at a spacing of 30 x 15 cm.

Effect of foliar nutrition of Mg, Zn and B on Oriental tobacco leaf production

Foliar nutrition of $MgSO_4$ (0.4%), B (0.2%) and $ZnSO_4$ (0.4%) and their combinations indicated that B (0.2%) with $ZnSO_4$ (0.4%) or with $MgSO_4$ (0.4%) or $ZnSO_4$ (0.4%) spray at 35 DAP recorded higher values for cured leaf and green leaf when the crop was planted at 30 x 15 cm at a fertilizer schedule of 10:20:10 NPK kg/ha.

Effect of mulches on Oriental tobacco leaf production

Feeler experiment was conducted with green leaf mulch, grass mulch, paddy straw mulch, no mulch and inter-cultivations along with earthing up to see the effect on Oriental tobacco leaf production. Indications are that paddy straw mulch in the inter-row spaces benefited the crop by producing 494 kg/ha cured leaf and 2,659 kg/ha green leaf and at par with two inter-cultures at 25 DAP and 50 DAP or with one inter-culture at 25 DAP followed by earthing up when the crop was planted at 30 x 15 cm at a fertilizer schedule of 10:20:10 NPK kg/ha.

Effect of different schedules of pot watering on Oriental tobacco leaf production

Pot watering @ 1 litre water per metre square at 30, 60, 90,120,150 DAP recorded a maximum of 470 kg/ha cured leaf compared to other watering schedules.

CTRI Research Station, Guntur

Effect of FYM, N, P and K on FCV tobacco leaf yield in permanent manurial trial

(P. Harishu Kumar and G. Raghupathi Rao)

Application of FYM @ 7.5t/ha produced significantly higher yields of green, cured and bright leaf and grade index by 34, 34, 15 and 23%, respectively over no FYM. Inorganic source of nitrogen @ 22.4 kg N/ha recorded significantly higher yields of all the characters over no nitrogen application. There was an increase of 8.7% in cured leaf and 6.2% in bright leaf production with the application of inorganic nitrogen application over no nitrogen application. No marked variation was noticed due to the application of either P or K in the production of FCV tobacco of all the leaf yield characters studied. As regards interaction, FYM x N or P or K in respect of cured leaf and bright leaf yields production was significantly higher with FYM + 22.4 kg N/ha when compared to no FYM and no inorganic nitrogen.

Effect of organic manures and inorganics on leaf yields of rainfed *Natu* tobacco (Permanent manurial trial)

(P. Harishu Kumar and G. Raghupathi Rao)

Application of FYM @ 15 t/ha and FYM @ 7.5 t/ha + neem cake to supply 30 kg N/ha while not differing amongst themselves, produced significantly higher total cured leaf and middle grade leaf over no FYM and neem cake to supply 60 kg N/ha. As regards inorganic sources, application of nitrogen @ 45 kg/ha significantly improved the total cured leaf, bottom, middle and top grade leaf over no nitrogen. Application of P_2O_5 at 110 kg/ha and potash at 55 kg/ha has also improved the total cured leaf and other leaf yield characters of *Natu* tobacco except the top grade leaf during the year under report. The interaction effects between organic sources vs inorganic sources indicated that the application of FYM at 15 t/ha and FYM 7.5 t/ha + neem cake to supply 30 kg N/ha in combination with inorganic sources of nitrogen, P_2O_5 and K_2O improved the yields over their respective controls.

Development of organically grown FCV tobacco in central Vertisols

(P. Harishu Kumar and G. Raghupathi Rao)

The experiment was conducted with four *in situ* green manuring practices viz., *pillipesara*, sunnhemp, *bajra* and control (no *in situ* green manuring) and seven combinations of biofertilizers to produce organic tobacco. Green manuring *in situ* with sunnhemp and *pillipesera* were found to be advantageous for FCV tobacco in Vertisols over

the control. Among the combinations of biofertilizers, application of *Azosprillium* + VAM + PSB produced significantly higher cured, bright leaf yields and grade index followed by the treatment with application of *Azotobacter* + PSB in almost all the yield characters of FCV tobacco in Vertisols.

Response of Oriental tobacco types to N and K fertilization under different agro-climatic conditions

(P. Harishu Kumar and G. Raghupathi Rao)

Four varieties viz., Izmir, Bergam, Xanthi and Komo were evaluated separately in RBD with three replications at Giddalur, L.K.Doddi (Raichur) and Munagal areas. In general, var. Bergam at all the three locations i.e. Giddalur, LK Doddi (Raichur) and Munagal showed superior performance in producing higher cured leaf yields of 791 (7.5 kg N and 20 kg K_2O/ha), 1,250 (15 kg N and 20 kg K_2O/ha) and 1,541 kg/ha (15 kg N and 20 kg K_2O/ha), respectively. Next best were Xanthi, Izmir and Komo for Giddalur, Raichur and Munagal locations, respectively.

CTRI Research Station, Kandukur

Studies on the influence of quality of irrigation water and fertilizer levels on growth and production of healthy seedlings from tobacco nurseries under SLS conditions

(R. Sreenivasulu and C. Chandrasekhararao)

An experiment was conducted in nursery using water containing 28, 50, 100, 200, 300, 400 and 500ppm chlorides in main plots and two fertilizer levels viz., recommended dose of fertilizer (RDF) and 1½ times to RDF in sub-plots. The germination count tended to decline slightly in response to increased chloride content but the results were non-significant. The diseases occurring in nursery, damping-off and blight showed a slight declining tendency with increased chlorides in irrigation water. However, the differences were non-significant. The damping-off and blight incidence were relatively more with increased fertilizer dose compared to RDF. The growth of seedlings as indicated by fresh and dry weight, decreased significantly with increase in chlorides in irrigation water. The weight of seedlings was more under increased fertilizer level, especially when high chloride water was used. However, the interaction effects were non-significant. The yield of transplantable seedlings decreased with increase in chlorides in water. The reduction was steep beyond 200 ppm chlorides. Significantly, higher number of transplantable seedlings were recorded under increased fertility level especially with water containing high chloride. The interaction effects were not significant.

Part of the experiment was carried out in pot culture also, to observe the effects of main plot treatments more clearly. The increase in chloride content in water decreased the germination count significantly, especially beyond 200 ppm. The effect on damping-off and blight were non-significant. Growth of seedlings as indicated by fresh and dry weights were affected more severely compared with steady on nursery side. Yield of transplantable seedlings was reduced significantly beyond 200 ppm chlorides in irrigation water.

Feeler experiment

Effect of different organics on growth, yield and quality of FCV tobacco under SLS conditions

(R. Sreenivasulu)

The southern light soils are low in organic matter content, which is necessary for improving yield and quality. This experiment was conducted to see the beneficial affects of different sources of organic materials and biofertilizers available in the market in comparison with FYM. Wellgro soil was tried at 100, 150, 200 and 250 kg/ha, vermin-compost at 1.5 t/ha, NADEP compost at 3.0t/ha, biofertilizers Vrikshamitra and Sanjeevani @ 20 kg/ha and 20 l/ha, respectively. On an average, the improvement in yields due to organics was 5.6% over control. Maximum yield was recorded with Vermicompost followed by NADEP compost, FYM and Wellgro soil @ 250

kg/ha and Wellgro soil @ 200 kg/ha. The mean values of nicotine content reducing sugars and chlorides were 1.98, 9.53 and 0.18%, respectively with minor variation among different treatments.

Effect of sucker control with chemicals on yields of FCV tobacco

(R. Sreenivasulu)

To find out an effective sucker control agent, some new chemicals at varying concentrations were tried along with recommended practices/chemicals. Prime + (flumetralin) and Stomp (pendimethalin) were tried @ 0.75, 1.00, 1.25 and 1.5% along with Sucker out, hand suckering and no topping.

When averaged over different methods and agents, topping improved the yields of cured leaf and bright leaf by 9.1 and 7.0%, respectively over no toping (control). It is inferred that Prime + @1.00% and Stomp @1.25% are promising for sucker control under SLS conditions. The mean values of nicotine, reducing sugars and chlorides in leaf were 2.37, 8.93 and 0.19%, respectively and nicotine tended to increase slightly in response to topping and sucker control.

Resource conservation through live bed system for improved productivity

(R. Sreenivasulu, Md. Osman*, V. Krishnamurthy and K.V. Rao*)

* CRIDA, Hyderabad

An experiment on live-bed system was conducted to dispose surplus run-off water safely and improve yield and quality of FCV tobacco in Southern Light Soils (SLS) areas. *Glyricidia maculata* which is a high biomass producer, less susceptible to grazing, with high coppicing ability and rich in nitrogen (3.0%) was grown on live-beds formed on contours. FCV tobacco variety Hema was raised at 65 x 65 cm spacing and 60-60-60 NPK kg/ha. The run-off and soil loss were reduced under live-bed system when compared to control. The yield was high under live-bed system compared to control even after accounting for the area occupied by live-beds. The chemical quality of leaf has not shown much change due to the treatments.

Effective conservation and utilization of South West monsoon rains for yield and quality improvement through cover cropping

(R. Sreenivasulu, Md. Osman*, V. Krishnamurthy and K.V. Rao*)

* CRIDA, Hyderabad

The experiment was laid out in split plot design with three replications with cover cropping treatments in main plots and nitrogen levels on FCV tobacco in sub-plots. Leguminous crops viz., greengram, cowpea and sunnhemp were raised along with cultivated fallow (farmers' practice) as control during *kharif*. FCV tobacco was raised during *rabi* with different nitrogen levels (25.0, 37.5, 50.0 and 62.5 kg N/ha). The run-off and soil loss were found to be more under fallow compared to cover crops, especially sunnhemp. Similarly, run-off was less under other land uses like tree crops and pastures when compared to FCV tobacco. The yield of FCV tobacco improved with the incorporation of cover crops, especially sunnhemp and cowpea. However, the differences were non-significant. Improvement was observed in yields with increase in nitrogen level up to 62.5 kg N/ha. However, the differences were significant up to 50 kg N/ha. There was saving of nitrogen up to 12.5 kg N/ha with sunnhemp green manuring. The chemical quality parameters of leaf indicated minor differences due to cover crops.

Effect of depth of life saving irrigation on growth, yield and quality of FCV tobacco

(R. Sreenivasulu, Md. Osman*, V. Krishnamurthy and K.V. Rao*)

* CRIDA, Hyderabad

An experiment was conducted to study the effect of depth of irrigation on tobacco crop with variety Hema. One life saving irrigation at 20, 30 or 40 mm depth and two irrigations at 15 + 15 mm and 20 + 20 mm were compared with no irrigation as control (Fig. 16).

Fig.16: Alternate Furrow Irrigation for water conservation

The results indicated improvement in green leaf, cured leaf and grade index, with life saving irrigation, over control. With one life saving irrigation, maximum yields were recorded at 40 mm depth followed by 30 mm and 20 mm. However, the differences between 30 mm and 40 mm depth were marginal. With two irrigations, cured leaf yield improved by 16.2% at 20 mm + 20 mm and by 13.8% at 15 mm +15 mm. The differences were significant in cured leaf yields. Leaf chemical quality parameters have not shown appreciable change. Giving two irrigations with harvested rain water may be a difficult option. The economics of one life saving irrigation at 30 mm depth was found to be quite favourable and the additional net returns were about Rs. 3,785/- per hectare, due to improved yield. Thus, the farm pond technology holds promise under SLS conditions, wherever ground water source is scarce and its quality is poor.

CTRI Research Station, Hunsur

Evaluation of vermicompost for its efficacy in FCV tobacco production

(M. Mahadevaswamy)

Vermicompost as organic source of nutrients was evaluated for its efficacy in field crop production during the third crop season of 2006-07. Application of vermicompost @ 4 t/ha + recommended NPK increased the cured leaf yield and top grade equivalent by more than 11% compared to recommended NPK + recommended FYM treatment and by 20% as compared to recommended NPK schedule alone. Application of vermicompost at various doses significantly increased the green leaf production compared to the recommended NPK treatment. In case of cured leaf yield and top grade equivalent, the yield differences were non-significant. However, results indicated that for getting higher yield of both cured leaf as well as top grade equivalent, spot application of 4 t/ha vermicompost (at the time of planting) was optimum for variety Kanchan under KLS conditions. The root-knot incidence was also significantly lower in all the vermicompost applied treatments (RKI: 1.29- 1.45) compared to NPK alone (RKI: 2.65). The cured leaf quality was not affected by vermicompost treatments.

The second year bulk trial conducted at Sollepura farm on the dose , time and method of application of vermicompost indicated that there was not much difference in the productivity between 2 t and 4 t/ha. Among the different methods of application, plant-hole application of the entire dose at the time of planting was found better compared to other methods of application.

Integrated nutrient management in FCV tobacco

(M. Mahadevaswamy)

Various organic sources such as FYM, press mud and vermicompost were evaluated in combination with inorganic fertilizers to find out optimum organic: inorganic ratio during the crop season of 2006-07 on sandy loam soil. The integrated nutrient management practice involving 25% organic and 75% inorganic form of nitrogen was found optimum compared to 50:50 or 75:25 ratios during the second year of the study. The cured leaf yield and top grade equivalent increased by about 8.8 and 9.0%, respectively with 25:75 ratio compared to 75:25 ratio. The treatment was also found better than the recommended NPK application

alone indicating the efficacy of integrated nutrient management for FCV tobacco. Among the different sources, vermicompost application was found to have better influence on growth and productivity than the application of press mud or FYM.

Feasibility of producing organic tobacco under KLS

(M. Mahadevaswamy)

A long term bulk trial on feasibility of producing organic tobacco under KLS condition was initiated at Sollepura farm during the crop season of 2006-07 with the following 4 treatments: fully organic farming practices (T_1), INM package with 75:25 (organic: inorganic) ratio (T_2), INM package with 50:50 (organic: inorganic) ratio (T_3) and conventional farming practice (recommended NPK & FYM) (T_4). Organic farming practices viz., use of tray nursery seedlings, spot application of vermicompost @ 6 t/ha at planting time, bio-fertilizer application @ 10 kg/ha, neem based organic application, use of bio-pesticides, raising green manure crop in *rabi* season after harvesting of *kharif* FCV tobacco were adopted.

Preliminary observation during the first year of the trial indicated that in the organic plot, there was about 35% decrease in the cured leaf production. The fully organic treatment recorded 979 kg/ha as compared to conventional treatment (1,526 kg/ha). However, the bright grade out turn was 82.8% in organic treatment compared to 75.8% in conventional practice indicating about 9.2% higher Top Grade Equivalent (TGE) yield in organic treatment compared to conventional method. The chemical analysis of the cured leaf indicated low nicotine in both X and L positions in the organic treatment. The trial is being continued to know the cumulative and long term effects of organic applications on the productivity and quality of the crop and soil organic matter.

Curing trials conducted with 'Turbofan'

Curing of FCV tobacco using 'Turbofan' as an energy saving device was taken up at Hunsur farm during the crop season of 2006-07. The average of four curings indicated that there was about 15% saving in wood fuel consumption compared to normal barn (without Turbofan). Similarly the total number of hours taken for complete curing operation was reduced from 140 to 119 hours. The visual observations showed comparatively less sponging of the cured tobacco because of better circulation of air inside the barn due to turbofan.

CTRI Research Station, Dinhata

Permanent manurial trial on *Motihari* tobacco

(R.L. Arya)

Data on permanent manurial trial showed that the application of 112 kg N + 112 kg P_2O_5 + 112 kg K_2O/ha significantly increased the green (17,162 kg/ha), cured (2,574 kg/ha) and first grade (820 kg/ha) leaf yield of *Motihari* tobacco as compared to control. Application of 112 kg N alone, 112 kg N + 112 kg K_2O/ha and 112 kg N + 112 kg P_2O_5/ha was comparable with each other and significantly superior to the treatments PK, P & K alone, 25 and 50 tonnes FYM /ha. It is clear from data that the application of nitrogen is essential for yield and quality of *Motihari* tobacco. Application of phosphorus either alone or in combination of different inorganic fertilizer and FYM significantly increased the P content in the leaves of *Motihari* tobacco as compared to other sources of fertilizers. Significantly highest K content in the leaf was recorded in the potassium applied treatment. Significantly highest nicotine content was obtained where nitrogen was applied either alone or in combination with other fertilizers. The organic carbon content (0.62%) and available K (246.3 kg/ha) was significantly influenced by application of organic and inorganic fertilizers.

Studies on sources, levels and time of nitrogen application on *Jati* tobacco variety Manasi

(R.L. Arya, S. Amarnath S. Roy and V. Krishnamurthy)

The experiment was conducted to study the effect of different sources (urea, CAN and AS), levels (75, 100 and 125 kg N/ha) and time of nitrogen application (100% basal, 75% basal + 25% at 30 DAP and 50% basal + 30% at 30 DAP + 20% at 45 DAP) on green, cured and first grade leaf yield, economics, nutrient composition of leaves and nutrient status in the soil of *Jati* tobacco variety Manasi. Basal application of 125 kg N/ha applied in the form of calcium ammonium nitrate is beneficial for producing highest productivity, quality and higher returns of *Jati* tobacco variety Manasi.

Studies on sources of organic manures and nitrogen levels in *Jati* tobacco variety Manasi

(R.L. Arya, S. Amarnath, S. Roy and V. Krishnamurthy)

The experiment was conducted to evaluate the effect of *in situ* green manuring with different crops (sunnhemp, dhaincha, greengram and Aman jute) levels of organic manure (FYM @ 0, 10, 20 and 30 t/ha) and nitrogen levels (50 and kg N/ha) on green, cured leaf yield, quality, economics, nutrient composition of leaves and status of nutrients in the soil. Application of green manuring with *dhaincha* and 10 tonnes FYM/ha along with 100 kg N/ha led to increased productivity and better quality, higher gross and net returns, B: C ratio and higher nutrient status in the soil in the newly released *Jati* tobacco variety Manasi under North Bengal condition.

Studies on effect of plant population and fertility levels on seed yield of *Jati* tobacco

(R.L. Arya, S. Roy, S. Amarnath and C. Chandrasekhararao)

Influence of different plant populations and fertility levels on the *Jati* tobacco var. Manasi in respect of growth attributes viz., plant height, number of leaves and number of branches per plant, yield attributing characters viz., number of fertile, non-fertile and total capsules and seed weight per plant, green and cured leaf, seed and seed equivalent yield and economics were studied in the trial. Significantly higher green and cured leaf, seed and seed equivalent yield of *Jati* tobacco were obtained at 90 x 30 cm spacing. Significantly higher growth and yield attributing characters, green and cured leaf, seed and seed equivalent yield were obtained with the application of 150:100:100 kg NPK/ha. Maximum monetary returns were recorded at 90 x 30 cm spacing and 150: 100: 100 kg NPK/ha in *Jati* tobacco var. Manasi.

CTRI Research Station, Vedasandur

Spacing and potassium requirement for the advanced breeding lines of country cheroot tobacco under Bhavani conditions

(M. Kumaresan and K. Palanichamy)

Different genotypes viz., HV 97-7, HV 97-10 and I 737 were tested at two levels of spacing (60 x 45 and 60 x 60 cm) and three levels of potassium (75, 100 and 125 kg/ha K_2O as K_2SO_4). The pooled data revealed that there were no significant yield differences between the genotypes. However, the genotype HV 97-10 recorded numerically higher yield (2,688 kg/ha). The spacing 60 x 45 cm significantly increased the cured leaf yield (2,742 kg/ha) over 60 x 60 cm spacing. The K levels did not influence the cured leaf yield.

Spacing and nitrogen requirement for the advanced breeding lines of chewing tobacco under Vedasandur conditions

(M. Kumaresan and K. Palanichamy)

Different genotypes (HV 98-16, HV 98-17 and Abirami) were tested under two spacings viz., 75x75 and 90 x 75 cm and at two N levels (75 and 100 kg N/ha in split plot design with three replications. The results of the pooled data revealed that genotypes had significant influence on the leaf width at topping /harvest and leaf length at harvest. The genotype HV 98-16 recorded the highest leaf width/length.

Spacing and nitrogen did not influence the growth attributes. The spacing significantly influenced the whole leaf yield. The spacing 75 x 75 cm increased the whole leaf yield (3,161 kg/ha) significantly. The genotype HV 98-16 significantly increased the total leaf yield (4,008 kg/ha) over HV 98-17 and Abirami. Similarly, significant increase in total leaf yield was observed with spacing 75 x 75 cm. The yield recorded was 4,202 kg/ha. It is concluded that HV 98-16 recorded the highest whole leaf yield and total leaf yield at a spacing of 75 x 75 cm and 75 kg N /ha.

Phosphorus management in chewing tobacco under Vedasandur conditions

(M. Kumaresan, P. Harishu Kumar and C. Chandrasekhararao)

The results of second year revealed that there were no significant differences among various 'P' management practices on the leaf length and yield. However, application of 50% P + PSB in the first year and application of 75% P alone in the second year recorded higher whole leaf yield (2,669 kg/ha) in the second year. The total leaf yield was higher (3,444 kg/ha) in the second year when 100% P + PSB was applied in the first year and 100% P alone in the second year.

Spacing and nitrogen requirement for the advanced breeding lines of chewing tobacco under Vedasandur conditions

(M. Kumaresan, K. Palanichamy and A.V.S.R. Swamy)

Different genotypes (HV 2000-2, HV 2000-6 and Abirami) were tested under two spacings (75 x 75 cm and 90 x 75 cm) and at two N levels (75 and 100 kg N/ha) in split plot design with three replications. The results of the first year revealed that the growth observations viz., leaf length/width did not have significant differences between the genotypes, spacings and nitrogen. The genotypes did not show significant differences with respect to whole leaf as well as total leaf yield. However, there was a numerical increase with HV 2000-6. The whole leaf and total leaf yield recorded were 2,396 and 3,043 kg/ha, respectively. The spacing had significant influence on the yield. The spacing 75 x 75 cm recorded an increased yield over the 90 x 75 cm spacing. Nitrogen did not influence the yield significantly. However, 100 kg N/ha recorded numerically higher yield over 75 kg N/ha. The interaction between genotype x nitrogen was significant. The genotype HV 2000-6 at 75 kg N/ha recorded the maximum total leaf yield of 3,141 kg/ha.

Agricultural Engineering

CTRI, Rajahmundry

Developing and constructing solar barn by using phase changing solar heat absorbing materials

(M. Sannibabu and B. Krishna Rao)

In the season 2005-06, inert materials viz. course sand , fine sand and carborudum were tested and found that the highest temperature absorbed by them were 5-10 °C,10-25 °C and 15-25 °C, respectively over ambient temperature. Regarding solar heat absorbing panels, the size was fixed as 50 X 50 cm. The phase changing materials viz., 1. Sodium carbonate, 2. Polyethylene glycol 6000, 3. Polyethylene glycol 4000, 4. Polyethylene glycol 600, 5. Parafin wax and 6. Sodium sulphate (anhydrous) were tested for heat absorbing and heat retention capacity and found that wax is the best for this work.

PROGRAMME 5 CROPPING SYSTEMS FOR SUSTAINABLE PRODUCTION

CTRI, Rajahmundry

Integrated rain water and nutrition management in tobacco based cropping systems in rain fed Vertisols

(S. Kasturi Krishna, S.V. Krishna Reddy, P. Harishu Kumar and V. Krishnamurthy)

As the yield of tobacco in cropping systems is less than that of sole tobacco, efforts were made to improve the yield of tobacco in the tobacco based cropping systems by agronomic management. During *kharif* season, maize and soybean and during *rabi* season, FCV tobacco were cultivated. Different treatments *viz.*, irrigation (one and two) and nitrogen levels (30, 45 & 60 kg/ha) were imposed in *rabi* tobacco.

Results of pooled data indicated that three systems maize – tobacco and fallow-tobacco being on par with each other recorded significantly higher green and cured and bright leaf yields and grade index whereas significantly lower green and cured leaf yields were observed in the soybean – tobacco system. Two irrigations significantly increased green leaf cured leaf and bright leaf yields and grade outturn than one irrigation. Application of 60 and 45 kg N/ha being on par with each other recorded higher yields and grade outturn than 30 kg N/ha. Interactions were not significant and higher cured leaf was recorded by fallow – tobacco with two irrigations and 60 kg N/ha.

In general, nicotine and reducing sugars were within the desirable levels. Significant differences were observed between the treatments for nicotine, reducing sugars and chlorides. Higher sugars were recorded in fallow - tobacco whereas higher nicotine and chlorides were recorded due to soybean – tobacco system. Two irrigations and 45 kg N/ha recorded higher values for nicotine, reducing sugars and chlorides. Nicotine values increased with increasing levels of nitrogen. Among the seasons, 2006-07 recorded significantly higher yields, reducing sugars and lower chlorides.

Moisture content increased with increasing depth. It was observed that moisture content was less in soybean – tobacco; whereas, higher moisture content was observed in fallow – tobacco and maize – tobacco during transplanting.

Productivity enhancement of soybean - bengalgram through integrated nutrient management in rain fed Vertisols of Andhra Pradesh

(S. Kasturi Krishna, S.V. Krishna Reddy, P. Harishu Kumar and V. Krishnamurthy)

The experiment was formulated to enhance the productivity of soybean-bengalgram cropping system in rain fed Vertisols as this system was found to be one of the viable alternative systems to sole FCV tobacco. Soybean was sown during *kharif* season with the following treatments: (1) 5 t FYM + 100% RD of NP, (2) 5t FYM+ 75% RD of N & P+ *Rhizobium* and PSB, (3) 25 t Vermicompost + 100% RD of N & P, (4) 3.25 t Vermicompost + 75% RD of N & P+ *Rhizobium* and PSB and (5) Recommended dose of fertilizers only. Chick pea was sown during *rabi* season with (1) 15 kg N + 50 kg P_2O_5, (2) 20 kg N + 37.5 kg P_2O_5 and (3) 20 kg N + 50 kg P_2O_5.

Results indicated that higher yields of soybean were recorded in FYM applied plots along with *Rhizobium* and PSB seed treatment to seed. Root dry weight and nodule dry weight was also high in these plots. Bengalgram yields showed significant differences due to residual effect of *kharif* crop nutrition management. Significantly higher yields of bengalgram were recorded in vermicompost with RDF applied plots. Vermicompost and FYM applied plots recorded significantly higher yields than RDF only without manures. Bengalgram yields showed significant differences due to application of fertilizers. Application of RDF gave higher yields than 25% reduction in N & P. Reducing 25% N decreased the yields by 5 % than RDF; whereas, 25% reduction in P decreased yields by 2.3% only. Nitrogen uptake

of the above ground parts of soybean and bengalgram was higher in plots where vermicompost and FYM was applied than the plots without organic manures. Though, gross returns were higher in vermicompost applied plots, net returns were higher in FYM with RDF applied plots as the input cost was higher in vermicompost applied plots.

Development of farming system through inter-dependable entrepreneurship under irrigated and un-irrigated conditions in black soils of East Godavari district

(M. Sannibabu, S. Kasturi Krishna and B. Krishna Rao)

The water harvested in the small pond will be utilized for irrigation for one-acre cultivable land and also pisci-culture. During 2006-07, tank bunds were planted with energy plantations like subabul, casuarina, acacia, eucalyptus and bamboo. Horticultural plants, coconut, banana, papaya, *moringa, guava* and *amla*. Fodder crops were raised in between energy plantation and on the slopes of tank bund.

CTRI Research Station, Jeelugumilli

Effect of *Rhizobium* and PSB inoculation on blackgram yield and its residual effect on succeeding FCV tobacco cv. Kanchan under irrigated Alfisols

(S.V. Krishna Reddy, S. Kasturi Krishna and C. Chandrasekhararao)

The experiment was conducted to study the effect of *Rhizobium* and phosphate solubilising bacteria (PSB) inoculation on blackgram yield and its residual effect on succeeding FCV tobacco cv. Kanchan under irrigated Alfisols. During *kharif* (June-Sept) blackgram crop was grown with four biofertilizer treatments (no inoculation, inoculated with either *Rhizobium* or PSB or both) along with sunnhemp (*in situ* green manuring) and fallow plots in a RBD, replicated six times. During *rabi*, tobacco was grown in a split plot design comprising of six main plots of *kharif* crops and three sub-plots of nitrogen levels (95, 115 and 135 kg N/ha) and replicated thrice.

Results of second year showed that combined application of *Rhizobium* and PSB inoculations to blackgram increased blackgram grain yield significantly as compared to single inoculation of either *Rhizobium* or PSB. Single inoculation of either *Rhizobium* or PSB also resulted in significantly higher yields as compared to no inoculation.

Among the cropping systems, sunnhemp-tobacco recorded significantly higher green leaf, cured leaf and grade index as compared to other treatments. Dual inoculation of *Rhizobium* and PSB to blackgram increased tobacco green leaf yield by 16.55%, cured leaf yield by 14.84%, and grade index by 16.56.% as compared to blackgram without inoculation. Single inoculation of blackgram with either *Rhizobium* or PSB also increased succeeding tobacco yields as compared to blackgram without inoculation. In respect of nitrogen level, green leaf, cured leaf and grade index were significantly more with 135 kg N/ha as compared to 115 kg N/ha. Interaction effects between preceding cropping system (biofertilizer used) and nitrogen level were not significant with regard to green leaf, cured leaf and grade index.

Effect of cropping systems on nitrogen requirement of tobacco

(S.V. Krishna Reddy, S. Kasturi Krishna and C. Chandrasekhararao)

The experiment was conducted for the second year with six treatments during *kharif* season viz., soybean, sunflower, groundnut, maize, sunnhemp (*in situ* green manuring) and fallow and three N levels of 95, 115 and 135 kg N/ha applied to FCV tobacco in the *rabi* season. The main objectives of the experiment are to find out the suitable preceding crop to *rabi* FCV tobacco, to find out the optimum level of nitrogen to tobacco after different preceding crops for better yield and quality of FCV tobacco and to evaluate the economics of different cropping systems.

All the *kharif* crops performed well and the yields are above average. Significant differences were noticed between the green

leaf, cured leaf and grade index of tobacco due to different cropping systems and nitrogen levels. Tobacco grown after sunnhemp (*in situ* green manuring) recorded significantly higher green leaf, cured leaf and grade index as compared to tobacco grown after other preceding crops. Groundnut - tobacco, sunflower - tobacco and fallow - tobacco recorded higher yields followed by soybean-tobacco. Maize - tobacco recorded significantly lower yields. Among the nitrogen levels, application of 135 kg N/ha recorded significantly higher green leaf, cured leaf and grade index as compared to 95 and 115 kg N/ha. Interaction effects between preceding cropping system and nitrogen level were not significant with regard to green leaf, cured leaf and grade index.

Effect of cropping system, source and ratios of organic manures on nitrogen requirement of tobacco

(S.V. Krishna Reddy, S. Kasturi Krishna and C. Chandrasekhararao)

The experiment was conducted for the second year with two cropping systems viz., sunnhemp (*in situ* green manuring) and fallow in *kharif* and three proportions of organic: inorganic source of N viz., 0: 100, 25:75 and 50:50 and three N levels of 90, 120 and 150 kg N/ha applied to FCV tobacco in the *rabi* season. The organic manure used was filter press cake. The main objectives of the experiment are to find out the most remunerative preceding cropping system, to find out optimum level of nitrogen and optimum proportion of organic: inorganic sources of nitrogen to produce quality leaf.

Sunnhemp *in situ* green manuring - tobacco recorded significantly higher green leaf yield, cured leaf yield and grade index as compared to fallow - tobacco. The 25:75 proportion of organic N: fertilizer N produced significantly higher green leaf yield and cured leaf yield as compared to 0:100 and 50:50 proportions of organic N: fertilizer N. The green leaf yield and cured leaf yield increased significantly with progressive levels of N applied up to 150 kg N/ha. However, application of 150 kg N/ha and 120 kg N/ha both being on par recorded significantly higher grade index as compared to 90 kg N/ha.

Studies on feasibility and economic viability of intercropping in FCV tobacco under irrigated Alfisol (NLS) conditions

(S.V. Krishna Reddy, S. Kasturi Krishna, C. Chandrasekhararao, P. Harishu Kumar and K. Siva Raju)

Tobacco under NLS conditions is grown with wider spacing (100 X 60 cm) and during the initial period of tobacco growth, most of the ground area is not covered by the crop canopy and sufficient amount of light will be available for growing short duration inter-crops. Tobacco was planted in paired rows (60 cm between pairs) keeping a distance of 140 cm between two pairs of tobacco plants thus, maintaining the recommended population of tobacco. Different crops *viz.* Amaranthus, spinach (*palak*), coriander, fenugreek, radish, carrot, onion, and garlic, were grown as inter-crops in between the paired rows of tobacco. Among the intercrops grown, *palak*, amaranthus and radish performed well followed by carrot and onion. The performance of coriander and fenugreek was below average.

There were no significant differences between green leaf, cured leaf and grade index between different intercropped treatments and sole tobacco. Due to intercropping, earthing up of tobacco was not done and also more number of irrigations were given to inter cropped tobacco than normally required (to sustain the intercrops at early stages of crop growth). Among the inter crops tried, tobacco + radish recorded highest net returns (Rs. 63,414) and benefit: cost ratio of 1.82 followed by amaranthus and garlic.

Studies on feasibility and economic viability of relay cropping in FCV tobacco under irrigated Alfisols (NLS) conditions

(S. V. Krishna Reddy, S. Kasturi Krishna, C. Chandrasekhararao and P. Harishu Kumar)

As tobacco is a multi-harvest crop, after 3 to 4 primings, the bottom 6 to 8 leaves are

removed and the space near the ground will receive sufficient sunlight for growing relay crops and as harvests advance, more and more light will be available for inter crops. As tobacco in NLS is grown under irrigated conditions, there will be no dearth of moisture to the crops. Tobacco was planted with normal spacing. Relay crops were sown when 5 to 6 leaves are left on the tobacco plant. Relay crops were sown on one side of the ridge and on both sides of the ridge.

There were no significant differences between GLY, CLY and grade index due to different relay crops grown. Tobacco yields were not affected by sowing on one side of the ridge or on both sides of the ridge. Among the relay crops grown, bottle gourd, cucumber, cluster bean, groundnut and watermelon performed better. Performance of ridge gourd was below average. Sowing on both sides of the ridge gave higher yields than sowing on one side of the ridge. Among the relay crops tried, tobacco + bottle gourd sown on both sides of the ridge recorded highest net returns (Rs. 85,090/ha) and benefit: cost ratio of 2.12 followed by cucumber sown on both sides of the ridge (net returns: Rs. 74,439/ha and benefit: cost ratio: 1.97).

CTRI Research Station, Hunsur

Integrated Farming System Model

In the Integrated Farming System model, during 2006-07, horticulture (mango, *sapota*, tamarind and pomegranate) and silvipasture tree components (eucalyptus, casuarina, neem and acacia with perennial forage legume) were established. The border tree crops like silver oak, casuarina, teak were also established and vegetative fencing with *Jatropa* sp. was taken up. The cropping system involving various crops like hybrid cotton, redgram + groundnut, maize + cowpea, *ragi* in *kharif* and field bean and *ragi* in *rabi* season were successfully raised. Crop rotation was followed between the two cropping system blocks to improve soil fertility and soil health. In the subsidiary system, various components like kitchen gardening, animal husbandry (cow and goats), fodder production, rain water harvesting and vermicompost activities were successfully carried out. The second year economic evaluation of the different system/ components indicated maximum net returns in the subsidiary components followed by cropping system (hybrid cotton, groundnut + redgram) and agri-horti system. Nearly 90% of the total revenue generated was from the subsidiary system which was mainly through the sale of milk, vegetables and animals. The total revenue from 1.0 acre model amounted to Rs.25,708/- with a cost benefit ratio of 1:3.40.

CTRI Research Station, Dinhata

Studies on nitrogen requirement of *Jati* tobacco variety Manasi in relation to different sequential cropping systems

(R.L. Arya, S. Amarnath, S. Roy and V. Krishnamurthy)

Among the various cropping sequences, highest grain yield (4,362 kg/ha) of *Aman* paddy was recorded when preceding crop of sesame was grown in the system followed by maize and *Boro* paddy. Application of 125 kg N/ha recorded highest grain and stover/stick/ straw yield of all pre-*kharif* and *kharif* crops grown in the system. However, minimum grain and stover/stick/straw yield of various pre-*kharif* and *kharif* crops was recorded with the application of 75 kg N/ha. It is concluded that jute – *Aman* paddy – tobacco cropping sequence is a more profitable cropping sequence in North Bengal region. Further, application of 125 kg N/ha recorded more cured and first grade leaf yield and higher monetary return in newly released *Jati* tobacco variety Manasi in the North Bengal region.

PROGRAMME 6

BIO-ECOLOGICAL AND PATHOLOGICAL STUDIES ON PESTS AND DISEASES

Plant Pathology

CTRI Research Station, Dinhata

Management of bacterial wilt in *Motihari* tobacco and biochemical and molecular characterization of pathogenic isolates

(S. Roy)

Survey

Bacterial wilt was recorded in *Jati* tobacco in Binanoi village (East and West) in Podali type in the range of 2.66 to 4.00%. In *Motihari* tobacco, the disease (0.8 – 2.6%) was recorded at different locations from 26.12. 2006 to 05.02. 2007. Among the other solanaceous crops, the disease (0.8%) was recorded in potato during Feb, 2007 (5.2.07). In the crop season 2006-07, there was outbreak of hollow stalk disease in *Motihari* tobacco. The rainfall received during February (73 mm) and March (12.6 mm) in 7 and 5 days created havoc as most favourable pre-disposing factor for rapid-build-up and spread of hollow stalk disease. The rapid colonization and spread of hollow stalk disease might have masked the colonization of bacterial wilt pathogen caused by *Ralstonia solanacearum*.

Nematology

CTRI Research Station, Hunsur

Survey for plant parasitic nematodes associated with tobacco

(S. Ramakrishnan)

Fields in Hunsur and Sollepura farms were surveyed for the association of root-knot nematodes and other plant parasitic nematodes associated with FCV tobacco crop. In addition to root-knot nematodes, presence of reniform nematode, *Rotylenchulus reniformis* and root lesion nematode, *Pratylenchus* sp. were also noted. The root-knot index in various fields on 0-5 scale ranged from 1.0 to 2.4 and 2.0 to 4.2 in Hunsur and Sollepura farms, respectively. The root-knot nematode incidence was more in Sollepura as compared to Hunsur farm. Survey conducted in tobacco growing areas of Hassan district during 2006 season revealed the presence of *Meloidogyne* spp., *Rotylylenchulus reniformis*, *Helicotylenchus* spp., and other free-living nematodes. Soil samples representing 59 villages from 13 tobacco growing clusters were processed for enumeration of plant parasitic nematodes. It was found that 27% of the samples were free from root-knot nematodes and in rest of the samples, the root-knot nematode population ranged from 5 to 87 infective juveniles (IJs) per 100 g soil. Moreover, it was found that almost 60% of the samples recorded low root-knot nematode population in the range of 0-20 IJs per 100 g soil.

Entomology

CTRI, Rajahmundry

Development and validation of weather based forewarning system for the major pests of FCV tobacco

(J.V. Prasad, U. Sreedhar and K.C. Chenchaiah)

Incidence of major pests as influenced by dates of planting

During the early planting (20th September), damage by defoliators, *Spodoptera litura* and *Helicoverpa armigera* was significantly high. The crop planted during the first week of October (regular or middle planting) was relatively less damaged by most of the major pests and recorded good growth. When the planting was delayed till the third week of

October, the crop was mainly affected by the aphids, *M. nicotianae* which resulted in severe sooty mould development in the infested plants. The incidence of stem borer was also quite high during late planting (Fig.17).

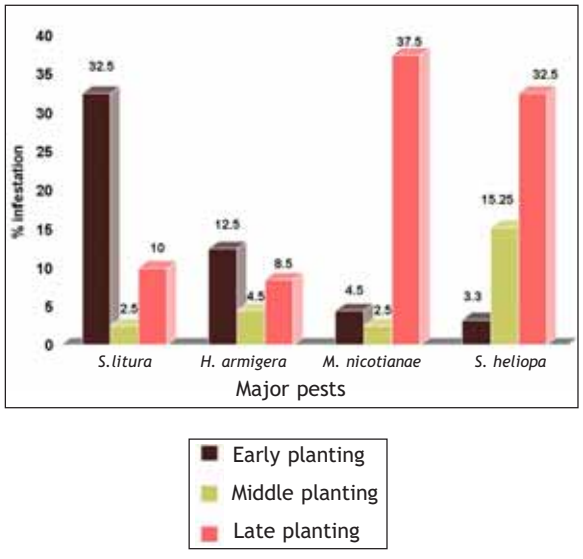


Fig.17: Incidence of major pests under different dates of planting during 2006-07

Spatial distribution of major insect pests in FCV tobacco

The spatial distribution of major pests in tobacco nurseries as indicated by dispersion parameters like mean (x), variance (s^2), mean/ variance and David Moore's index (s^2 / x^{-1}) suggest that the distribution of *S. exigua* and *S. litura* is aggregated, the degree of aggregation being quite high in case of the latter (Table 6). The tobacco bud worm *H.armigera* and the white fly, *B. tabaci* are less uniformly distributed in the nurseries. The parameters of dispersion suggest that the spatial distribution of major pests in the field crop is aggregated because a higher variance is recorded than the mean incidence of all these pests.

Relationship between the pest incidence and weather parameters

During the first date of planting, 75% of variability in the incidence of *S. litura* was explained by weather parameters and none of them had significant influence on the

Table 6: Spatial distribution of tobacco pests in the field crop

Dispersion parameter	*S.litura*	*H.armigera*	*S.heliopa*	*Leaf curl*
Mean incidence (%)	50.27	20.00	39.44	25.55
Variance (s^2)	183.74	152.94	158.49	120.26
Variance/mean	3.65	7.65	4.02	4.71
David Moore's Index (s^2/x^{-1})	2.65	6.65	3.02	3.71

incidence. Maximum temperature, minimum temperature and rainfall had a significant negative influence on the incidence of whiteflies. Similarly, incidence of leaf curl was significantly but negatively influenced by minimum temperature. The per cent infestation of *M. nicotianae*, *H.armigera* and the number of the predator *Nesidiocoris tenuis* per plant showed a significant negative correlation with minimum temperature.

In the 5th October planting, 64% variability in the number of whiteflies/plant could be explained by weather parameters. Maximum temperature influenced the incidence of this pest negatively whereas minimum temperature had a significant positive influence. The incidence of leaf curl, *H.armigera* and *M. nicotianae* and the number of the predator *N. tenuis* was negatively influenced by the minimum temperature.

During the late planting (20th October), 91% variability in the incidence of *S. litura* could be explained by weather parameters. Maximum temperature and rainfall exhibited significant negative association with the incidence of *S. litura* during this period. Mean number of whiteflies per plant had a significant positive association with minimum temperature. The incidence of *H.armigera* and *M. nicotianae* were influenced by weather parameters to an extent of 87 and 92%, respectively. Maximum temperature had a significant positive influence; whereas, minimum temperature had very significant negative effect on the incidence of both these pests during late planting.

Studies on the ecological role of *Nesidiocoris tenuis*, an omnivorous mirid bug in tobacco ecosystem

(J.V. Prasad, U. Sreedhar, S. Gunneswara Rao and K. Siva Raju)

The ability of the bug to predate on the eggs of lepidopteran pests is established in this study and it was observed that the predation increased with the advancement of age of the eggs. It was also noted that the predation of the eggs of *H. armigera* was comparatively low, which could be due to single egg laying habit of the pest. The ability of the mirid bug to predate on the lepidopteran larvae decreased as the larvae grew older and it had ceased by the 6th day in all the cases, except *S. exigua* where the predation stopped after the larvae attained 4 days of age. The mirid bug *N. tenuis* could feed on the nymphs of *M. nicotianae* to some extent but it was not found predating on either parthenogenetic adults or winged adults. It was observed that the tobacco types had some bearing on the predatory potential of the bug. The tobacco types, *Lanka*, *Bidi*, Burley and *Natu* supported very high predation; whereas, the least predation was recorded in the background of Oriental tobacco. Castor which is not a natural host of the omnivore did not support any predation of neonate *S. litura* larvae.

PROGRAMME 7 INTEGRATED PEST AND DISEASE MANAGEMENT

Plant Pathology

Reaction of germplasm accessions to *Orobanche*

(C.A. Raju)

Sixty germplasm accessions and 29 selected accessions which showed lower incidence during previous years were assessed for their reaction to *Orobanche* during this year in an *Orobanche* sick field. The data indicated that overall incidence of *Orobanche*, in general, was better than last year (54.0% as against 27.6% average of last year), as compared to normal incidence of 60 to 80% in the same sick field during earlier years. In addition, there was no emergence of *Orobanche* after 70 days of planting which may be attributed to delay in planting and lack of rains after planting. Only two varieties/ accessions showed low incidence of less than 25%, while all other accessions showed high incidence of *Orobanche*. Among the 29 selected accessions which showed comparatively low incidence of *Orobanche* during previous years, only two accessions showed less than 25% incidence while all others showed higher incidence. Similarly, a total of 725 tobacco plants belonging to 58 different wild types/species and 2 controls (Hema and VT 1158) were screened under natural conditions in a sick field against *Orobanche*, with one irrigation to get increased incidence of *Orobanche*. The *Orobanche* incidence ranged from 0 to 100% in different accessions. *Nicotiana* sp. TW 110 and 111 (*N. repanda), N.* sp. TW 20 *(N. quadrivalvis*), TW 86 *(N. stocktonii*), TW 91 (*N. occidentalis*), ITB 520 (*N. longiflora* 4x), *N. trigonophylla, N. undulata* showed no incidence of *Orobanche* since last 2 or 3 years. Four entries (*N. undulata, N. trigonophylla, N. stocktonii* and *N. repanda)* showed no incidence for the second year also. Two entries (TW-111 and ITB-520) consistently showed no incidence of *Orobanche* since last three years.

CTRI Research Station, Hunsur

Testing the efficacy of copper hydroxide 77% against fungal diseases in tobacco nursery

(M. M. Shenoi)

Copper hydroxide 77% was evaluated against various nursery diseases viz., damping-off, leaf blight, black shank, anthracnose and frog-eye spot in a replicated trial. All the treatments involving copper hydroxide 77% alone or in combination with metalaxyl MZ 72 WP were significantly superior to untreated check for the control of the fungal diseases in nursery as well as for the yield of healthy transplants. It is concluded that these two active ingredients i.e., copper hydroxide and metalaxyl MZ can be used on rotation in FCV tobacco nurseries for the effective control of all the major fungal diseases instead of incorporating single fungicide metalaxyl MZ repeatedly along with carbendazim, thereby reducing the possibility of development of resistance in pathogens to metalaxyl and carbendazim.

Studies on soreshin disease in FCV tobacco nursery

(M. M. Shenoi)

The study indicated that propiconazole (@ 0.05 and 0.10%), a triazole compound is highly effective in controlling soreshin disease (92.6%). Other promising fungicides were thiophanate methyl, carbendazim and chlorothalonil which showed disease control efficacy in the range of 63.6 to 84.7% at different dosages.

Studies on root-knot nematode - *Fusarium* wilt disease complex in FCV tobacco

(S. Ramakrishnan and M.M. Shenoi)

A replicated field trial with bio-agents in rational combinations was conducted against root-knot nematode - *Fusarium* wilt disease complex in field sick with both the pathogens. Results revealed that, at 70 DAT, application

of *Pseudomonas fluorescens* @ 1 g/plant in combination with *Aspergillus niger* enriched FYM @ 100 g/plant recorded 53.0% reduction in *Fusarium* wilt disease incidence and also recorded reduced RKI of 2.01 compared to 3.80 in untreated check. The total cured leaf yield and bright grade yield were 1,245 kg/ha and 870 kg/ha, respectively compared to 992 kg/ha and 594 kg/ha, respectively in untreated check. Pooled results of two years data on evaluation of bio-agents in rational combinations against root-knot nematode – wilt disease complex revealed that application of *P. fluorescens* @ 1 g/plant in combination with *A. niger* enriched FYM @ 100 g /plant at the time of planting resulted in 61.4% decrease in wilt disease incidence at 70 DAT compared to untreated check. Similarly, there was significant reduction in root-knot disease incidence in terms of RKI to 1.93 as compared to RKI of 3.71 in untreated check plots. Subsequent increase in total cured leaf yield and bright grade yield was 1,311 kg/ha and 926 kg/ha, respectively as compared to 1,042 kg/ha and 615 kg/ha, respectively in untreated check.

Plant growth promoting rhizobacterium (PGPR) *Pseudomonas fluorescens* mediated suppression of root-knot nematode in FCV tobacco nursery

(S. Ramakrishnan and M.M. Shenoi)

Pseudomonas fluorescens (pf1 strain) in different dosage levels was evaluated for the third year against root-knot nematodes in FCV tobacco nursery, along with untreated check and carbofuran @ 10 g/m^2 as standard chemical check. Results revealed that at 60 DAS, *P. fluorescens* @ 5 g/m^2 recorded significantly reduced root-knot index (RKI) of 2.00 compared to RKI of 2.50 in carbofuran treated beds and RKI of 3.62 in untreated check. Reduction in root-knot nematode incidence in terms of RKI in treated beds ranged from 14.4 to 44.7%. Reduction in final soil population of root-knot nematodes after experimentation ranged from 27.2 to 44.2% in *P. fluorescens* treated beds compared to check. The subsequent increase in root-knot free healthy transplants yield in *P. fluorescens* treated beds ranged from 31.0 to 46.2% compared to check.

The bio-agent, *P. fluorescens* (pf1 strain) was also evaluated against root-knot nematodes in FCV tobacco nursery for its compatibility with other nematode management practices such as carbofuran, neem cake and soil solarization. Application of *P. fluorescens @ 10* g/m^2 in neem cake (400 g/m^2) amended solarized nursery beds in combination with carbofuran @ 10 g/m^2 recorded increased number of healthy transplants (725.0/m^2), which is 52.7% increase over untreated check (474.7/m^2). The same treatment recorded reduced RKI of 2.10, compared to 2.60 in carbofuran alone and 3.72 in untreated check on 0-5 scale. Such combination treatment also caused 48.3% reduction in root-knot nematode soil population compared to untreated check. Hence, it is clear that application of *P. fluorescens* in combination with chemical nematicide carbofuran and organic amendment like neem cake does not reduce its efficacy against root-knot nematodes in FCV tobacco nursery.

Pooled results of three year trial in FCV tobacco nurseries revealed that:

- Application of *Pseudomonas fluorescens* in lignite based formulation does not cause any phytotoxicity to affect tobacco seed germination.
- At 60 DAS, application of *Pseudomonas fluorescens* @ 5 g/m^2 recorded increased number of total root-knot free healthy transplants of 901.2/m^2, which was 54.4% increase over untreated check (583.7/m^2).
- *Pseudomonas fluorescens* @ 5 g/m^2 recorded reduced root-knot index (RKI) of 1.85 compared to 2.45 in chemical check (carbofuran @ 10 g/m^2) and 3.50 as RKI under 0-5 scale in untreated check. Further, it also resulted in 52.9% reduction in root-knot nematode soil population compared to check.

Screening of tobacco germplasm against root-knot nematodes

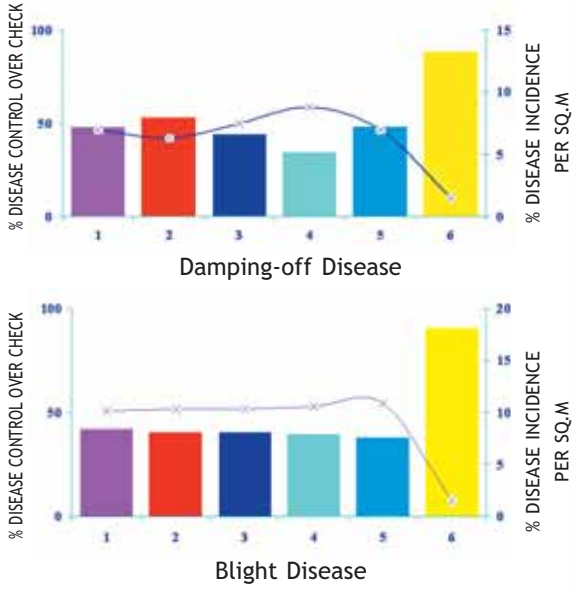
(S. Ramakrishnan and K.N. Subrahmanya)

A total of 33 tobacco germplasm material (FCH lines) maintained at CTRI Research Station, Hunsur were screened against root-knot nematodes under sick field conditions. Experimental results revealed that the lines viz., FCH 196, 199, 201, 204, 205, 207, 208, 211, 212, 219, 220, 221, 223, 224, 225, 226, 227 and 228 recording RKI of < 2.0 were found most promising against root-knot nematodes. Another 25 germplasm materials including eight AT & JL series lines were subjected to screening against individual species of root-knot nematodes viz., *Meloidogyne incognita*, *M. javanica* and *M. arenaria* in nursery microplots. None of the AT & JL series material were resistant to all the three species of root-knot nematodes and all the lines were found susceptible to *M. javanica*. Four lines, AT & JL-V8#1, AT & JL-16#3, AT & JL-V18#3 and AT & JL-V21#1 were found promising against both *M. incognita* and *M. arenaria*. The lines, RK9, 10, 11 and 12 were found to be promising against all the three species of root-knot nematodes. Whereas, RK7 and RK13 were found to be promising against *M. arenaria* only. The lines FCH 196 and FCH 199 were found to be promising against both *M. javanica* and *M. arenaria* with RKI ranging from 1.0 to 1.5 under 0-5 scale.

Bio-intensive management of root-knot nematode and soil borne fungal diseases in FCV tobacco nursery

(S. Ramakrishnan and M.M. Shenoi)

Farmyard manure enriched with nematode and fungal antagonists, *Pseudomonas fluorescens*, *Trichoderma viride* and *Aspergillus niger* either singly or in rational combinations were evaluated @ 4 kg/m^2 against root-knot nematodes and other soil-borne fungal pathogens in FCV tobacco nursery (Fig.18). Preliminary results of the trial indicated that, application of FYM enriched with *P. fluorescens* and *A. niger* @ 4 kg/m^2 recorded maximum number of healthy transplants (635.7/m^2) and was on par with recommended chemical schedule (625.2/m^2). Increase in healthy transplants was 30.2 and 28.1% over untreated check (488.1/m^2). At 60 DAS, *P. fluorescens* + *A. niger* enriched FYM, *P. fluorescens* + *T. viride* enriched FYM and chemical check were on par with each other in recording reduced RKI of 1.90, 2.00 and 1.88, respectively compared to 3.87 as RKI in untreated check. Similarly, FYM enriched with



1. Pf alone, 2. Tv alone, 3. An alone, 4. Pf+ Tv, 5. Pf+ An, 6. Rec. Check

Fig.18: Bio-intensive management of Root-knot & soil-borne fungal diseases

P. fluorescens + *A. niger,* FYM enriched *with P. fluorescens* + *T. viride* and chemical check were on par with each other by significantly reducing the final soil population of nematodes compared to untreated check. FYM enriched with bio-agent, singly and in rational combination recorded significant decrease in damping-off at 35 DAS (34.8 to 48.2%), damping-off + blight at 45 DAS (38.3 to 42.3%) and black shank (24.3 to 48..6%) compared to untreated check. But the treatments also significantly differed from chemical schedule, which was superior in decreasing the damping-off by 88.8%, damping-off + blight by 90.8% and black shank by 91.8% compared to untreated check.

CTRI Research Station, Dinhata

Management of bacterial wilt in *Motihari* tobacco and biochemical and molecular characterization of pathogenic isolates

(S. Roy, S. Amarnath, R.L. Arya and K. Siva Raju)

Integrated Disease Management of bacterial wilt

The experiment was conducted in bacterial wilt sick plot for management of bacterial wilt in *Motihari* tobacco var. Dharla. Bacterial wilt incidence was significantly lower in soil in the treatment, liming + fallow for 30 days + bacterial drench inoculation and in the treatment having same schedule with addition of green manuring with *dhaincha* as compared to fallow for 30 days + bacterial drench inoculation and fallow for 30 days + green manuring with *dhaincha* + bacterial drench inoculation. In the treatments where liming was not included, higher incidence of bacterial wilt was noticed indicating that liming of soils helps in lowering the population of the pathogen in the soil.

Role of biocides against damping-off of seedlings and growth promoting activity in *Jati* and *Motihari* tobacco nurseries

(S. Roy, S. Amarnath and R.L. Arya)

The influence of biocides i.e. *Trichoderma viride* and *Pseudomonas fluorescens* against damping-off of seedlings caused by *Pythium aphanidermatum* and also their growth promotion activities in *Jati* and *Motihari* tobacco seedlings raised in nursery have been studied. Significantly higher incidence of the disease was observed in nursery plots devoid of SSP followed by treatment of SSP only. In the treatments having *T. viride* + *P. fluorescens*, the disease was not recorded which indicates that mixed inoculation has significant impact in suppressing the disease. There is no clear trend of the biochemical parameters of the seedlings as per the defence chemicals viz., peroxidase, polyphenol oxidase, phenol and OD phenol released as a result of biotic/abiotic stress.

Screening for resistance against brown spot and hollow stalk in germplasm accessions of *Jati* (*N. tabacum*) and *Motihari* (*N. rustica*) in North Bengal

(S. Amarnath and S. Roy)

Screening for resistance against brown spot in *Jati* and *Motihari* tobacco

A total of 60 and 179 germplasm accessions for *Jati* and *Motihari* tobacco, respectively were screened for resistance to brown spot under field conditions. In *Jati* and *Motihari* tobacco, the disease scoring has been represented in the form of per cent disease intensity (PDI) at three different dates of observations and area under disease progress curve (AUDPC) between 1st and 2nd , 2nd and 3rd and 1st and 3rd dates of observations for 60 and 179 germplasm of *Jati* and *Motihari* tobacco accessions, respectively. The data indicates that there is gradual increase in the PDI from 1st to 2nd , 2nd to 3rd and 1st to 3rd dates of observations both in *Jati* and *Motihari* tobacco. Based on AUDPC score between 1st and 3rd observation dates, the germplasm accessions were ranked in four different categories viz., resistant (R) having AUDPC range between 0 – 250; moderately resistant (MR) from 250.1 – 500; moderately susceptible (MS) from 500.1 – 750 and highly susceptible (HS) > 750.

Entomology

CTRI, Rajahmundry

Studies on persistency and dissipation of insecticides in tobacco

(U. Sreedhar, C. V. Narasimha Rao and J.V. Prasad)

Effect of simulated rain on persistent toxicity of chlorpyrifos to *S. litura* on FCV tobacco

The mean persistent toxicity index (PTI) of chlorpyrifos in control (no rain but insecticide spray) was 725.00 as against 329.04 & 420.75, 191.71 & 286.25, 53.99 & 132.03 and 26.27 & 80.87 in sets sprayed without and with sticker, that received 5,10,25 and 50 mm rains, respectively. Though there is no increase in mean PTI in the sets that received rain up to 2 hrs after spray, the mean PTI values are 292.21, 333.40, 392.21, 420.16 and 445. 65 in the sets sprayed with insecticide + sticker, that received rain after 6, 12, 24, 48 and 72 hrs after spray as against 258.90, 295.02, 332.99, 297.70 and 254.69 in the sets without sticker & spreader. Rains occurring up to 6 HAS brought about much reduction in toxicity as compared to the rain occurring after 12 HAS and beyond. It was observed that rain levels and persistent toxicity of chlorpyrifos with or without sticker were negatively correlated. The increase in PTI with addition of sticker to chlorpyrifos showed that the persistent toxicity of the insecticide can be protected with the sticker at low levels of rain intensity.

Effect of simulated rain on persistent toxicity of acephate to *S. litura* on FCV tobacco

The mean persistent toxicity index of acephate in control was 806.0 as compared to 475.74 & 535.56, 418.24 & 459.73, 180.16 & 230.26 and 86.34 & 145.70 within the sets that received 5, 10, 25 and 50 mm rains without and with sticker, respectively. The reduction in persistent toxicity was gradual up to 10 mm and it was greater at 25 and 50 mm. The mean persistent toxicity of acephate at 0 rain interval was 197.66 as against 569.33 in sets that received rain after 72 h of spraying in insecticide + sticker treatments as against 197.55 & 521.63 in the treatments without sticker. The rain of 5, 10, 25 and 50 mm levels occurring within first 6 h of the spray reduced the insecticidal toxicity more as compared to later intervals. Rains of 5 and 10 mm occurring 24 h after the spray did not considerably reduce the toxicity of acephate. Though there is no increase in mean PTI in the sets treated with insecticide + sticker, that received rain up to 2 hrs after spray, the mean PTI values are 407.89, 497.44, 557.41, 577.92 and 569.33 that received rain after 6, 12, 24, 48 and 72 hrs after spray as against 365.09, 438.74, 479.83, 521.63 and 513.47 in the sets without sticker & spreader.

Dissipation of chlorpyrifos in FCV tobacco

A field trial was conducted to study the residue dissipation of chlorpyrifos in FCV tobacco. The results showed that there is a negative correlation between the pre-harvest interval after spray and the residue levels in the leaf. The residue levels decreased with increase in time interval between insecticide spray and harvest of the leaf. The highest residue of 1.94 ppm were recorded in the treatment in which the interval between insecticide spray and harvest of leaf was 5 days. It was 1.85 ppm and 1.56 ppm in the treatment where the time interval was 4 and 9 days, respectively. The residues were 1.51 ppm even 10 days after treatment. The residue levels came down drastically when the pre-harvest interval was 13 days but still they were higher (0.80 ppm) than the GRL (0.50 ppm). The residues were recorded to be below GRL (0.24 ppm) only after 15 days after treatment in fourth pick. In general the residues were below GRL from third pick onwards.

Evaluation of trap crops against bud worm in FCV tobacco

(U. Sreedhar)

A field experiment was conducted to find out if the effectiveness of trap crop in reducing the infestation of budworm, *H.armigera* on FCV tobacco can be enhanced with foliar spray of neem seed kernel suspension (NSKS) on tobacco. Two sets of promising trap crops viz., marigold with single whorl florets (sw) and marigold with multi-

whorl florets (mw) and *Rustica* tobacco (*Nicotiana rustica*) were planted around FCV tobacco plots. In one set FCV tobacco was sprayed with 0.5% NSKS. These treatments were compared with FCV tobacco plots without trap crop but sprayed with NSKS 0.5% and FCV tobacco plots without trap crop and without NSKS spray in a replicated field experiment.

Budworm infestation in tobacco

A significant reduction in budworm infestation was observed in tobacco plots with trap crops + NSKS spray as compared to plots with trap crop and without NSKS spray.

Population of budworm on trap crops

All the trap crops planted around FCV tobacco plots sprayed with NSKS recorded significantly higher number of eggs and larvae as compared to trap crops planted around tobacco without NSKS spray. FCV tobacco plots with *Rustica* tobacco as trap crop + NSKS spray on FCV tobacco recorded significantly higher number of eggs than all other treatments at 40 and 50 DAP (16.53 & 17.00/plant). At 60 DAP, though it recorded highest number of eggs (15.00) it was on a par with marigold-sw + NSKS spray (14.33). *Rustica* tobacco with NSKS spray on tobacco recorded highest larval population (6.87 – 8.40) at all the observations followed by marigold-sw + NSKS spray.

Natural enemy activity

On tobacco, *Nesidiocoris* sp., coccinellids, spiders and syrphids were recorded of which *Nesidiocoris* sp. was predominant. More coccinellids, spiders and syrphids were recorded on marigold-mw and their activity was also found to be more on tobacco with marigold-mw as trap crop. Similarly, population of other predators and parasitoids were more on marigold-mw followed by marigold-sw. NSKS spray did not adversely affect the activity of natural enemies on tobacco.

Yield

Tobacco plots with marigold-sw + NSKS and *Rustica* + NSKS recorded higher cured leaf yields than all other treatments except in marigold-sw+ NSKS which recorded significantly higher cured leaf yield than tobacco with marigold-sw. Significantly higher bright leaf yield was recorded in marigold-sw and *Rustica* tobacco with and without NSKS spray than control. Among the treatments marigold-sw+ NSKS and *Rustica* tobacco + NSKS recorded higher bright leaf yield. Similar trend was observed for grade index also.

Influence of proportion of trap crop to the main crop on the infestation of *H.armigera* in FCV tobacco

An experiment was conducted to find out the optimum proportion of trap crop to main crop to minimise the infestation of budworm, *H.armigera* in FCV tobacco. Two rows of trap crop (marigold) was planted after every 10, 20, 25, 50, 75 and 100 rows of FCV tobacco and compared with FCV tobacco without trap crop. The results showed that all the treatments recorded significantly less infestation as compared to control (tobacco without trap crop) except in 2% trap crop to main crop at 50 DAP. Budworm infestation in tobacco at 40 DAP was found to be highest (18.68) in 2% trap crop plots and it was least in 20% trap crop plots. Tobacco plots with 4, 8, 10 and 20 per cent trap crop were found to be on a par with each other and only 20% trap crop plots recorded significantly less (12.87) infestation as compared to 2.67% trap crop plots (15.31). At 50 DAP, the infestation in tobacco plots with 2.67, 4, 8, 10 and 20% trap crop were on a par with each other. Similar trend was observed at 60 DAP.

Studies on stem application of insecticides for management of tobacco aphid, *Myzus nicotianae*

(U. Sreedhar and J. V. Prasad)

Studies on the efficacy of stem application of insecticides against tobacco aphid, *M. nicotianae* on FCV tobacco were conducted. Imidacloprid 200 SL and thiamethoxam 25 WG were applied to the stem @1:20, 1:30 and 1:40 dilutions and were compared with foliar spray (FS) of imidacloprid and thiamethoxam @ 50 g a.i./ha in a replicated field experiment.

Combined analysis of two seasons data showed that stem application of imidacloprid @1:20 & 1:30 and thiamethoxam @1 :20 were found to be on par with foliar spray of imidacloprid and thiamethoxam at 6 DAT as shown by mean no. of aphids/plant. Whereas all the doses of imidacloprid stem application and thiamethoxam 1:20 were found to be equally effective as that of imidacloprid and thiamethoxam foliar sprays at 10 and 14 DAT. Thiamethoxam 1: 30 and 1:40 were found to be inferior to other treatments. Similar trend was observed in both the seasons. Pooled analysis of yield data showed that foliar spray of imidacloprid and thiamethoxam recorded highest green leaf, cured leaf, bright leaf and grade index followed by stem application of imidacloprid @ 1:20, 1:30 and thiamethoxam 1:20. Based on the aphid infestation and yield parameters, imidacloprid 1:30 and thiamethoxam 1:20 were most effective among the stem application treatments.

Leaf curl incidence

It was observed that leaf curl incidence was significantly less as compared to control (18.77%) in all the treatments. Least leaf curl incidence (9.15%) was recorded in imidacloprid FS followed by thaimethoxam FS (9.88%). These two treatments were found to be on a par with stem application of imidacloprid at all the doses.

Natural enemy activity

Thiamethoxam recorded higher natural enemy population as compared to imidacloprid used either as foliar spray or stem application. The population of all the predators was more in stem application of thiamethoxam followed by stem application of imidacloprid. The tobacco plots treated with foliar spray of imidacloprid and thiamethoxam recorded least natural enemy population. Among the natural enemies, population of *Nesidiocoris* sp. was more, followed by coccinellids and syrphids. Stem application of insecticides supported more natural enemies as compared to foliar spray.

Development, validation and refinement of IPM module for Burley tobacco

(U. Sreedhar and R. Subba Rao)

Three modules viz., IPM, biological control and chemical control were tested in Burley tobacco at BTRC, Jeddangi.

Components of IPM

- Sorghum as border crop around tobacco in IPM plot
- Imidacloprid @0.005% spray at 25 DAP to manage leaf curl in IPM plot
- Chlorpyrifos @0.05% spray to manage stem borer
- One spray of *Sl* NPV to manage *S. litura*
- Hand-picking and application of *Ha* NPV for management of bud worm
- Two sprays each of 0.5% NSKS, *Sl* NPV and *Ha* NPV in biological control plot
- Five insecticide sprays in chemical control plot with imidacloprid; chlorpyrifos and acephate at 20, 30, 40, 50 and 60 DAP

The results showed that the infestation of budworm, *H.armigera* was more followed by stem borer. The infestation of insect pests was more in biological control plot as compared to IPM and chemical control plots. Stem borer infestation ranged from 6.60 – 14.20 in biological control, 4.40 – 6.80 in IPM and 4.20-8.20 in chemical control plots. Leaf curl incidence was 4.60 - 10.20 in biological control, 1.00 – 5.00 in IPM and 0.80 – 5.80 chemical control plot. The infestation of *S. litura* in IPM plot ranged from 1.20 - 6.40; whereas, it was 0.80 – 14.60 in biological control and 0.66-8.00 in chemical control plot. Budworm infestation was lowest in IPM plot (0.20 – 6.20) and highest in biological control plot (1.80-20.80); whereas, it was 0.40 -7.00 in chemical control. On sorghum border crop around IPM plot, more coccinellids (0.6 - 12.60/plant) were recorded as compared to other predators during the season. Among others, spiders were predominant (4.20 - 8.00) followed by syrphids (1.80 - 5.20) and wasps (0.20 - 1.60). Green leaf yields in IPM, chemical control and biological control plots were 12,790, 10,500

and 9,306 kg /ha and the cured leaf yields were 1,695, 1,625 and 1,410 kg/ha, respectively.

Studies on compounds with insecticidal value from wild *Nicotiana* species

(J.V. Prasad, S. Gunneswara Rao and K. Siva Raju)

Experiments with crude sugar ester fractions from *N. gossei* and *N. trigonophylla* on tobacco aphid, *M. nicotianae* revealed that both the extracts brought about a significant mortality of the tobacco aphid at all concentrations tested. The highest mortality was recorded in the case of crude sugar esters @2% from *N. trigonophylla*. Compared to the sugar ester fraction from *N. gossei* , the sugar ester fraction from *N. trigonophylla* was observed to be more bio-active against tobacco aphid. The sugar ester fraction from *N. gossei* was incorporated into the artificial diet of *H.armigera* larvae at concentrations from 0.25 to 2.50 mg/g of diet and three-day old larvae were used in the bio-assay. The results showed that the mortality in the range of 22 and 29% was recorded at concentrations of 1.25 and 2.50 mg/g of the diet. The weight of the larvae 5 days after treatment was significantly low in all the treatments compared to control with maximum reduction being recorded at 2.50 mg/g concentration. Significant reduction in per cent pupation was observed only at concentrations of 1.25 and 2.50 mg/g of diet. The mean larval period was significantly prolonged in the diets with sugar fractions ranging from 0.50 to 2.50 mg. Adult emergence was significantly influenced in all the treatments compared to control. Thus, the crude sugar fraction from *N. gossei* appears to have growth regulatory properties though they did not exhibit significant toxicity to the larvae of *H.armigera*.

Screening of different tobacco germplasm against stem borer, *Scrobipalpa heliopa* Lower

(P. Venkateswarlu, R.V.S. Rao and S. Gunneswara Rao)

Screening under artificial infestation

A total of 60 FCV tobacco germplasm lines including 23 exotic and 37 indigenous lines were screened. The results indicated that among exotic lines, mean per cent seedlings infested by stem borer ranged from 33.33 to 100. Candel and NC-71 recorded least (33.33%) infestation compared to others. In the case of indigenous lines, *Karedu* and *Putcha* recorded less per cent (37.5) seedlings infested than the rest.

Infestation in different types of tobacco

Stem borer infestation was assessed at five different locations *viz.*, Rajahmundry, Jeddangi, Jeelugumilli, Hunsur and Guntur. There is difference in stem borer infestation among different types of tobacco and different locations. Among different locations, less than 5% infestation was recorded at Guntur and Hunsur. Less than 1% infestation was observed in Bhairavi (*Natu*), Banket A1 (early planting at Jeddangi), Hema and VT 1158 at Guntur. Oriental tobacco registered highest (92.6%) infestation at Jeddangi followed by FCV tobacco, Hema (27.3%) at Rajahmundry.

Studies on the efficacy of organic solvent leaf extracts against oviposition, feeding and growth and development of tobacco caterpillar, *Spodoptera litura* Fab.

(P. Venkateswarlu, K. Siva Raju, J.V. Prasad)

Dimethyl sulfoxide extract (2%) of 12 botanicals (dry leaves) viz., neem, *Pongamia*, tobacco, *Ipomoea*, *Datura*, *Occimum*, bougainvillea, custard apple, *Neerium*, papaya, *Lantana* and *Calotropis* were evaluated against growth and development of tobacco caterpillar, *Spodoptera litura* Fab. on castor. Among the 12 botanicals, neem was found to be the best growth regulator and ovipositional repellent against *S. litura* in the laboratory. *Pongamia, Lantana, Calotropis*, papaya and custard apple were the next best treatments. Larval mortality was more (90%) in *Calotropis* followed by custard apple (86.6%), papaya (80.0%), *Lantana* & *Neerium* (76.6%) and neem (73.3%). Larval length & weight, pupal length, weight were less whereas larval period and pupal period were more in all the treatments compared to control. Adult emergence was nil in neem, custard, *Lantana* and *Calotropis*. Adults have

not laid eggs in *Pongamia* and papaya treatments. Total number of eggs laid in each egg mass was also less in all botanical treatments compared to untreated control. Egg hatching was nil in *Neerium*. Highest egg hatching (81.5%) was recorded in untreated control followed by *Occimum* (49.7%), bougainvillea (48.6%), *Ipomoea* (37.9%), tobacco (33.4%) and *Datura* (21.7%).

Efficacy of various aqueous leaf extracts against tobacco stem borer, *Scrobipalpa heliopa* Lower

(P. Venkateswarlu, K. Siva Raju and S. Gunneswara Rao)

Among the botanicals, neem extract significantly reduced the infested plants over control, but it was on par with *Calotropis*, *Pongamia*, custard apple, *Datura* and *Lantana*. Per cent reduction of infested plants over control at 45 days after planting was more (81.70) in chlorpyriphos followed by neem (63.41), *Calotropis* (58.53), *Pongamia* (56.09), custard (54.87), *Datura* (52.43) and *Lantana* (52.43). In the remaining treatments, the per cent reduction of infested plants over control was below 50%. Yield data indicated that chlorpyriphos recorded significantly highest yield. However, it did not differ from neem except grade index. Cured leaf yields (kg/ha) were more (1,899) in chlorpyriphos followed by neem (1,795), *Pongamia* (1,785), *Calotropis* (1,779), custard (1,776), Jatropa (1,773), *Datura* (1,761), *Lantana* (1,739), papaya (1,734), tobacco (1,733) and *Cassia* (1,713).

AICRP on Biological Control

Biological control of *Spodoptera exigua* in tobacco nurseries with bio-pesticides

(S. Gunneswara Rao and P. Venkateswarlu)

NSKS @ 2%, *Beauveria bassiana* @10^{13} spores/ha and *Nomuraea rileyi* @10^{13} spores/ha were equally effective with 72-78% less seedlings damaged over control followed by *B.t* kurstaki @ 2 kg/ha with 62% and EPN 2 billion IJ/ha with 42% less seedlings damaged over control.

Validation of trap crop and border crop modules for the management of lepidopteran pests on tobacco

(S. Gunneswara Rao and P. Venkateswarlu)

Plants damaged by *H. armigera* in tobacco sole crop were significantly higher than in tobacco associated with *Tagetes*. Except at 45 days after transplanting (DAT), there was significant difference in the occurrence of damage between two seasons. Parasitization by hymenoptera was significantly higher in tobacco with *tagetes* than in tobacco grown alone. Parasitization by diptera was higher in tobacco grown along with *tagetes* as border crop except at 45 DAT. Per cent plants damaged by *S. litura* were significantly higher in tobacco sole crop than in tobacco grown with castor. Seasons had no impact on parasitization by hymenoptera and diptera while tobacco grown with castor as trap crop had significantly higher parasitization. The results indicated that by growing one row of trap crop of *tagetes*/castor around main field of tobacco, the reduction in damage to tobacco due to *H.armigera* was nearly 50% and the enhancement of parasitization by hymenoptera and diptera was 78% over sole crop of tobacco. Whereas, the reduction in damage in tobacco due to *S. litura* with castor trap crop was 34% and enhancement of parasitization was 68%.

Studies on the efficacy of adjuvants in *Ha* NPV persistence and their impact on tobacco quality

(S. Gunneswara Rao and P. Venkateswarlu)

Ha NPV in combination with boric acid was superior followed by tannic acid, jaggery plus teepol, surf plus teepol, *Ha* NPV alone and *Ha* NPV in combination with starch plus jaggery. *Ha* NPV alone was inferior to its combination with boric acid or tannic acid. At 7days after spraying, lowest leaf damage was observed with *Ha* NPV in combination with boric acid followed by tannic acid and *Ha* NPV alone whereas highest leaf damage was observed with *Ha* NPV in combination with starch plus jaggery, surf plus teepol and jaggery plus

teepol. Among the treatments higher green leaf yields were obtained with *Ha* NPV in combination with boric acid or tannic acid. Significantly lowest cured leaf yield was obtained in *Ha* NPV in combination with starch and jaggery. The reduction in leaf damage due to addition of adjuvants like boric acid/tannic acid/jaggery/starch/teepol/surf to *Sl* NPV or *Ha* NPV was only 4% in case of *S. litura* and 1% in case of *H. armigera* over NPV used without these adjuvants. Addition of adjuvants did not affect chemical qualities of tobacco leaf. Hence, it was concluded that in tobacco field crop, NPVs can be used without any adjuvants.

Evaluation of BIPM package on Soybean

(S. Gunneswara Rao and P. Venkateswarlu)

BIPM package

- *Telenomus remus* against *Spodoptera litura* @ 1 lakh parasitoids/ha released as soon as the egg masses of *S. litura* were observed
- One spray of *Sl* NPV @1.5x10^{12} PIB/ha along with 0.5% crude sugar as adjuvant
- One spray of *B.t kurstaki* @ 2 kg/ha

Farmer's practice

- One spray of monocrotophos @0.015% and two sprays of chlorpyrifos @0.05% to control leaf webber and *S. litura*, respectively

There was significant reduction of larval population in BIPM after release of *T. remus* over FP where in one spray of insecticide was applied. There was significant further reduction in larval population after one spray of *Sl* NPV over FP where in second round of insecticide spray was applied. Before treatment, there was significantly less leaf webber population in BIPM over FP. Seven days after application of *B.t.* k. in BIPM, the larval population of leaf webber was significantly high in BIPM over FP. BIPM in soybean utilizing *T. remus, Sl* NPV and *B.t.* k. was superior in suppressing larval population of *S. litura* and it was on par with farmer's practice in suppressing the leaf webber population with *B.t.* k. The yield of soybean was 16.25% higher than in farmer's practice. The cost benefit ratio for BIPM was 1:4.

CTRI Research Station, Guntur

Evaluation of Imidacloprid application methods for the control of sucking pests

(G. Raghupathi Rao)

Aphid population was significantly low in the plots treated with imidacloprid foliar application (1.9 /plants) and was on par with foliar application of acephate two days after treatment. Though stem application of imidacloprid showed relatively lower population, the population was quite high over foliar application of insecticides. Similar trend was observed at 4, 6 and 8 days after treatment. Incidence of whitefly, in general, was very low. However, among the treatments, foliar application of imidacloprid followed by acephate showed lowest whitefly population. The plots treated with foliar application of imidacloprid followed by acephate showed lowest natural enemy population. The activity of coccinellids and syrphids was more in stem application. In general, stem application of imidacloprid showed more natural enemies as against foliar application. Highest green leaf, cured leaf, bright leaf and grade index was recorded in foliar application of imidacloprid followed by acephate.

Evaluation of high pressure sprayer for the management of insect pests of FCV tobacco

(G. Raghupathi Rao)

Incidence of aphids was observed 2, 4, 6 and 8 days after spraying (DAS). The aphid population, 2 DAS ranged between 3.5 and 10.0 aphids/plant and did not vary significantly among the different treatments. At 4 DAS, the treatment, spray through high pressure sprayer @ 2 lit/min at every row with 40 cm swath width (T6), recorded significantly lowest population of 3.9 aphids/plant followed by spray through high pressure sprayer @ 2 lit/min at every row with 60 cm swath width (T2) as against 12.0 in control. Similar trend was noticed after 6 and 8 days of observation. The data indicate that the treatment, T6 recorded

lowest population of 4.4 aphids and was found to be superior in minimizing the aphids on tobacco. *H. armigera* larval population recorded after the first spray varied significantly in different treatments between a minimum of 0.6 and maximum of 2.0 larvae/plant. The larval population was significantly low in plots in the treatment, T6 (0.6 larvae/plant with 0.6% of infested plants) followed by 0.8 larvae/plant with 0.9% infested plants in the treatment, spray through high pressure sprayer @ 1 lit/min at every row with 60 cm swath width (T1). After subsequent sprayings, population was in the range of 0.6 to 1.7 larvae/plant with 0.5 to 2.6% infestation in different treatments as against 2.7% in control. It was significantly low (0.5 larvae/plant) in treatment, T6 followed by T1.

Bio-ecology and management of tobacco aphid under central black soil conditions

(G. Raghupathi Rao)

At 2 DAS, aphid population was significantly low in maize bordered + imidacloprid treated plot (5.4 aphids/plant) and was on par with imidacloprid treated plot (6.1 aphids/plant). Though all the treatments were found to be significantly superior in minimizing the population over control, the plots that received tobacco decoction and *B. bassiana* showed relatively higher population and were ineffective in minimizing the population. Similar trend was noticed at 4,6 and 8 DAS. The data based on mean aphid population showed lower aphid population in the plots bordered with maize + imidacloprid spray closely followed by insecticidal spray and nivaar treated plots. Tobacco yields, green, cured and bright leaf were significantly high in maize border + imidacloprid treated plot and was on par with imidacloprid treated plot. In general, the incidence of aphids ranged between 0.5 and 8.6/leaf during the season. The population was very high during the 1st week of January. The incidence showed gradual increase from 2nd week of November (0.5 per leaf) to 1st week of January (8.6 per leaf). Thereafter, it declined gradually till the end of the season.

CTRI Research Station, Kandukur

Management of insect pests of tobacco by plant extracts

(K. C. Chenchaiah)

Control of *S. litura* by selected plant extracts

The plant extracts differed significantly in controlling the insects but were not superior to chlorpyriphos. The lowest attack (8.17 % plants damaged) was recorded in chlorpyriphos followed by extracts of *L. aspera* and *T. arjun*. Plant damage reduced as the concentration of each plant extract increased.

Control of *H. armigera* by selected plant extracts

It is inferred that the plant extracts differed significantly in controlling the insects attack to the capsules by *H. armigera* but not superior to the chlorpyriphos spray. The lowest attack (3.87 % capsules damaged) was recorded in chlorpyriphos followed by the extracts of *V. rosea* var. *alba*. Plant damage reduced as the concentration of each plant extract increased.

Control of aphid, *M. nicotianae* by plant extracts

In this experiment, 45 plant extracts were evaluated under laboratory for the control of tobacco aphid, *M. nicotianae*. The results indicated that all the plant extracts differed significantly in controlling the tobacco aphid and it ranged from 45 to 90% at 10 µl concentrations, 24 hours after the treatment. The extracts of *Lantana camera, Thivita nerifolia and Nictanthus* sp. controlled the aphid up to 90% followed by *Piper* sp., *Myconia* sp., *Adianthes* sp. and *A. marmelos*.

Management of cigarette beetle by plant extracts and inorganic salts

(K. C. Chenchaiah)

Fourteen inorganic salts at different doses were evaluated for the control of *Lasioderma serricorne*. Cent per cent mortality of the grubs was recorded when the seed (1g) were mixed with 10 µg sodium chloride and potassium chloride followed by ferrous sulphate. Calcium carbonate caused only 6% grub mortality. Similar trend was observed when 5 µg of the three inorganic salts were mixed separately with the seed.

PROGRAMME 8

SOIL FERTILITY, WATER QUALITY AND NUTRIENT MANAGEMENT

CTRI, Rajahmundry

Soil fertility Investigations : Preparation of soil test summaries, nutrient indices and soil fertility maps of tobacco growing soils of India

(V. Krishnamurthy, C. Chandrasekhararao and M. Mahadevaswamy)

Lime requirement & Exchangeable cations in soils of Hassan district

The lime requirement and exchangeable Ca^{++} and Mg^{++} of selected soil samples (pH < 5.0) of Arakalgud and Holenarisipur taluks of Hassan district were determined. The lime requirement was between 1.2 to 1.7 t/ha and the exchangeable Ca^{++} varied between 1.84 to 6.57 cmol (p^+) kg^{-1} and Mg^{++} between 0.52 to 3.41 cmol (p^+) kg^{-1} .

Leaf chemical analysis of FCV tobacco in Karnataka

FCV tobacco leaf samples (X and L) from Hassan district of Karnataka were analysed for nutrient composition, chemical quality and leaf burn. Leaf calcium content varied from 1.18 to 2.02 in X position and 1.39 to 2.36 in L position. Magnesium content varied from 0.77 to 1.43 in X position and 0.61 to 0.88 in L position. Leaf burn varied from 4.94 to 10.27 in X position and 5.96 to 14.6 in L position. Leaf samples collected from different clusters of Karnataka were also analyzed for nutrient composition, chemical quality and leaf burn and were within the acceptable range.

Nutrient uptake by irrigated *Natu* tobacco grown in Northern Light Soils

The *Natu* tobacco plant samples collected from CTRI RS, Jeelugumilli were analysed for nutrient concentration in different plant parts and the uptake was computed. The nitrogen concentration was more in lamina compared to midrib; whereas, reverse was the trend with potassium. Uptake of N, P and K by *Natu* tobacco in NLS is around 70, 5.05 and 97.2 kg/ha, respectively. Nutrient removal by Kommugudem variety is higher compared to Rangapuram.

Soil fertility survey of FCV tobacco growing areas of Shimoga, Chikkamagalur & Davanagere Districts and chewing tobacco growing areas of Chitradurga district in Karnataka

Soil fertility assessment of FCV tobacco growing soils of Shimoga, Chikkamagalur and Davanagere districts and also the chewing tobacco growing areas of Hiriyur taluk of Chitradurga district was undertaken during 2006-07 (Table 7). A total number of 152 soil samples (0-22.5 and 22.5- 45.0 cm) from 30 villages of four taluks were collected from FCV tobacco areas and 30 soil samples (0-22.5 & 22.5- 45.0 cm) from Hiriyur taluk where chewing tobacco was under cultivation were collected for soil fertility evaluation. The soils are moderately acidic, low in soluble salts and chlorides. Soil available P content of Shikaripura was medium in surface soil and low in sub-surface soils. In the other *taluks*, soil available P is high indicating that P dose can be reduced in these soils. Soil available K is medium in Tarikere taluk where as in other taluks it is high in surface soils. Hence, potassium @ 120 kg/ha is to be applied for FCV tobacco growing areas of Tarikere taluk. Chewing tobacco areas of Hiriyur taluk are alkaline, medium in soluble salts, high in chlorides, low in organic carbon and high in available P in surface as well as sub-surface soils. Available potassium was medium in surface and sub-surface soils.

Determination of critical level of zinc for FCV tobacco in soils of NLS area

(P.R.S. Reddy and C. Chandrasekhararao)

Exhaust crop, maize was raised for two seasons in 30 pots with Jeelugumilli soil (150 kg/pot). Soil samples were collected before raising exhaust crop to quantify the initial fertility status of soil. An amount of 7.2 g N and 6.0 g K/pot was given in the form of CAN

Table 7: Soil fertility data (mean values) of FCV and Chewing tobacco growing areas of Karnataka

Taluk	Soil depth (cm)	pH (1:2) AT 25 ^{0}C	TSS(EC) (dS/m)	Organic Carbon (%)	Available P (kg/ha)	Available K (kg/ha)	Chlorides (ppm)
FCV tobacco							
Shimoga (10)*	0-22.5	5.5	0.177	0.24	88.6	444	37.7
	22.5-45.0	5.4	0.178	0.22	82.5	424	48.1
Honnali (13)*	0-22.5	6.2	0.184	0.41	62.1	315	32.8
	22.5-45.0	6.1	0.177	0.41	33.8	268	30.2
Shikaripura (2)*	0-22.5	5.7	0.285	0.44	21.1	328	48.5
	22.5-45.0	5.5	0.280	0.42	6.1	280	41.0
Tarikere (5)*	0-22.5	5.7	0.120	0.23	76.6	200	26.2
	22.5-45.0	5.8	0.119	0.23	54.0	178	27.1
Chewing tobacco							
Hiriyur (9)*	0-22.5	8.0	0.541	0.40	64.5	257	134.0
	22.5-45.0	8.1	0.496	0.38	40.2	208	100.5

* Number of villages surveyed

and SOP to the exhaust crop. Phosphorus fertilizer was not given to the crop since the soil had very high amounts of available P. Soil samples were collected after harvest of exhaust crops for analysis. Soil samples colleted before and after first exhaust crop were analysed for all the desired parameters except zinc, which is in progress. Nutrient removal by maize crop in the first season from each pot was calculated.

Initial soil fertility status

Experimental soil used in the pots is sandy loam in texture with ~ 86% sand and 11% clay. Soil is slightly acidic in reaction with low soluble salts and chlorides. Soil organic carbon content is low and ranged from 0.244 to 0.407% between pots (mean: 0.331%). Available P of soil is very high and ranged from 64.3 to 109.4 mg/kg (mean: 81.5 mg/kg). Available K of soil is in general medium and ranged from 52 to 144 mg/kg (mean: 83.1 mg/kg). Variation in soil fertility status in respect of organic carbon and available P between plots is relatively low (CV values: 13.8 to 16.0%) and relatively high in respect of available K (CV value: 28.8%). Hence, it is proposed to conduct the pot experiment with the test crop in a randomized block design.

Dry matter yield of exhaust crops

Mean dry matter yield of maize in different replications of first season varied from 1,054 to 1,376 g/pot with grand mean of 1,196 g/pot and CV of 20.8%. Mean dry matter yield of maize in different replications of second season varied from 848 to 950 g/pot with grand mean of 907 g/pot and CV of 21.6%.

Soil fertility status after harvesting first exhaust crop

Significant changes in pH, EC and Cl status of soils were not observed due to growing exhaust crop for one season. Organic carbon content decreased slightly from 3.31 to 3.20 g/kg; whereas, available P decreased from 81.5 to 74.1 mg/kg and available K decreased from 83.1 to 78.6 mg/kg due to growing exhaust crop for one season.

Nutrient composition and removal by exhaust crop

Mean concentration of nutrients in the first season maize crop was 0.828% N, 0.16% P and

1.60% K. Mean nutrient removal by the exhaust crop in the first season was 9.84 g N, 1.838 g P and 19.04 g K/pot. Taking in to consideration of application of 7.2 g N and 6.0 g K/pot to the crop, the net loss of nutrients from soil in the pot due to growing one season exhaust crop was 2.64 g N, 1.838 g P and 13.04 g K/pot.

Investigations on phosphorus and potassium dynamics of FCV tobacco growing soils of Prakasam and Nellore districts

(C. Chandrasekhararao, V. Krishnamurthy and P.R.S. Reddy)

Twenty eight soils samples (0-9"& 9-18") were collected from 11 auction platforms of SLS and SBS areas of Prakasam and Nellore districts. Sub-soils (9-18") of these samples were analysed for particle size analysis. Sub-soils of SBS varied between silty loam to clay. The clay content of sub- soils varied between 22.36 to 42.69%. Texture of sub-soils of SLS varied between sandy loam to clay. The clay content in these soils varied between 15.07 to 43.80 %

Exchangeable cations and cation exchange capacity

Cation exchange capacity (CEC) and exchangeable cations were determined in SLS and SBS soils (Table 8). Among all the exchangeable cations, calcium was dominant followed by magnesium and sodium. In general Southern black soils have higher CEC and exchangeable cations compared to southern light soils. Sub-soils have higher CEC, exchangeable calcium and sodium compared to surface soils.

Phosphorus fractions

Phosphorus fractions in surface soils of SLS and SBS were estimated (Table 9). Among all the fractions, occluded-Fe-P was maximum followed by Ca-P, Al-P and Fe-P. Southern black soils have higher amounts of each fraction compared to Southern light soils.

Table 8: CEC and Exchangeable Cations (cmol (p^+) Kg^{-1}) in SBS and SLS

Soil zone	Depth (cm)	CEC	Ca^{+2}	Mg^{+2}	K^+	Na^+
SBS	0-22.5	57.2	45.86	8.84	0.894	1.189
SBS	22.5-45.0	61.1	51.1	7.89	0.564	1.359
SLS	0-22.5	33.8	26.3	4.81	0.438	0.78
SLS	22.5-45.0	36.8	29.0	4.88	0.353	0.85

Table 9: Phosphorus fractions (ppm) in SLS and SBS

Soil zone	Al-P	Fe-P	Ca -P	Occluded-Fe-P	Occluded-Al-P
SBS	70.3	39.3	343.6	2978	12.4
SLS	61.5	37.4	178.3	2973	17.7

PROGRAMME 9

ALTERNATIVE USES OF TOBACCO AND REDUCTION OF HARMFUL SUBSTANCES

CTRI Research Station, Jeelugumilli

Evaluation of advanced breeding lines for tar content under Northern Light Soil condition

(K. Sarala, C.V. Narasimha Rao, T.G.K. Murthy and R.V.S. Rao)

Thirteen advanced breeding lines (ABL) were assessed for their tar content during 2005-06. All the breeding lines recorded lower tar values (17-23 mg/cig) than Kanchan (24 mg/cig). The lines viz., JS 124 (17.2 mg/cig), JS 116 (17.7 mg/cig) and JS-78 (18.6 mg/cig) are in bulk trial.

BTRC, Jeddangi

Developing high yielding Burley cultivars with low TSNA levels

(T.G.K. Murthy, P.V. Venugopala Rao, R.V.S. Rao, C. V. Narasimha Rao, R. Subba Rao and K. Sarala)

Evaluation of yield and TSNA content in identified parents and hybrids

About 100 Burley germplasm lines were screened for TSNA content and yield potential. Among them, the germplasm lines viz., Apia, Ky 10, Va 510, By 64 and By. Resistant lines were identified as having low TSNA content besides low nicotine conversion. The five lines were crossed with three high TSNA cultivars viz., Banket A-1, Burley 21 and BSRB-2. The resulting 15 hybrids were evaluated for yield potential and leaf quality along with 8 parents in a randomized block design with 3 replications at BTRC, Jeddangi during 2006-07.

Results indicated that among all, only one hybrid, By 64 x Banket A-1 exhibited heterobeltiosis over Banket A-1 with 39% for green leaf yield (13,323 kg/ha) and 25% in cured leaf (1,528 kg/ha), while most of the hybrids showed heterosis over the low TSNA parents. Cured leaf samples of all the plots in the experiment were collected and are being processed for estimation of TSNA and related traits and carrying out genetic analysis of the trait. The F_2 progeny of two best crosses, By 64 x Banket A-1 and Va 510 x Banket A-1 haven been sown for raising segregating generations and make selections for plant type, yield and low TSNA content. The project has been concluded.

CTRI Research Station, Vedasandur

Breeding for high seed and oil yield in tobacco

(K. Palanichamy and C.V. Narasimha Rao)

Replicated evaluation trial

Twenty one identified germplasm accessions of chewing, cheroot and cigar filler etc. were evaluated in a replicated trial with 3 replications for seed yield traits. The maximum seed yield of 1,839 kg/ha was recorded in NP 47 followed by 1,619 kg/ha in Bhagyalakshmi, 1,469 kg/ha in T.N. Palayam and 1,465 kg/ha in I 64. NP 15, GT 6, Penswar and Madranski were the lines that recorded about 1,200 kg/ha.

Bulk evaluation

Six of the germplasm accessions viz., NP 19, NP 47 Regional Connecticut, A 145, Strain 705 and A 119 were evaluated along with 3 chewing tobacco varieties Bhagyalakshmi, Meenakshi and Abirami in bulk plots for seed yield traits under primed and unprimed conditions. Under primed conditions, A 119 recorded 1,057 kg/ha seed yield per ha followed A 145 with 895 kg/ha. Under unprimed condition, NP 19 recorded the highest seed yield of 1,359 kg/ha followed by Regional Connecticut with 1,160 kg/ha and the check Bhagyalakshmi recorded 1,167 kg/ha.

Influence of topping on seed yield

With this objective of synchronization of flowering through topping, a study was planned with 3 varieties viz., Abirami (chewing), Krishna (cigar filler) and I.737 (cheroot) under

two spacings, 75 x 75 cm and 60 x 50 cm, and topping at bud stage and no topping. The seed yield was high in Krishna and Abirami. It was high in closer spacing of 60 x 50 cm as compared to 75 x 75 cm. Topping at bud stage and allowing the top suckers to grow resulted in a mean increase in seed yield by 49% over no-topping.

CTRI, Rajahmundry

Evaluation of *rustica* tobacco types for seed and seed oil production under conserved soil moisture condition in Vertisols of Andhra Pradesh

(P. Harishu Kumar, R. Subba Rao and K. Siva Raju)

The experiment was laid out in RBD with 16 varieties of *rustica* tobacco planted at 30 x 30 cm spacing irrigated twice at a fertility level of 100 kg N/ha to evaluate the seed oil production of different *rustica* tobacco types.

The line SH 30 recorded the maximum seed yield of 1,384 kg/ha and significantly superior to all the *rustica* varieties. The *Tabacum* lines A 145 and GT 7 recorded 1,566 and 1,235 kg seed/ha, respectively. Among the *Rustica* varieties, maximum seed oil percentage was recorded by SH 31 with 34.52% however, the seed yield was low compared to SH 30. Hence, the oil yield was 435 kg/ha under SH 30. The two varieties A 145 and GT 7 recorded 428 and 429 kg oil/ha with 27.30 and 34.75% oil in seed, respectively.

Performance of varieties and their hybrids in the production of seed and leaf biomass

(P. Harishu Kumar, S.V. Krishna Reddy and K. Siva Raju)

The experiment was laid out in RBD with two varieties (A 145 & G T 7) and two hybrids ((A 145 x GT 7 & GT 7 x A 145)) at three levels of N (50, 100 and 150 kg N/ha) at a spacing of 80 x 40 cm for evaluating seed and leaf biomass production. One irrigation was given at 35 DAP and the crop received one rain (2.5 cm) at 60 DAP.

The variety, A 145 recorded 1,155 kg seed/ha and N levels did not influence the seed yield while GT-7 recorded 1,213 kg/ha seed yield. Increasing levels of N up to 100 kg/ha to A 145 recorded maximum seed yield of 1,333 kg/ha while increasing N up to 150 kg N increased seed yield by 42 kg only recording 1,375 kg/ha. The hybrid A 145 x GT 7 recorded an average seed yield of 1,432 kg/ha. Though, increasing levels of N from 50 to 100 kg increased the seed yield, the differences were non-significant; whereas, the hybrid, GT 7 x A 145 on an average recorded 1,239 kg/ha seed yield.

Maximum oil recovery was in A 145 x GT 7 with 459 kg/ha at 100 kg N/ha and at par with A 145 at 100 kg and 150 kg N level. GT 7 did not show higher values compared to A 145. However, the hybrid GT 7 x A 145 at 100 kg N level recorded 422 kg oil/ha.

The variety GT 7 has recorded maximum leaf biomass of 53.76 t/ha and N levels did not bring any significant increase. However, maximum biomass of 53.76 t/ha was recorded at 100 kg N. The hybrid GT 7 x A 145 was found better next to GT 7 in leaf biomass production recording around 48.90 t/ha. After the leaf biomass was removed, the left out panicles were allowed to bear seed and the seed oil was estimated. The variety A 145 recorded fairly higher values of oil recovery of 171 kg/ha at 150 N compared to 79 kg oil at 100 kg N from GT 7. However, the hybrid GT 7 x A 145 recorded about 177 kg oil at 50 kg N/ha compared to 138 kg from A 145 x GT 7 hybrid at 100 kg N.

Nitrogen fertilization had influenced solanesol, nicotine and leaf protein recovery in both the varieties and their hybrids. Maximum solanesol recovery was recorded at 100 kg N in both the varieties A 145 and GT 7 and their hybrids. Increasing N levels beyond 100 kg/ha reduced solanesol recovery. Maximum amount of nicotine 184.44 kg was recorded by A 145 at 100 kg N/ha. Increasing levels of N decreased nicotine recovery in the hybrids. At 50 kg N/ha level, A 145 x GT 7 recorded 183.29 kg/ha, while GT 7 x A 145 recorded 141.77 kg/ha. However, the differences were non-significant. The two

varieties, A 145 and GT 7 recorded 857 and 912 kg/ha leaf protein, respectively while their hybrid's performance was at lower level. A 145 x GT 7 and GT 7 x A 145 recorded 607 and 795 kg/ha, respectively. However, GT 7 at 100 kg N/ha recorded maximum leaf protein of 1,130 kg/ha.

Evaluation of tobacco hybrids for leaf biomass and seed yields

(P. Harishu Kumar, C. V. Narasimha Rao, K. Siva Raju, M. Anuradha, and R.V.S. Rao)

Four varieties, their hybrids and reciprocals were evaluated in a randomized block design with three replications at a fertility level of 100 kg N + 50 P_2O_5 + 50 K_2O + 50 kg S/ha at a spacing of 80 x 40 cm in Vertisols for leaf biomass, phytochemicals and seed yields. The crop received one irrigation at 35 DAP and one rain at 60 DAP (2.5 cm).

Maximum leaf biomass of 52.49 t/ha was recorded by HDBRG tobacco closely followed by GT 7 x A 145 (49.74 t) and GT 7 x HDBRG (49.51 t) and is at par with GT 7 (42.80 t), A 145 x HDBRG (45.14 T), TI 163 x GT 7 (43.4 t) GT 7 x TI 163 (43.2 t) and HDBRG x GT 7 (47.034 t). Maximum solanesol 36.73 and 35.92 kg/ha was recorded in TI 163 and HDBRG tobacco, respectively. None of the hybrids was superior to these varieties. Maximum nicotine of 111.01 kg/ha was recorded in the hybrid A 145 x TI 163, closely followed by A 145 x HDBRG (102.88 kg), A 145 x GT 7 (102.17 kg) and HDBRG x TI 163 (102.12 kg). Leaf protein was maximum in A 145 x HDBRG (755 kg) followed by GT 7 x A 145 (753 kg) and TI 163 x HDBRG (703 kg).

The NR activity was very high in the crosses TI 163 x HDBRG and HDBRG x TI 163 or GT 7 x HDBRG and HDBRG x GT 7 and GT 7 x TI 163 indicating possible increase in sink activity and the corresponding biomass and seed yields were 39.00 t, 1,146 kg & 38.37 t, 1,105 kg & 43.20 t, 1,227 kg & 47.31 t, 1,411 kg and 49.51 t, 1,438 kg, respectively.

In all the above cases, the acid phosphatase activity was also high indicating increased metabolic activity. Similarly, HDBRG and GT 7 recorded high acid phosphatase activity with high biomass. The peroxidase and polyphenol oxidase activities did not vary widely among the hybrids.

Leaf biomass, seed and seed oil recovered from bulk testing plots

The seed was collected from shoot emanated after collection of biomass. The seed was analysed for oil content and the oil yield was estimated. From the bulk testing plots for biomass + seed + oil yield, the cross HDBRG x TI 163 yielded 36.313 t biomass, 416 kg seed and 134.00 kg oil per hectare.

Seed weight, oil percentage and oil recovery in bulk testing plots

The bulk testing plots exclusively maintained for seed indicated that maximum seed yield of 2,118 kg/ha was realized from the cross HDBRG x A 145 with an oil yield of 751 kg/ha whereas the cross TI 163 x A 145 recorded 1,943 kg/ha seed and oil yield of 755 kg/ha being the largest producer. However, maximum oil content (40.86%) was recorded in TI 163 x HDBRG.

Evaluation of tobacco hybrids for seed yield and oil

(P. Harishu Kumar, C.V. Narasimha Rao and K. Siva Raju)

Four varieties, their hybrids and reciprocals were evaluated in a randomized block design with 3 replications at a fertility level of 100 kg N + 50 kg P_2O_5 + 50 kg K_2O + 50 kg S at a spacing of 80 x 40 cm in Vertisols for seed and oil yield. The crop received one irrigation at 35 DAP and one rain at 60 DAP. The leaf biomass was allowed to perish on the plant itself.

Maximum seed yield of 2,417 kg/ha was recorded in the hybrid HDBRG x A 145 followed by its reciprocal cross A 145 x HDBRG with 2,256 kg seed/ha and were significantly superior to all other crosses or straight varieties. Maximum oil content in seed (41.11%) was recorded in the cross TI 163 x HDBRG followed by HDBRG x A 145 with 40.13% and were at par with TI 163 x A 145 and significantly superior to others.

The seed oil recovery was 972 kg/ha from the cross HDBRG x A 145 closely followed by its reciprocal cross A 145 x HDBRG with 789 kg/ha. The cross HDBRG x A 145 is the only one that recorded 972 kg/ha oil and was significantly superior to all other crosses of varieties.

Biochemical characterization of tobacco seed oil

(K. Siva Raju, C.V. Narasimha Rao, R.V.S. Rao and V. Krishnamurthy)

The tobacco seed oil content was estimated in 115 tobacco germplasm accessions of various tobacco types. Among the 57 germplasm accessions of exotic air-cured type screened, the oil content varied from 20.88 (EAC 50) to 38.15% (EAC52). Among the Burley accessions, the oil content varied from 25.12 to 36.51% whereas, in *Bidi* accessions, the oil content ranged from 27.11 to 39.01%. In Japan air-cured tobacco accessions, the oil content ranged from 19.61 and 39.66%.

Evaluation of smoke constituents in tobacco and tobacco products

(C. V. Narasimha Rao)

An attempt was made to work out the correlations between total particulate matter (TPM) and solanesol content in the blend and in the filter pad. Highly significant positive correlation coefficients, 0.9994, 0.9967 and 0.9933 were observed between TPM and blend solanesol, TPM and solanesol in the pad and blend solanesol and solanesol in the pad, respectively.

Studies on Tobacco Specific Nitrosamines (TSNAs) in Indian tobacco and tobacco products

(C. V. Narasimha Rao)

In order to examine the differences in the levels of TSNAs in FCV tobacco samples from NLS, SLS and KLS, the data were subjected to Student's paired t-test employing the statistical software SIGMATAT 3.5. The differences between NLS and SLS and NLS and KLS were highly significant. However, the differences between SLS and KLS were not significant and were at par.

TSNAs in air-cured samples

In the case of non-FCV tobacco types viz. Burley, HDBRG, Chewing tobacco (TN) and Chewing tobacco (WB), a highly significant difference exists between Burley and chewing tobacco (WB) and HDBRG and chewing tobacco (WB). However, the differences among Burley and HDBRG, Burley and Chewing tobacco (TN), HDBRG and Chewing tobacco (TN) were not significant.

Influence of curing methods on TSNA in chewing tobacco from Tamil Nadu

Significantly higher levels were recorded in smoke-cured samples when compared to pit-cured and sun-cured samples (Fig.19). There were no significant differences among varieties.

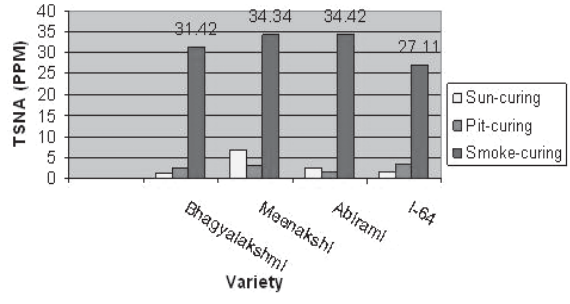


Fig.19: Influence of curing on TSNAs in chewing tobacco

Exogenous application of ascorbic acid and tannic acid

Exogenous application of ascorbic acid resulted in highly significant reduction (46.5%) in TSNA and significant reduction in nicotine (15.8%) when compared to tannic acid (TSNA: 13.9% and nicotine: 3.7%) at 30 DAS. Though non-significant, the levels of nitrate (6.31 and 6.37 mg/g) were low when compared to the untreated sample (8.37 mg/g).

Monitoring of pesticide residues in tobacco samples from different areas

(C.V. Narasimha Rao)

Pesticide residue analysis in FCV tobacco leaf samples received from different auction platforms in KLS, NLS, SLS and SBS has been completed. In general, all the pesticide residues are with in the Guidance Residue Levels except in a few cases (Table 10).

Table 10: Organochlorine pesticide residue levels in FCV tobacco samples from Andhra Pradesh and Karnataka (ppm)

Tobacco Zone	TotalBHC	í- BHC	Chlorpyrifos	Dieldrin	Total Endosulfan	Total DDT
NLS(20)*	0.03 (ND-0.17)	0.01 (ND-0.04)	0.06 (ND-0.46)	0.01 (ND-0.07)	0.10 (ND-0.70)	0.03 (ND-0.16)
KLS(40)*	0.008 (0.005-0.012)	0.002 (0.001-0.003)	0.003 (0.002-0.01)	ND	0.002 (ND-0.017)	0.001 (ND-0.014)
SLS/SBS/ CBS(25)*	0.15 (ND-0.44)	0.04 (ND-0.09)	0.10 (ND-0.50)	0.04 (ND-0.07)	0.22 (0.05-2.25)	0.04 (0.02-0.22)
GRL	0.50	0.50	0.50	0.05	1.00	0.40

* Figures in parenthesis represens number of samples analysed

Synthesis and biological evaluation of solanesol derivatives as novel bioactive substances

(C.V. Narasimha Rao and Kanwal Raj)

Solanesol content in different types of tobacco and germplasm material

Considerable variation in solanesol content was observed in Burley (0.20 to 0.75%) and *Rustica* (0.30 to 1.40%) tobacco germplasm lines and *Nicotiana* species (ND to 4.00 %) samples. Among the FCV tobacco samples, maximum solanesol content was recorded in the samples from NLS (mean: 0.85% and range: 0.40 – 1.30%) followed by SLS (mean: 0.35% and range: 0.15 – 0.75%) and KLS (mean: 0.22% and range: 0.05 – 0.70%). Maximum solanesol content was recorded in HDBRG tobacco samples (mean: 2.18% and range: 0.50 – 3.75%).

Solanesol content in different plants of Solanaceae family varied from 0.05 to 0.40% in plants other than tobacco, higher content being recorded in *S. tuberosum*, *S. melongena*, *S. lycopersicum*, *C. annum* and *N. physaloides* when compared to *D. stramonium*, *S. nigrum*, *C. nocturnum* and *S. xanthocarpum*.

Changes in solanesol content during curing

Solanesol content increased from 0.25% at the 1st harvest to 0.80% at the 4th harvest. From green leaf to yellowing stage, 60, 95.5, 34.6 and 12.4% increase in solanesol content was observed at 1st, 2nd, 3rd and 4th harvest, respectively. When compared to yellowing stage, about 50% increase was recorded at 1st and 4th harvests in the colour fixing stage. About 32% increase was observed from leaf drying to stem drying stages at 1st, 2nd and 3rd harvests. In chewing tobacco samples from Tamil Nadu, solanesol content was low in sun-cured samples (0.05 – 0.70%) when compared to pit-cured (0.55 – 1.10%) and smoke-cured (1.30 to 2.80 %) samples.

Solanesol derivatives and their biological activity

A number of O- alkylated xanthone, carbazoles and coumarins have been synthesized and screened for their *in vitro* antidiabetic activity as glucose-6-phosphatase, glycogen phosphorylase and alpha glucosidase inhibitors. Compounds which were showing significant per cent inhibition were also tested for *in vivo* antihyperglycemic activity in sucrose loaded normal and streptozotocin (STZ)-induced diabetic rats. These compounds showed 22.1, 24.4 and 26.7% and 20.8, 25.0, 20.5% lowering in sucrose loaded normal rats and STZ induced diabetic rats at a dose of 100 mg/kg. Another important compound SDB ethylenediamine [N- Solanesyl-N, N-bis (3,4 dimethoxybenzylethylene-di-amine] which is known to potentiate anticancer drugs was prepared by known methods for biological evaluation.

PROGRAMME 10

AGRICULTURAL EXTENSION AND INFORMATION TECHNOLOGY

AGRICULTURAL EXTENSION

Assessment of identified slow moving technologies in NLS area of Andhra Pradesh

(Y. Subbaiah and S.K. Naidu)

The adoption status of FCV tobacco technologies in NLS tobacco growing area was ascertained. Primary, secondary and tertiary causes for non-adoption were studied. Technologies viz., time and dose of nitrogen fertilizer application, topping stage and opening of ventilators of a curing barn, having technology based constraints were selected for On-farm Testing (OFT) through farmers participatory approach.

Evaluation of Tobacco Portal System

(Y. Subbaiah and S.K. Naidu)

Structured interview schedule is prepared and pre-tested. Two villages from each of the experimental area and control area of each tobacco zone viz., NLS, SLS, SBS and CBS were selected on purposive basis. 100 farmers (50 from experimental and the rest from control area) from each tobacco growing zone were selected on random sampling basis. Thus, 400 farmers constituted as sample for the study. Zone-wise, year-wise and technology component-wise utilization pattern was studied. Sampling was done both in experimental and control areas. Comparative study of experimental and controlled areas and further improvement of portal system will be taken up.

Changing scenario of cropping pattern (SLS, SBS and CBS regions) and stress analysis of tobacco farmers of AP

(K. Suman Kalyani and S. K. Naidu)

The comparative analysis of SLS, SBS and NLS areas was obtained after a thorough study of the three areas. All the three areas were compared based on certain parameters viz., soil, climate, land holdings, socio-economic status, training & skill, price, family involvement, employment potential, farmers' typology, popular varieties, cultural practices, lease & loans, load of sticks, green manuring crops, cattle population, Farm Yard Manure, yields and other alternative crops.

At every Auction Platform, NTRM collection boxes were kept by the Tobacco Board for detection and collection of NTRM. All the collection boxes were observed to be filled with the following materials: paper, grass, feathers, plastics, dust & sand particles, Panparag & nut powder sachets, jute ropes, twine threads, nails, binding wire pieces, match sticks, cigar, & *Bidi* butts. The causative factors and the preventive measures were also given.

Conclusions

- Fuel cost is increasing due to the advent of Power stations in and around. Two and half tonnes of firewood is required per barn for each curing.
- The cost of the fuel increased from Rs. 1000/- to Rs. 1500/- per tonne.
- The fire-wood used by the farmers include *Adivi Thumma* (Acasia *arabica), Mamidi Katte* (Mango), *Sarvi Chivukulu* (Casuarina stems), *Chilla Kampa etc.*
- The rate of consumption of fuel has increased due to improper maintenance of barns (non-repair of flue-pipes, furnaces and roofs).
- Farmers are overloading @ 900 to 1100 sticks per barn in case of Black soils and @ 1200 to 1400 sticks in case of Light soils which results in poor quality leaf.
- The incentives and advantages given for light soil regions have made majority of the farmers to register their farms under light soils. Hence, farmers feel that the soil reclassification should be done again

- The farmers of Southern light soil area are going up to 15 acres per barn i.e. 60 to 70 quintals leaf (authorized quantity is 40 quintals leaf from 10 acres).
- The yields for black soils (8 to 10 q/ acre) are higher than the light soils (4-6 q/ acre).
- SLS & SBS farmers are getting a net income of Rs. 10,000/- to 15,000/- per acre per anum by cultivating Eucalyptus & Subabul.
- Cost of cultivation has increased by 25 - 30% due to the increased labour (15% to 20%) and fuel cost (10 - 15%).
- *Orobanche*, aphids, stem borer and *Spodoptera* were the major problems in SBS & SLS regions.

Front Line Demonstration on Siri (Cy 135) in NBS area of Andhra Pradesh

(S.K. Naidu, Y. Subbaiah, K. Suman Kalyani and K. Sarala)

The Front Line Demonstration with the newly released variety **'Siri'** was conducted in farmers fields at Katavaram and Katheru, in East Godavari District for its popularization. The variety was compared with VT 1158. The varieties were planted at 70 x 50 cm in one acre plot each. The recommended fertilizer dose i.e. 50 kg N/ha was applied by PRPF method 3 weeks before planting. The crop growth and cultural practices were regularly monitored. All the recommended practices were scrupulously followed by the farmers. *Sl* NPV was supplied to the farmers for spraying against tobacco caterpillar. The pheromone traps of *Spodoptera litura* and *Heliothis armigera* were also installed in the demonstration plots to monitor these pests. Judicious topping was done in both the varieties at the bud stage at Katavaram; whereas, at Katheru the crop was un-topped.

Pest and disease incidence

Observations were recorded on the incidence of pests and diseases. The results indicated that both the varieties were found to be susceptible to pests and diseases. The incidence of ground beetle, stem borer, aphids, tobacco caterpillar, bud worm, TMV and leaf curl were recorded in both the varieties in two locations. The farmers were advised to take up suitable control measures.

Performance of varieties

The newly released variety Siri performed better at both the locations. The Siri variety showed vigorous growth compared to VT 1158. Even though suckers were developed at the base of some plants in Siri at the early stage, the growth of the crop was not affected. On an average the Siri variety yielded 2,518 kg/ ha cured leaf and 1,671 kg/ha bright leaf with 13 and 22% increase against VT 1158, respectively.

The results of Front Line Demonstration (FLD) clearly indicated that the newly released variety Siri is having an edge over VT1158 in yields i.e. about 300 kg/ha more than the ruling variety VT 1158 in terms of cured leaf yield as well as bright grades. The trial plot farmers and other farmers who have visited the plots were impressed and convinced with the performance of newly released variety Siri under field condition. Farmers are more interested to grow Siri variety because of its vigorous growth and high yielding capacity. They also opined that Siri variety needs more nitrogen.

Trend analysis of cost of production and price behaviour of FCV tobacco in SLS area of Andhra Pradesh

(Y. Subbaiah and S.K. Naidu)

The enhanced yield due to adoption of improved varieties and innovative technologies & price fluctuations warrant a thorough analysis of trends in cost of production and price behaviour of FCV tobacco in SLS area. Sampling was done adopting Stratified Random Sampling procedure by selecting all the auction platforms being operated under SLS area, one village under each auction platform and 20 farmers from each selected village. Thus, 120 farmers were formed as sample for this study.

Trends will be analysed by application of logarithmic equations.

Critical analysis of the empowerment of farm women in tobacco growing agency area of East Godavari district

(K. Suman Kalyani and S. K. Naidu)

The following Burley tobacco cultivating villages viz., Bornagudem & Vogupalem in Rajavommangi Mandal, Gontuvani Palem & Addatheegala in Addateegala Mandal and Puligogulapadu & Malaiah Pakalu in Yeleswaram Mandal, were selected on purposive random sampling technique in order to obtain the socio-economic data and for introduction of income generation activities (Table 11).

ARIS CELL

Information Technology

Creation of Web pages for CTRI

(H. Ravi Sankar and J.A.V. Prasad Rao and C.V. Narasimha Rao)

CTRI website domain name was changed to www.ctri.org.in and hosted the same in Internet. New hyperlinks were provided and updated the site regularly.

Expert system for different diseases of major crops in Andhra Pradesh

(H. Ravi Sankar and C. A. Raju)

Software development and testing has been completed. A new module entitled "Expert system for identification and management of abiotic stresses in tobacco" was developed and data entry is in progress.

Decision support system for quality evaluation of flue-cured tobacco

(H. Ravi Sankar and V. Krishnamurthy)

Data-sheet has been prepared with 24 parameters classified into four categories namely quality parameters, physical parameters, manufacturing parameters and smoke parameters. Software development, testing and debugging has been completed. Data entry is in progress.

Designing algorithms for data classification

(H. Ravi Sankar)

Three new algorithms were designed in classification which improves the efficiency in terms of memory and time. One of the designed algorithms entitled "An algorithm for classification in data mining based on classification codes" was applied to flue-cured tobacco data for diagnosis of nutrient deficiencies. Software has been developed and testing is in progress.

Information system on agricultural pests of coastal Andhra Pradesh

(U. Sreedhar and H. Ravi Sankar)

Software development has been completed. Debugging and testing of each module with sample data has been completed. Data-sheets for insect pests of rice, maize and sugarcane prepared. Data entry is in progress.

Table 11: Activity profile and work performance of tribal women

Activity	Frequently	Often	Rarely	Rank
Preparatory cultivation	86	12	02	04
Manuring	78	12	10	05
Transplanting	88	12	–	02
Cultural operations	68	22	10	06
Plant Protection	24	12	–	08
Harvesting & Stringing	92	08	–	01
Grading	88	12	–	03
Baling/ Packing	44	12	10	07

TECHNOLOGY ASSESSED AND TRANSFERRED

- **In Andhra Pradesh**, the Front Line Demonstrations (FLDs) conducted in NBS Zone indicated that the newly released variety, Siri performed better than the check, VT 1158. The variety Siri yielded 300 kg more cured leaf per ha with 66.5% bright grades.

- **In Karnataka**, confirmatory trial on efficacy of vermicompost application in FCV tobacco field crop revealed that vermicompost application @ 4 t/ha (at the time of planting) along with recommended NPK dose was optimum for getting maximum productivity and bright grade outturn. Integrated management practice involving 25% organic and 75% inorganic (25:75 ratio) was found more effective in increasing both cured leaf yield and top grade equivalent, compared to 50:50 or 75:25 ratios. Vermicompost was found to have better influence on growth and productivity than other organic manures like FYM or press mud.

- **In Tamil Nadu**, application of 50% P + PSB in the first year and application of 75% P alone in the second year recorded higher whole leaf yield (2,669 kg/ha) in the second year. The total leaf yield was higher (3,444 kg/ha) in the second year when 100% P + PSB was applied in the first year and 100% P alone in the second year. Application of 75% recommended N + 2.5 kg *Azotobacter* + 2.5 kg *Azospirillum* + 2.5 t FYM/ha to FCV tobacco is recommended for higher yields and net returns to the farmers of Shimoga region in Karnataka.

- Application of recommended dose of fertilizer (220 kg N/ha) along with bio-fertilizer, *Azotobacter* @ 4.0 kg /ha (10^8 cfu^{-1}) to *Bidi* tobacco is recommended for maximizing yield and net returns to *Bidi* tobacco farmers of middle Gujarat Agro-climatic zone III. Planting of *Bidi* tobacco hybrid, GTH 1 in second fortnight of August with 45 to 60 days old seedlings is recommended to the farmers in middle Gujarat agro-climatic zone for maximizing yield and net returns. Green manuring with sunnhemp or FYM @ 12.5 t/ha was found effective in increasing the productivity of *Bidi* tobacco at Anand. A seed rate of 8 kg/ha is recommended for *Rustica* tobacco nurseries.

- One furrow-irrigation during grand growth period (50-60 days after planting) to *Pikka* tobacco variety, Gajapati is recommended to the farmers of Orissa for improved productivity and quality of tobacco and for higher net returns.

- Application of 50 kg K_2O/ha to chewing tobacco is recommend for adoption by the farmers in Tamil Nadu for higher net returns.

- Bulk trials in ten farmers' fields indicated that application of zinc sulphate along with recommended dose of fertilizer and FYM recorded 8.3% higher tobacco yields as compared to no application of zinc sulphate at Nipani, Karnataka.

- Maize – Tobacco system can be recommended to the farmers in NBS as an alternative cropping system to sole tobacco and Soybean – Chickpea cropping system is a profitable alternative to FCV tobacco grown in the region.

EDUCATION AND TRAINING

The Central Tobacco Research Institute has undertaken educational activities like training the farmers, organising field days, *Kisan Melas*, exhibitions, workshops and meetings in collaboration with Tobacco Board, Agricultural Market Committees, State Agricultural Universities, State Agricultural Departments, M/s. ITC Ltd., ILTD Division, and M/s. Maddi Lakshmaiah & Co., at Village level to increase the tobacco productivity and quality during 2007-08.

A workshop on "FCV tobacco production practices" for KLS farmers was organized on 11.5.2007 at CTRI Research Station, Hunsur. All the Scientists and Technical Officers along with the farmers attended this meeting.

Field IRC was conducted at CTRI Research Station, Jeelugumilli to monitor the experiments conducted at Jeelugumilli on 11.1.2007.

Training programme on "Soil and water analysis" was conducted to the field Officers of GPI during September 3-14, 2007 at CTRI, Rajahmundry.

Training programme was conducted to management trainees of GPI Ltd., Guntur during January 8-12, 2008 at CTRI, Rajahmundry.

Kisan Mela was conducted at CTRI Research Station, Guntur on 18.1.2007

Farmers' Day was celebrated on 24.2.2007 at CTRI Research Station, Dinhata, W.Bengal.

Sl. No.	Programme & Participant (s)	Date & Place
	Training programme to farmers on 'Nursery management and plantation of seedlings in field'	
1.	Dr. M. M. Shenoi & K. N. Subrahmanya	19.4.2007 at Neelangala
2.	Dr. M. M. Shenoi & K. N. Subrahmanya	23.042007 at Chikkabemmathi
3.	Dr. M. M. Shenoi	24.4.2007 at Beeranahally
4.	Dr. M. M. Shenoi & Dr. M. Mahadevaswamy	25.4.2007 at Chennakeshavapura
5.	Dr. M. M. Shenoi & K. N. Subrahmanya	26.4.2007 at Jadaganakoppalu
6.	K. N. Suabrahmanya & Dr. M. Mahadevaswamy	27.4.2007 at Muthinahundi
7.	Dr. M. M. Shenoi & K. N. Subrahmanya	30.4.2007at Doddabelalu
	Training to Adarsa Rytus in agriculture and allied activities	
8.	Dr. S.V. Krishna Reddy	May 11-12, 2007 at ARS, Vijayarai
9.	M. Nageswararao	May 11-12, 2007 at Tanuku
	FCV tobacco field crop management	
10.	Dr. M. M. Shenoi & Dr. M. Mahadevaswamy	21.5.2007 at Siddapura
11.	Dr. M. M. Shenoi & K. N. Subrahmanya	22.5.2007 at Malangi
12.	Dr. M. M. Shenoi & C. Mahadeva	23.5.2007 at Kalkere
13.	Dr. M. M. Shenoi & K. N. Subrahmanya	24.5.2007 at M.G.Koppal
14.	K. N. Subrahmanya & Dr. M. Mahadevaswamy	25.5.2007 at Kudloor
15.	Dr. M. Mahadevaswamy & C. Mahadeva	28.5.2007 at Hardur
16.	K. N. Subrahmanya & C. Mahadeva	29.5.2007 at Moodalakoppal
17.	Dr. M. Mahadevaswamy	30.5. 2007 at Chennagundi

Sl. No.	Programme & Participant (s)	Date & Place
	Farmers' meeting on 'Light soil Burley 2007 crop - Prevalence of pests & diseases'	
18.	Dr. P. Harishu Kumar & Dr. U. Sreedhar	September 8-9, 2007 at Narsipatnam and Jeddangi
19.	Dr. J.V. Prasad & I.V. Subba Rao	10.9.2007 at Jaggampet, Gokavaram and Sankavaram
20.	S. Gunneswara Rao & I.V. Subba Rao	13.9.2007 in West Godavari district
	Training programme on 'Seed bed preparation, nursery management, pest & disease control in seed beds'	
21.	T. Krishna Murthy, G. Adinarayana & I.V. Subba Rao	6.9.2007 at Yernagudem
22.	Dr. S. V. Krishna Reddy	11.9.2007 at Bodigudem
	Training programme on 'Nursery management'	
23.	B. S. N. Reddy & K. Seshasai	7.9.2007 at Jeelugumilli
24.	T. Krishna Murthy & I. V. Subba Rao	13.9.2007 at Chatiyala
	Training programme to farmers on 'PHPM'	
25.	Dr. M. M. Shenoi	1.9.2007 at Bannur & Madanur
26.	Dr. M. Mahadevaswamy	1.9.2007 at Karpuravally
27.	Dr. M. M. Shenoi	4.9.2007 at Kalkere
28.	K. N. Subrahmanya	4.9.2007 at Hanagallu
29.	K. N. Subrahmanya	6.9. 2007 at Kupe
30.	Dr. M. M. Shenoi	7.9.2007 at Vadur
31.	Dr. M.Mahadevaswamy	11.9.2007 at Kagada
32.	K. N. Subrahmanya	12.9.2007 at Kalahally
33.	C. Mahadeva	12.9.2007 at Hoskote
34.	C. Mahadeva	13.9.2007 at MR Hosahally
35.	K. N. Subrahmanya	14.9.2007 at Hirikyanthanhally
36.	Dr. M.Mahadevaswamy	17.9.2007 at Mardur
37.	Dr. M.Mahadevaswamy	18.9.2007 at Adgur
38.	C. Mahadeva	18.9.2007 at Malangi
39.	Dr. M. Mahadevaswamy	19.9.2007 at V. Ramenhally
40.	K. N. Subrahmanya	19.9. 2007 at V.G.Koppalu
41.	C. Mahadeva	20.9.2007 at D.G.Koppalu
42.	K. N. Subrahmanya	21.9.2007 at Neelangala
43.	Dr. M. M. Shenoi	27.9.2007 at Badagalapura
	Training programme and field visit	
44.	Dr. A.R. Panda	14.9.2007 at Tangutur, Vaviletipadu
45.	Dr. A.R. Panda	24.9.2007 at DC Palli
46.	Dr. A.R. Panda	25.9.2007 at Kondepi
47.	Dr. A.R. Panda	27.9.2007 at Maddiralapadu, Bodavada
48.	Dr. A.R. Panda	29.9.2007 at Ongole

Sl. No.	Programme & Participant (s)	Date & Place
	Training programme to the growers and technical staff of Tobacco Board	
49.	S. Nageswararao & Shanti Nandivelu	4.10.2007 at Mirthipadu
	Training programme on 'Seed bed preparation, nursery management, pest & disease control in seed beds'	
50.	M. Nageswararao & K. Seshasai	5.10.2007 at Thotapalli Village
	Training programme to SLS growers on "Good agricultural practices"	
51.	Dr. V. Krishnamurthy, Dr. C. A. Raju, Dr. P. Harishu Kumar, Dr. K.Sarala, Dr. J. V. Prasad, Dr. K. Nageswara Rao, Dr. B. Krishna Rao, S. K. Naidu, G.Adinarayana and T. Krishna Reddy	October 9-10, 2007 at CTRI, Rajahmundry
	Training programme, Field visit & Farmers' meet	
52.	Dr. A.R. Panda	9.10.2007 at Agraharam
53.	R. Sreenivasulu & Dr. K.C. Chenchaiah	12.10.2007 at Yerrareddypalem
54.	Dr. A.R. Panda	16.10.2007 at Kondepi
55.	Dr. A.R. Panda	26.10.2007 at Ongole
56.	Dr. A.R. Panda	30.10.2007 at Ongole
57.	R. Sreenivasulu	30.10. 2007 at Voletivaripalem and Chundi
	Training programme on 'Main field preparation, ridge formation, plantings, inter-cultivations, IPM and irrigations'	
58.	M. Nageswararao & K. Seshasai Sai	25.10.2007 at Bandapuram
59.	Dr. S. V. Krishna Reddy	31.10.2007 at Makkinavarigudem
60.	Dr. S. Kasturi Krishna	6.10.2007 at Kandrikagudem
	Training programme on 'Main field operations in NLS'	
61.	M. Sanni Babu	6.11.2007 at Gopalpuram, Kandrikagudem and Surapuvarigudem
	Field visit	
62.	Dr. V. Krishnamurthy, Dr. C. A. Raju, Dr. R. V. S. Rao, Dr. P. Harishu Kumar, S.K.Naidu & S.Nageswara Rao	6.11.2007 at Dommeru
63.	Dr. C.A. Raju & K. Sesha sai	8.11.2007 at Jangareddygudem
	Training programme on 'Fertilization, ridge formation, plantations, inter-cultivations, IPM and irrigations'	
64.	Dr. S. V. Krishna Reddy	13.11.2007 at Potineedupalem
65.	M. Sanni Babu	14.11.2007 at Kotanagaram
66.	S. Gunneswara Rao	14.11.2007 at Aswaraopeta
67.	Dr. S. Kasturi Krishna	15.11.2007at Yernagudem and Peddapuram

Sl. No.	Programme & Participant (s)	Date & Place
	Training programme, Field visit & Farmers' meet	
68.	Dr. K.C. Chenchaiah	15.11.2007 at Kondepi
69.	Dr. A.R. Panda	15.11.2007 at Ongole
70.	R. Sreenivasulu & Dr. K.C. Chenchaiah	19.11.2007 at Kunamnenivaripalem
71.	R. Sreenivasulu & Dr. K.C. Chenchaiah	21.11.2007 at Mallavarappadu
	Demonstration of power weeder – cum – ridger - cum - intercultivator	
72.	R. Subba Rao & Dr. B. Krishna Rao	26.11.2007 at Kandrikagudem
	Field day & Farmers' meet	
73.	Dr. A.R. Panda	30.11.2007 at Ongole
74.	R. Sreenivasulu	3.12.2007 at D. Lakshmipuram
	Training programme on 'Main field preparation, fertilizer application, ridge formation, plantations, inter-cultivations, IPM and irrigations'	
75.	Dr. V. Krishnamurthy, Dr. C. A. Raju, Dr. R. V. S. Rao & Dr. P. Harishu Kumar	December 5-6, 2007 at Badrachalam
76.	R. Subba Rao	12.12.2007 at Raghudevapuram
	Field visit and training programme on 'IPM, topping & desuckering, harvesting & curing'	
77.	Dr. K. Siva Raju	18.12.2007 at Peddapuram
78.	Dr. S. Kasturi Krishna	18.12.2007 at Yernagudem
	Field visit, Farmers' meet and training programme	
79.	Dr. K.C. Chenchaiah	18.12.2007 at Cherukurpadu and Lingamgunta
80.	Dr. K.C. Chenchaiah	19.12.2007 at Vippatlapadu, Marrichetlapalem and Cheemakurthi
81.	Dr. A.R. Panda	20.12.2007 at Podili and KV Polu
82.	Dr. A.R. Panda	22.12.2007 at Maddiralapadu
83.	Dr. A.R. Panda	27.12.2007 at Darsi
84.	R. Sreenivasulu & Dr. K.C. Chenchaiah	27.12.2007 at K.V. Palem and Ramapuram
	Field day on 'Influence of yield and quality of tobacco organic/biofertilizers and IPM measures'	
85.	Dr. D. V. Subhashini & Dr. S. Kasturi Krishna	27.12.2007 at Kandirikagudem
	Tobacco workshop	
86.	R. Sreenivasulu & Dr. K.C. Chenchaiah	30.12.2007 at CTRI R S, Kandukur
	Field visit	
87.	Dr. A.R. Panda	31.12. 2007 at DC Palli and Marripadu
	Field visit to on-farm trial plot	
88.	M. Nageswara Rao, S. Nageswara Rao & G. Adinarayana	5.01.2008 at Gopalapuram

Sl. No.	Programme & Participant (s)	Date & Place
Training programme on 'Topping & desuckering, harvesting & curing'		
89.	M. Nageswara Rao	9.1.2008 at Taduvai
Field visit, Farmers' meet and training programme		
90.	Dr. A.R. Panda	9.1.2008 at Lingamguntla & MG Palem
91.	R. Sreenivasulu	10.1.2008 at DC Palli
92.	Dr. A.R. Panda	11.1.2008 at Kaligiri and J Gunta
93.	Dr. A.R. Panda	17.1.2008 at Vellampalli
94.	R. Sreenivasulu & Dr. K.C. Chenchaiah	17.1.2008 at Salakanuthala and Machavaram
Training programme on 'Topping & desuckering, harvesting & curing, grading and PHPM'		
95.	Dr. S.V. Krishna Reddy	18.1.2008 at Surapavarigudem
Visit of the Tobacco Board inter-agency team to review the progress of implementation of various extension schemes to asses the crop condition and preliminary yield estimation		
96.	Dr. K. Nageswara Rao	January 18-22, 2008 at Thorredu, Devarapalli, Gopalapuram, Koyyalagudem and J.R.Gudem-I & II
Training to farmers on curing		
97.	R. Sreenivasulu & Dr. K.C. Chenchaiah	19.1.2008 at Vengamukkapalem
Interaction with tobacco growers		
98.	J. Siva Sai	22.1.2008 at CTRI RS, Jeelugumilli
99.	Dr. S. Kasturi Krishna & Dr. J. V. Prasad	23.1. 2008 at CTRI, Rajahmundry
Field day		
100.	Dr. D .V. Subhashini & M. Nageswara Rao	23.1.2008 at Vedallakunta
Field day and curers training programme		
101.	A.V. Sekhar Babu & Ameer Ali	23.1.2008 at Gunturpalli
Field day and training programme on 'Balanced fertilization, IPM and tray seedlings plantation'		
102.	Dr. S. V. Krishna Reddy	23.1.2008 at Darbhagudem
Training programme on 'Topping & desuckering, harvesting & curing, grading and PHPM'		
103.	Dr. S. Kasturi Krishna	24.1.2008 at Murari
Training to farmers on curing		
104.	R. Sreenivasulu	24.1.2008 at Kothur
Field day and training programme on 'Balanced fertilization, IPM and tray seedlings plantation'		
105.	Dr. S. V. Krishna Reddy	25.1.2008 at Markendayapuram

Sl. No.	Programme & Participant (s)	Date & Place
	Field day and training programme on 'Influence of yield and quality of tobacco by using seedlings raised in trays and IPM measures'	
106.	M. Nageswara Rao & S. Nageswara Rao	1.2.2008 at Atchaipalem
107.	S. Gunneswara Rao & Dr. K. Siva Raju	5.2.2008 at Yernagudem
	Field day	
108.	R. Sreenivasulu & Dr. K.C. Chenchaiah	5.2.2008 February, 2008 at Kamepalli
	Training programme to SBS growers of Kondapi on study tour	
109.	Dr. S. Kasturi Krishna	6.2.2008 at CTRI, Rajahmundry
	Field day	
110.	R. Sreenivasulu	7.2.2008 at Thummagunta
111.	Dr.S. V. Krishna Reddy	11.2.2008 at Darbhagudem,
	Training programme on 'Topping & desuckering, harvesting & curing, grading and PHPM'	
112.	R. Subba Rao, Dr. K. Nageswara Rao, Dr. J. V. Prasad & S. Nageswara Rao	9.2.2008 at Kunavaram
	Training programme on 'Harvesting & curing, grading & post-harvest product management and NTRMs'	
113.	R. Subba Rao & Dr. K. Siva Raju	9.2.2008 at Katavaram
	Workshop on 'Good Agricultural Practices (GAP) in tobacco production for NLS'	
114.	Dr. K. Nageswara Rao, Dr. S. V. Krishna Reddy, Dr. D.V. Subhashini, Dr. C.Chandrasekhrarao & Dr. J. V. Prasad	13.2.2008 at CTRI RS, Jeelugumilli
	Training programme on 'Curing, grading and NTRMs'	
115.	Dr. S .Kasturi Krishna	12.2.2008 at Chinnayagudem
	Training programme on 'Topping & desuckering, harvesting & curing, grading and post-harvest product management'	
116.	Dr. S.V. Krishna Reddy & Dr. K. Siva Raju	14.2.2008 at Koyyalagudem
	Field day on 'Recent technology advancements in tobacco production: Focus on organic manuring'	
117.	R. Subba Rao & I.V. Subba Rao	19.2.2008 at Krishnapuram
	Field day	
118.	R. Sreenivasulu	24.2.2008 at D. Laksmipuram
119.	R. Sreenivasulu & Dr. K.C. Chenchaiah	25.2.2008 at Chavatapalem
120.	R. Sreenivasulu & Dr. K.C. Chenchaiah	27.2.2008 at Ammapalem
	Workshop on 'Good Agricultural Practices (GAP) in tobacco production'	
121.	Dr. K. Nageswara Rao, Dr. S .Kasturi Krishna, Dr. K. Sarala & Dr. J. V. Prasad	27.2.2008 at CTRI, Rajahmundry

Sl. No.	Programme & Participant (s)	Date & Place
	Training Programmes: 1. Harvesting, curing and grading & 2. Post-harvest product management and NTRMs	
122.	S. Nageswara Rao & T. Krishnamurthy	15.2.2008 at Katavaram
	Field day in the on-farm trial plot and programme on 'Varietal trial with UV5 in comparison with Kanchan and efficacy of BT (Biopesticides) over chlorophyriphos for control of Spodoptera'	
123.	Dr. J. V. Prasad & S. Gunneswara Rao	18.2.2008 at Thirumalapuram
	Field day and training programme on 'Balanced fertilization, IPM and tray seedlings plantation'	
124.	Dr. S. V. Krishna Reddy	23.2.2008 at Darbhagudem
	Field day in the on-farm trial plot	
125.	Dr. K. Siva Raju & Dr. D.V. Subhashini	4.3.2008 at Devarapalli
	Training programme to curers	
126.	R. Subba Rao	7.3.2008 at Rapaka
	Field day in the on-farm trial plot	
127.	R. Subba Rao & Dr. K.Sarala	13.3.2008 at Katavaram

RYTHU SADASSU

1.	Dr. K. Nageswara Rao, Dr. U. Sreedhar & Dr. S. Kasturi Krishna	Organized by the Department of Agriculture, Eluru on 7.6.2007 at Jangareddygudem
2.	Dr. S.V. Krishna Reddy & S. Gunneswara Rao	Organized by the Department of Agriculture, Eluru on10.6.2007 at Denduluru
3.	M. Sanni Babu, Dr. S. Kasturi Krishna & Dr. Y. Subbaiah	Organized by CTRI RS, Guntur on 11.6.2007 at Guntur

GUEST LECTURES/ORIENTATION ROGRAMMES

1.	Dr. K.C. Chenchaiah	*Grameena Pragathi Pradarshana* held at Karamchedu
2.	Dr. S. Kasturikrishna	'*Natu* tobacco growers meet' organized by M/s Nagarjuna Fertilizers and Chemicals Ltd. Held at Singarajupalem on 17.10.2007
3.	Dr. K. Siva Raju	Guest lecture to Biotechnology students of Governmentt Autonomous College, Rajahmundry on 15.11. 2007

Sl. No.	Programme & Participant (s)	Date & Place
4.	Dr. M. Mahadevaswamy	Lecture on 'Practices in horticulture based integrated farming system in Alfisols' at Ranchi on 5.12.2007
5.	Dr. C. A. Raju & Dr. K. Nageswara Rao	Orientation programme to the farmers of SLS and SBS on 'Latest methods in tobacco cultivation' at CTRI RS, Kandukur on 30.12.2007
6.	Dr. C. Chandrasekhararao & Dr.K.Sarala	Awareness Campaign on 'Bio-diversity: Upliftment of down trodden communities, targeting poor rural women' at S.C. Community Hall, Diwancheruvu on 15.3.2008

RADIO TALKS

Sl. No.	Name	Topic, Station & Date of broadcast
1.	V.V. Lakshmi Kumari	Role of safe and sanitary food in health care (12.4.2007, AIR, Visakhapatnam)
2.	Dr. C. Chandra Sekhara Rao	Suitable soils for FCV tobacco cultivation and importance of soil testing (18.4.2007, AIR, Visakhapatnam
3.	E. Vijayaprasad	Tips in selection of lands for cultivation of orchards (19.4.2007, AIR, Visakhapatnam)
4.	Dr. P. Harishu Kumar	Importance of summer ploughs and greenmanure crops for FCV tobacco production (18.05.2007, AIR, Visakhapatnam)
5.	Dr. P.V.V. Siva Rao	Virus and bacterial diseases in cattle- Symptoms/ treatment/prevention (29.5.2007, AIR, Visakhapatnam)
6.	Dr. U. Sreedhar	IPM in FCV tobacco using pest monitoring methods (8.6.2007, AIR, Visakhapatnam)
7.	Dr. K.C. Chenchaiah	Role of bio-pesticides in Integrated Pest Management of tobacco (9.6.2007, AIR, Vijayawada)
8.	N. Aruna Kumari	Utilization of solar energy in preparation of food products (11.6.2007, AIR, Vijayawada)
9.	Dr. P. Venugopala Rao	Management practices for burley tobacco nurseries in agency area of AP (16.6.2007, AIR, Visakhapatnam)
10.	N. Aruna Kumari	Women empowerment programmes of KVK (26.7.2007, AIR, Visakhapatnam)

Sl. No.	Name	Topic, Station & Date of broadcast
11.	Dr. S.V. Krishna Reddy	Modern methods in tobacco nursery production (28.7.2007, AIR, Visakhapatnam)
12.	Dr. R.V.S. Rao	High yielding varieties of FCV tobacco -—Characteristic features (23.8.2007, AIR, Visakhapatnam)
13.	J.V.R. Satyavani	Tips for cultivation of Bhendi (4.9.2007, AIR, Vijayawada)
14.	R. Sudhakar,	Profitable coir fibre industry (10.9.2007, AIR, Vijayawada)
15.	Dr. C.A. Raju	Pest and disease management in tobacco nurseries (14.9.2007, AIR, Visakhapatnam)
16.	S. Jitendranath	Tips for fodder cultivation in *Godavari islands* (15.9.2007, AIR, Vijayawada)
17.	Dr. C.V.Narasimha Rao	Alternative uses of tobacco (16.9.2007, AIR, Visakhapatnam)
18.	V.V. Lakshmi Kumari	Importance of fruits and vegetables in health protection (23.9.2007, AIR, Vijayawada)
19.	Dr. P.V.V.S. Siva Rao	Rearing of different breeds of backyard poultries (25.9.2007, AIR, Vijayawada)
20.	Dr. U. Sreedhar	Insect pest management in tobacco (16.10.2007, AIR, Vijayawada)
21.	N. Aruna Kumari	Utilization of Soy products in the regular diet and preparation of various recipes (11.11.2007, AIR,Vijayawada)
22.	E. Vijayaprasad	Integrated pest management in Guava *(Psidium guajava)* (22.12.2007, AIR, Vijayawada)
23.	Dr. B. John Babu	Tips to reduce calves' mortality rate (25.12.2007, AIR, Vijayawada)
24.	J.V.R. Satyavani	Integrated management practices for high yields in cashew (20.1.2008, AIR, Visakhapatnam)
25.	V.V. Lakshmi Kumari	Role of millets in Integrated Health & Nutrition management (22.1.2008, AIR, Visakhapatnam
26.	R. Sreenivasulu	Tips for tobacco leaf harvest, curing and grading (12.2.2008, AIR, Vijayawada)
27.	Dr. Y. Subbaiah	Management practices in dryland agriculture (6.3.2008, AIR, Visakhapatnam)
28.	R. Sudhakar	Banana fibre products -- Related industries (9.3.2008, AIR, Vijayawada)
29.	Dr. M. Anuradha	Topping in tobacco - - Precautions to be taken in suckericide application (13.3.2008, AIR, Visakhapatnam)

TV PROGRAMMES

1.	Dr. M.M.Shenoi	Issues related to tobacco crop	12.5.2007
2.	Dr. M. Mahadevaswamy	Interculture, topping and fertilizer application in FCV tobacco	11.7.2007
3.	Dr. M. M. Shenoi	Diseases and pests of FCV tobacco	17.7.2007
4.	Dr. M. M. Shenoi & K. N. Subrahmanya	Topping, harvesting and Post-harvest Product Management	28.7.2007
5.	K. N. Subrahmanya	Harvesting & curing of FCV tobacco in KLS	4.10.2007
6.	K. N. Subrahmanya	Storage & grading of FCV tobacco in KLS	6.10.2007
7.	Dr. S. Roy	Leaf curl of tobacco	21.12.2007
8.	Dr. S. Roy	Bacterial wilt and Hollow stalk of tobacco	23.1.2008
9.	Dr. S. Roy	Brown spot of tobacco	5.3.2008

EXHIBITIONS

An exhibition stall of CTRI depicting the tobacco production technologies was arranged in the premises of CTRI RS, Guntur on 11th June, 2007 in connection with the *Rythu Sadassu*, organized by the Government of Andhra Pradesh. About 3,000 farmers from Guntur Division have participated in the programme.

PRESS MEET

A press meet was arranged on 2.12.2007 on the eve of the visit of Dr. P.L. Gautam, Dy. Director-General, (CS) and Dr. K. C. Jain, Asst. Director-General, (CC), ICAR, New Delhi to CTRI.

KRISHI VIGYAN KENDRA, KALAVACHARLA

Krishi Vigyan Kendra of CTRI has disseminated proven viable technologies and facilitated thousands of farmers, farm women, rural & tribal youth towards technology adoption in agriculture and allied areas.

SIGNIFICANT ACHIEVEMENTS

- A total of 121 training programmes in different disciplines were conducted covering 3,860 farmers, farm women, rural youth and extension functionaries.
- FLDs on sesamum, blackgram and bengalgram were implemented in 25 ha area.
- Field level embryo transfer programme was implemented in collaboration with the State Department of Animal Husbandry and Sri Venkateswara Veterinary University and 60% success rate was achieved with 6 newly born calves.
- Three new disciplines viz., Plant Protection; Value-addition; and Fisheries were added to the existing five disciplines of Krishi Vigyan Kendra.
- Intercropping of redgram with soybean was found most remunerative and was popularized in upland areas of East Godavari district.
- Mango seedlings (20,000) were reared and grafted to supply to the needy farmers.
- KVK was recognized as Training Centre for Field Experience Training of ARS trainee scientists.

ARS probationers with the Director

- A State-Level Seminar on "Improved Technologies for Higher Productivity in Cashew" was organized on 08.02.2008.

Seminar on Cashew

- Collaborative programmes were organized and an amount of Rs.5.2 lakhs was contributed towards resource generation.
- XVIII SAC meeting of Krishi Vigyan Kendra was organised at CTRI, Rajahmundry on 28.02.08 to review the work carried out by KVK.

Scientific Advisory Committee Meeting

SUCCESS STORIES OF KVK

- Popularization of Paddy Drum Seeder for direct seeding in paddy

Paddy Drum Seeder in operation

- Vertical expansion of backyard poultry units through supply of eggs and chicks throughout the state
- Production of 20,000 mango & cashew grafts for supply to the needy farmers
- Introduction of *Casuarina* and *Eucalyptus* multiplication
- Focus on integrated technologies in different disciplines
- Introduction of Banana Fibre Extractor in North Eastern region of the country under the National Technology Mission
- Women empowerment through vocational training
- Generation of Rs.10,10,595/- through trainings, consultancy and farm receipts as against the target of Rs.5,00,000/-

TECHNOLOGY ASSESSED & REFINED

- Transplantation of 15 days old seedlings in SRI system of rice out scored the yield by 6% as compared to recommended 8-12 days aged seedlings
- Direct seeding by Row Seeder in rice proved viable and reduced the crop duration by at least 10 days and increased the grain yield by 5%
- Balanced fertilizer application for higher yields of cashew in light soils has improved net yields from 3.4 to 8.0 kg per tree
- In citrus, pruning of trees and timely spraying of recommended insecticides, swabbing the tree trunk with neem oil/ Bordeaux paste to a height of 1 m has increased the net income by Rs.6000/- per ha
- Deworming in pregnant buffaloes and administering antihistamines has reduced the disease incidence and increased the milk yield by 400 ltrs/ animal/year
- Feeding of turkey poults (up to 45 days) with concentrates has reduced the mortality by about 80% and improved the weight by 110 grams
- Coir yarn making through motorized ratts proved viable and enhanced the yarn yield by about 60% coupled with quality
- Cattle treated with *E care se* – 10 ml injection 20 days prior to calving shed the placenta in time. Thus, reduced the incidence of infection and improved the conception rate
- Cost : Benefit Ratio in respect of soil test based fertilizer application in rice was enhanced to 2.08 from 1.84 (general recommendation) in delta area of East Godavari district
- Family income was increased by 20% (Rs.1200/- to 1500/-) through multiple skill concept

AWARDS AND RECOGNITIONS

❖ Best Administrative Worker Award for 2007 was given to Smt. Rohini, UDC, CTRI Research Station, Hunsur, Karnataka.

Smt. Rohini receiving the Award

◆ ISCA Best Poster Award-08 in Agricultural and Forestry Sciences was given to Dr. B. Krishna Rao, Scientist, CTRI, Rajahmundry for the paper entitled "Decision support system for improving water use-efficiency in canal command areas" at the 95th Indian Science Congress held at Andhra University, Visakhapatnam on 07.01.2008

Dr. B. Krishna Rao receiving the Best Poster Award

❖ KVK of CTRI is recognized as Training Centre for Field Experience Training of ARS trainee scientists.

❖ KVK of CTRI is recognized as the lead centre for women empowerment activities in Zone –V.

LINKAGES AND COLLABORATIONS

CTRI has developed strong linkages with various organisations at regional, national and international level. At regional level, linkage between CTRI and various state government departments and Agril. Universities in Andhra Pradesh, Tamil Nadu, Karnataka, Bihar, Gujarat and West Bengal was established to provide an effective thrust to Indian tobacco development. Central organisations like Tobacco Board, Directorate of Tobacco Development, Chennai, Department of Biotechnology and lead banks are associated with different tobacco development programmes.

Research projects have been taken up with the collaboration of various research organizations such as CRIDA, Hyderabad, CDRI (CSIR), Lucknow, CIAE, Bhopal, PDBC, Bangalore and NBSS&LUP, Nagpur.

Sl. No.	Name of the Collaborating Agency	Project title/Activity
a) National Institutes and Agricultural Universities		
1.	Central Drug Research Institute, Lucknow	Synthesis and biological evaluation of solanesol derivatives as novel bioactive substances
2.	Bureau of Indian Standards	Development of Indian standards for tobacco and tobacco products
3.	CRIDA, Hyderabad	Watershed based NRM strategies for rainfed area of Prakasam district in Andhra Pradesh
4.	Tobacco Board	Model Project Area scheme and on-farm trials for improving yield and quality of FCV tobacco in different zones
5.	National Research Centre for Soybean, Indore	Conducting IVT & AVT trials of soybean varieties
6.	National Bureau of Soil Survey & Land Use Planning, Nagpur	Soil resource mapping of tobacco growing soils in India
7.	NRC for Oil Palm, Pedavegi	Production technology of oil palm and intercropping of FCV tobacco in oil palm
8.	Department of Agriculture in different States	Transfer of technology in non-FCV types and supply of inputs
9.	Indian Meteorology Dept., Pune	Maintenance of meteorological observatories at different Stations
10.	M/s ITC Ltd.-ILTD Divn., M/s. Godfrey Phillips India Ltd., M/s. VST Industries Ltd. and ITA, Guntur	Research and development activities, organising training programmes, field trials on latest packages, variety release proposals, manufacturing tests and storage tests
11.	NRC on Rapeseed Mustard, Bharatpur, Rajasthan	Testing of promising lines of mustard
12.	PDBC, Bangalore	Coordinated trials in biological control
13.	Uttar Banga Krishi Viswavidyalaya Pundibari,	Ph.D. programme on Management of brown spot disease in *Motihari* tobacco in West Bengal
(b)	**International Institution**	
1.	CORESTA, France	Evaluation of pest and disease resistant varieties

ALL INDIA NETWORK RESEARCH PROJECT ON TOBACCO

Salient research findings emanated from the experiments conducted at different centres of AINRP(T) (Rajahmundry, Pusa, Anand, Shimoga, Nipani, Nandyal, Berhampur, Araul, Hunsur, Guntur, Dinhata, Ladol, Kandukur, Jeelugumilli and Vedasandur) during the crop season 2006-07 in different disciplines are summarized below.

CROP IMPROVEMENT

Initial varietal trials (IVT)

Initial varietal trials with 10 entries of FCV tobacco, 2 entries of FCV tobacco hybrids, 4 entries of *Bidi* tobacco and 4 entries of *rustica* tobacco were conducted separately for each type at different centres of AINRP (T) during 2006-07 season. The promising entries at different centres were promoted to AVT in respective centres. Promising FCV tobacco entries were Cy 156 at Rajahmundry, Cy 156, A 1 and A 3 at Shimoga, Cy 156, Cy 159, Cy 153, JS 62 and FCH 201 at Guntur, A 1, A 3 and FCH 201 at Hunsur, A 3, JS 62, JS 117, FCH 201 and LV 1 at Jeelugumilli and JS 62, LV 1, Cy 159, 55 Mx-1-15 and Cy 156 at Kandukur. Promising FCV tobacco hybrid entries were CH 1 and CH 3 at Shimoga, Hunsur and Jeelugumilli. The promising *Rustica* tobacco entries, AR 91, AR 92, AR 93 and AR 94 were promoted to AVT I at Anand. Promising *Bidi* tobacco entries ABD 105, ABD 106, ABD 107 and ABD 108 at Anand & Nipani were promoted to AVT I.

Advanced varietal trials (AVT)

FCV tobacco entries, V 4230 and V 4219 at Rajahmundry, KST 27 and KST 28 at Shimoga, CH 3 at Hunsur and Shimoga and CH 1 at Jeelugumilli and *Bidi* tobacco entries, NBD 159 and ABD 99 at Nandyal were approved for testing in bulk trials in view of their superior performance.

The advanced breeding FCV tobacco entry, Cy 118 Sel-1 showed superior performance with respect to all yield characters in AVT over two years at Guntur and proposed for critical evaluation under station bulk yield trials and on farm trials at Guntur.

Combined analysis of pooled results of AVT at Kandukur for 2004-06 indicated that N 98 was significantly superior to all the three checks for all the yield parameters.

In the irrigated *Natu* advanced line, 45-90 was found significantly superior to best check, Kommugudem with 18% increase in total cured leaf yield and 22% increase in *Melimi* leaf out turn at Jeelugumilli.

Four *Bidi* tobacco hybrids were evaluated at Nandyal against checks A 119 and GTH 1 in AVT I on hybrid tobacco. The hybrid, BTH 123 recorded the maximum cured leaf yield of 2,340 kg/ha followed by check hybrid, GTH 1 (2,201 kg/ha), BTH 126 (2,741 kg/ha) and check variety A 119 (1,339 kg/ha).

Significantly higher yields over the best check, Bhavyasree were obtained in AVT II in respect of *Bidi* tobacco entries, ABD 93 (2,275 kg/ha), NBD 136 (2,178 kg/ha), NBD 134 (2,108 kg/ha), ABD 92 (1,998 kg/ha) and NBD 147 (1,970 kg/ha) at Nipani, Karnataka.

The *Bidi* tobacco hybrid, NBTH 801 recorded significantly higher yield (1,328 kg/ha) over the better check variety, Bhavyasree. However, NBTH 105 (1,221 kg/ha) and NBTH 325 (1,328 kg/ha) also gave higher yields over better checks, NBD 43 and Bhavyasree at Nipani, Karnataka.

The advanced breeding Chewing tobacco lines, HV.94-19 and HV 94-21 recorded higher total and whole leaf yields with significant superiority over two checks, Bhagyalakshmi and VR 2, in AVT during 2006-07 season as well as in pooled analysis of two seasons at Vedasandur. Line, HV 94-19 is proposed for critical evaluation under bulk and on-farm trials.

Bidi tobacco lines suitable for early planting, normal planting, drought conditions and higher seed yield under Gujarat conditions were identified and further work is in progress.

Advanced *Bidi* tobacco breeding lines, ABD 105 and ABD 106 showed resistance to root-knot nematodes coupled with comparable yields to the checks. These lines will be critically evaluated for resistance to all the races of nematodes at different centres during the season 2007-08.

BULK TRIALS

Bulk trial conducted at Kandukur during 2006-07 also indicated the superiority of N 98 over all the three check varieties and this was followed by KST 28 and Cy 144.

In bulk evaluation trial of FCV tobacco entry, Cy 149 along with the controls, recorded 1,900 kg/ha compared to 1,825 kg/ha of the best control, Siri at Rajahmundry.

Performance of ABD 90, a *Bidi* tobacco entry is better than the entries, ABD 77, ABD 87 and NBD 119 in the bulk trial conducted at Nandyal, Andhra Pradesh.

Other salient findings in Crop Improvement

Advanced FCV tobacco breeding line, Cy 79 from Kandukur centre, recommended for identification in the Variety Identification Committee Meeting on 10th June 2004 has been released as Kanthi in 2006 by the Andhra Pradesh State Seed Sub-Committee for Varietal Release for cultivation in Southern light soils of Andhra Pradesh.

Advanced FCV tobacco breeding line, II-1624 from Guntur centre, recommended for identification in the Variety Identification Committee Meeting on 10th June 2004 has been released as Hemadri in 2006 by the Andhra Pradesh State Seed Sub-Committee for Varietal Release for cultivation in Southern light soils, Southern Black soils and Central Black soils of Andhra Pradesh.

Advanced *Natu* tobacco breeding line, NG 73 from Guntur centre, recommended for identification in the Variety Identification Committee Meeting on 10th June 2004 has been released as Bhairavi in 2006 by the Andhra Pradesh State Seed Sub-Committee for Varietal Release for cultivation in black soils of Andhra Pradesh under rainfed conditions.

Advanced FCV tobacco breeding line, Cy 135 from Rajahmundry centre, recommended for identification in earlier Workshop during 2005 has been released in 2006 as Siri by the Andhra Pradesh State Seed Sub-Committee for Varietal Release for cultivation in Traditional black soils of Andhra Pradesh.

The release proposal of a *Bidi* tobacco variety, NBD 43 from Nipani centre is submitted to the Karnataka State Variety Release Committee and its release is awaited.

F4 progeny of four crosses planted and seed collected to advance to F5 in the projects on hybridization and selection to evolve superior *Bidi* and *Natu* tobacco varieties at Nandyal.

CROP PRODUCTION

Application of 75% recommended N + 2.5 kg *Azotobacter* + 2.5 kg *Azospirillum* + 2.5 t FYM/ha to FCV tobacco is recommended for higher yields and net returns to the farmers of Shimoga region in Karnataka.

The present recommendation of 120 kg K_2O/ha to FCV tobacco will continue under Mysore conditions in KLS as the K content of cured leaf and burn related K were not significantly increased due to application of potassium at higher doses of 140 and 180 kg K_2O /ha.

Application of recommended dose of fertilizer (220 kg N/ha) along with bio-fertilizer, *Azotobacter* @ 4.0 kg /ha (10^8 cfu-1) to *Bidi* tobacco is recommended for maximizing yield and net returns to *Bidi* tobacco farmers of middle Gujarat Agro-climatic zone III.

Planting of *Bidi* tobacco hybrid, GTH 1 in second fortnight of August with 45 to 60 days old seedlings is recommended to the farmers in middle Gujarat agro-climatic zone for maximizing yield and net returns.

Green manuring with sunnhemp or FYM @ 12.5 t/ha was found effective in increasing the productivity of *Bidi* tobacco at Anand, Gujarat.

A seed rate of 8 kg/ha is recommended for *Rustica* tobacco nurseries in Gujarat in view of the large variability (>34%) seen in the test weight of *Rustica* seeds.

Bulk trial results confirmed that *Pikka* tobacco leaf yields can be increased by giving one flow-irrigation during stress period. An increase of 28.3% in leaf yield was obtained during 2006-07 with one flow-irrigation over no irrigation at Berhampur, Orissa. One furrow-irrigation during grand growth period (50-60 days after planting) to *Pikka* tobacco variety, Gajapati is recommended to the *Pikka* tobacco farmers of Orissa for improved productivity and quality of tobacco and for higher net returns.

Pooled results over three years revealed that tobacco-tomato intercropping system (2:4) recorded highest tobacco equivalent yield of 1,549 kg/ha compared to sole crop (1,235 kg/ha) and it also recorded maximum net returns at Berhampur, Orissa.

Pooled results over three years revealed that tobacco-chilli intercropping system (2:4) recorded highest tobacco equivalent yield of 1,369 kg/ha compared to sole crop (1,264 kg/ha) and it also recorded maximum net returns at Berhampur, Orissa.

In Orissa, yield of *Pikka* tobacco increased with increasing levels of nitrogen application from 80 to 120 kg/ha. Organic and inorganic N in the ratio of 25:75 was found superior for *Pikka* tobacco.

Significant improvement in seed yield, oil content and oil yield of chewing tobacco variety, A 145 was observed due to sulphur application at Shimoga, Karnataka.

Application of 275 kg N/ha to *Bidi* tobacco gave significantly higher leaf yield (2,278 kg/ha) over 225 kg N/ha (2,143 kg/ha) and 175 Kg N/ha (1,956 kg/ha) levels at Araul, Kanpur.

Three years' study at Araul, Kanpur on economic viability of tobacco/non-tobacco crops during *rabi* season indicated that highest net return was obtained by growing hookah tobacco (Rs. 17,111/ha) than bengalgram (Rs. 8,815/ha), mustard (Rs. 6,876/ha), linseed (Rs. 6,413/ha) and wheat (Rs. 5,299/ha).

Bhendi-tobacco gave higher net returns in tobacco based cropping systems at Nandyal. Soybean and sunflower crops were also found better alternatives to fallow-tobacco.

Bulk trials in ten farmers' fields indicated that application of zinc sulphate along with recommended dose of fertilizer and FYM recorded 8.3% higher tobacco yields as compared to no application of zinc sulphate at Nipani, Karnataka.

Higher population at spacing of 75 x 30 cm recorded higher seed yield, capsule weight and primed leaf of chewing tobacco in 2006-07 season and also in the earlier season at Vedasandur. Different levels of N (75, 100 & 125 kg/ha) did not significantly influence the above characters.

An increase of 1.54% in whole leaf yield and an increase of 5.6% in total leaf yield of *chewing* tobacco were obtained in bulk trials due to potassium application over no application of potassium. Application of 50 kg K_2O/ha to *chewing* tobacco is recommend for adoption by the chewing tobacco farmers in Tamil Nadu for higher net returns.

CROP PROTECTION

Frog-eye spot disease in *Bidi* tobacco can be managed by spraying of 0.05% carbendazim @ 600 l spray fluid/ha twice at an interval of 15 days starting from initiation of the disease. Next best is spraying of 0.1% propiconazole 25 EC @ 600 l spray fluid/ha twice at an interval of 15 days starting from initiation of the

disease. This technology is recommended to *Bidi* tobacco farmers of Nipani area in Karnataka.

Root-knot disease in *Bidi* tobacco can be managed by spot application of poultry manure @ 1 t/ha + carbofuron 3G @ 5 kg/ha at the time of planting in Nipani area. This technology is recommended to *Bidi* tobacco farmers of Nipani area in Karnataka.

Advanced breeding *Bidi* tobacco lines, hybrid lines and germplasm lines were evaluated under natural unprotected conditions against major diseases of tobacco at Nipani. Entries of AVT I, ABD 99 and ABD 154 were found promising by showing multiple disease resistance against frog-eye leaf spot, brown leaf spot and TMV. The popular check A 119 recorded moderately resistant reaction for frog-eye leaf spot and brown leaf spot along with station checks Bhavyasree and NBD 43. The AVT II entries, ABD 94, ABD 95, NBD 138 and NBD 139 showed multiple disease resistant reactions. All the entries of AVT II showed mild reaction for TMV except NBD 134 and NBD 147 which showed susceptible reaction. The IVT entries, ABD 106 and ABD 107 showed multiple resistant reaction. Hybrid entry, BTH 128 was found susceptible for TMV whereas BTH 126 showed multiple resistance against frog-eye leaf spot, brown leaf spot and TMV.

The survey undertaken in Nipani and surrounding areas indicated that brown leaf spot appeared on one month old crop while frog-eye leaf spot appeared late. The aphid incidence was more on all dates of planting. The severity ranged from 10.1-15.2%. The incidence of root-knot nematode was in range of 10-15% at the time of harvest and damping-off was the major constraint in the nursery.

All the 203 genotypes/cultures screened for their reaction against *S. litura* damage under natural infestation were found susceptible to this pest at Anand.

Observations on the seasonal activity of whitefly, *Bemisia tabaci*, revealed that the pest remained in very low numbers throughout the year on various crops. Comparatively high activity was observed in *brinjal* (i.e. above two flies/leaf) during 47th to 49th std. weeks followed by cotton and Indian bean at Anand.

The results of monitoring resistance development in *Pythium aphanidermatum* to metalaxyl MZ, revealed that resistance has not been developed in the pathogen to the chemical under Anand conditions.

In the integrated management of nematodes, leaf curl, frog-eye and brown spot diseases in *Bidi* tobacco field at Anand, the results revealed that delay in planting from September III week to October I week significantly reduced frog-eye and root-knot diseases over early planting. Cured leaf yield was significantly higher in September I week planting over August planting. The differences in respect to yield, frog-eye spot and root-knot diseases were significant between treated and control plots.

The survey in tobacco growing areas of West Bengal indicated that the incidence of bacterial wilt, mosaic virus, TLCV, hollow stalk and brown spot diseases in *Motihari* (*N. rustica*) tobacco ranged from 0.94-2.66%, 1.53-5.10%, 0.92-3.33%, 7.05-29.05% and 4.11-28.89%, respectively. The survey also indicated that incidence of mosaic virus, TLCV, bacterial wilt and brown spot in *Jati* tobacco ranged from 2.0-4.58%, 3.22-3.75%, 0.6-1.5% and 10.28-32.33%, respectively.

Seventy two germplasm lines and 42 hybrid lines of *Bidi* tobacco were screened against *Spodoptera* and aphid at Nandyal. In germplasm lines, lowest *Spodoptera* incidence of 4.47% was recorded in ABD 66, followed by NBD 164 (7.31%) and AKBDT 0307 (9.9%). Remaining all other lines recorded more than 10% damage. Regarding the incidence of aphid, 28 lines recorded score of one, 11 lines recorded less than one and remaining lines recorded zero. Among the hybrid lines, lowest *Spodoptera* incidence of 2.88% was recorded in GT4 X NBD 80-2 cross and highest incidence (26.27%) was recorded in GT4 X ABD-91 cross. In all the crosses, aphid score was zero except

in A119 X GT7 where in score recorded was 0.4.

Jowar as barrier crop against aphid played a major role in obstructing the movement of aphid in to the main field of *Bidi* tobacco at Nandyal. As a result, aphid incidence was low in IPM plot (42%) compared to non-IPM plot (92%). Like wise, trap crop castor played an important role in trapping the larvae and egg masses of *Spodoptera*. Aphid score of 1.25 (0-2) was recorded in IPM plot, compared to non-IPM plot where it was 3.5 (1-5).

CROP CHEMISTRY AND SOIL SCIENCE

Bidi tobacco genotype, ABD 36 recorded highest leaf protein yield (1,147 kg /ha) followed by *Bidi* tobacco variety, A 119 with 1,090 kg/ha. *Bidi* tobacco variety, A 119 recorded highest seed yield (677 kg/ha) and seed oil (255 kg/ha) at Anand. However, oil content was higher in the genotype, 103-9-101 at 39.4% as against 37.64% in A 119. Studies using GLC have established the fact that tobacco seed oil is free of nicotine.

The nicotine content in all the varietal trials was within the normal range. The maximum nicotine content (8.77%) was found in GT 5 while, ABD 90 showed lowest nicotine (5.10%) content. All the hybrid entries contained lower nicotine than the varieties GT 5 and GTH 1. The nicotine content of all the genotypes under irrigated condition was higher as compared to unirrigated condition at Anand, Gujarat.

In the large scale trial of *rustica* tobacco, variety GC 1 contained highest nicotine. The nicotine content of AVT and IVT trials varied from 3.69 to 5.55% and 2.62 to 4.95%, respectively at Anand, Gujarat.

Nicotine, reducing sugars and chloride contents were significantly altered due to manurial application in low land conditions. Highest nitrogen, nicotine and reducing sugars contents were recorded with inorganic fertilizers. No change in nicotine content was observed due to different levels of nitrogen. Nitrogen and nicotine contents in leaf were significantly low with green manuring of sunnhemp in light textured soil at Anand, Gujarat.

Highest nicotine, lowest reducing sugar and chloride content of *rustica* tobacco at Anand, Gujarat were recorded in irrigation with alternate furrow method. Irrigation level of 1.1 IW/CPE ratio produced better quality of *rustica* tobacco with maximum nicotine content.

Highest nicotine content of *rustica* tobacco was recorded with inorganic source of recommended dose of fertilizers at Anand, Gujarat.

WORKSHOP

The XVIII Tobacco Workshop of All India Network Research Project on Tobacco was held at Anand Agricultural University, Anand during August 11-12, 2007.

Dr. V. Krishnamurthy, Director, CTRI lighting the lamp to inaugurate the Workshop

Dr. K.C. Jain, Asst. Director General (CC), ICAR addressing the delegates in the Workshop

EMPOWERMENT OF WOMEN IN AGRICULTURE

- A long duration (75 days) vocational training (off-campus) on "Banana fibre extraction and fibre products making" was conducted for 30 rural women at Tirunalveli, Tamil Nadu. The programme was sponsored by Mother India Voluntary Organization.
- Two training programmes of two months duration each on "Banana fibre extraction and making products from fibre" were conducted for 40 rural women at Yeleswaram, East Godavari district and Chagallu, West Godavari district. The programmes were sponsored by GAMANA and GUARDS voluntary organizations, respectively.
- Five automatic coir 2-ply yarn making units were promoted through KVK at Morampudi, Yanam, Damireddipalli, Kakinada, Gudivada. The units were established with an investment of Rs.7.00 lakhs to 10.00 lakhs and each unit is earning a net profit of Rs.10,000/- to 20,000/- per month. Currently, a total of 17 coir automatic units are running successfully and 150 women are employed as coir workers in these units.
- Two *adda* leaf plate/paper making units were promoted at Gokavaram and Kalavacharla villages. The units were established with an investment of Rs.2.00 and Rs.5.00 lakhs, respectively. Each unit working with 10-15 women is earning a net income of Rs.15,000/- per month.

Adda leaf plate making

- Nine vocational sponsored training programmes were conducted on Banana fibre extraction, fibre products making, and coir yarn making.
- Twenty beneficiaries are working as coir master trainers with Coir Board, DRDA and imparting skills in yarn making at 20 centres in Andhra Pradesh and earning a consolidated pay of Rs.3,000/- per month.

Yarn making

- The trained rural & tribal women in coir and leaf plate making units are earning an amount of Rs.2,000/- to 3,000/- per month through employment generation.
- Two months duration *batik printing* training programme was organized at Mukkamala village from 10-8-07 to 10-10-07 and a total of 25 rural youth have undergone training.
- Two weeks duration skill upgradation training in fabric printing was conducted at KVK, Kalavacharla and a total of 15 rural youth (females) have undergone training.

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A bulletin on "Improved Technologies for Higher Productivity in Cashew" (Telugu) – Y.Subbaiah, J.V.R.Satyavani, E.Vijayaprasad & V.Krishnamurthy.

A manual on "Integrated Health & Nutrition Management" – Y.Subbaiah, V.V. Lakshmi Kumari & N.Aruna Kumari.

CTRI Diamond Jubilee Publications

1) Diamond Jubilee Souvenir (1947-2007)
2) Improved Production Technology for FCV Tobacco in Andhra Pradesh- A Pocket Guide
3) Modern Production Technology for Tobacco Cultivation in Southern Light Soils (in Telugu)
4) CTRI in the Services of Farmers: Leaflets (in Telugu)
5) Safe Use of Crop Protection Agents in Tobacco (in English)
6) Safe Use of Crop Protection Agents in Tobacco (in Telugu)
7) Micro-sprinklers for Tobacco Seedling Production (Pamphlet)

Golden Jubilee Publications of CTRI RS, Hunsur

1. Calendar of agricultural operations for FCV tobacco in KLS (in Kannada)
2. Calendar of agricultural operations for FCV tobacco in KLS (in Kannada-Desk calendar)
3. Improved package of practices for FCV tobacco crop in Karnataka (in Kannada)
4. Tray nursery seedling production technology in KLS
5. Calendar of agricultural operations for FCV tobacco in KLS (in English-CD form)
6. FCV tobacco varieties in KLS
7. CTRI Research Station, Hunsur – A profile
8. Diseases and pests of FCV tobacco in KLS- A diagnostic key
9. Eco-friendly approaches for the management of diseases and pests of FCV tobacco in KLS

Technical Bulletins in Kannada published by CTRI RS, Hunsur

1. Integrated management practices for the control of wilt disease in FCV tobacco crop (Revised - 2007)
2. Raising seedlings in plastic trays using "Tray Nursery" technology (Revised - 2007)
3. Improved Agrotechniques recommended for FCV tobacco nursery management in KLS (Revised - 2007)
4. Agricultural practices to be followed in May month by FCV tobacco farmers (Revised - 2007)
5. Agricultural practices to be followed in June month by FCV tobacco farmers (Revised - 2007)
6. Organic manure and inorganic fertilizer recommendations for the FCV tobacco cultivars grown in Karnataka (Revised - 2007)
7. Agricultural practices to be followed in July month by FCV tobacco farmers (Revised - 2007)
8. Agricultural practices to be followed in August month by FCV tobacco farmers (Revised - 2007)
9. Agricultural practices to be followed from September month on wards till auctions by FCV tobacco farmers (Revised - 2007)
10. Integrated management of FCV tobacco crop in KLS - Improved package of practices and social responsibility (Revised - 2007)

LIST OF APPROVED ON-GOING PROJECTS

Sl. No	Institute Code	Title of the project and Investigator(s)
CROP IMPROVEMENT		
1	Cy.5b.	Maintenance of the genus *Nicotiana* T.G.K. Murthy R.V.S. Rao
2	G.S.1	Germplasm acquisition, maintenance, multiplication, evaluation and utilization R.V.S. Rao and T.G.K. Murthy
3	Br.6.1.4(a)	Incorporation of disease resistance for tobacco mosaic virus (TMV) P.V. Venugopala Rao and C.A. Raju
4	Br.2	Evolving superior varieties of FCV tobacco through hybridization P.V. Venugopala Rao
5	Cy.7(i)	Tissue culture studies in tobacco (I) Interspecific hybridization T.G.K. Murthy and K. Sarala
6	Cy.7(iii)	Tissue culture studies in tobacco (III) Micropropagation of elite lines and other selections K. Sarala and T.G.K. Murthy
7	Cy.2.1 (f)	Incorporation of aphid resistance from *N. gossei. N. repanda, N. x umbratica-nesophila and N. x benthamiana -repanda* T.G.K. Murthy, R.V.S. Rao, U. Sreedhar and K. Siva Raju
8	Bio-tech-4	Development of virus tolerant tobacco lines under *in vitro* K. Sarala, C.A. Raju, P. Venkateswarlu and K. Siva Raju
9	Br.7	Developing hybrid FCV tobacco suitable for traditional black soil area of Andhra Pradesh T.G.K. Murthy, R.V.S. Rao, P.V. Venugopala Rao and K. Sarala
10	MB-9	Evaluation of advanced breeding lines for yield and quality K. Sarala, R.V.S. Rao, P.V. Venugopala Rao and T.G.K. Murthy
11	Biotech-5	Maintenance, evaluation and characterization of tobacco transgenics K. Sarala, J.V. Prasad and K. Siva Raju
12	Biotech-6	Molecular Mapping of tobacco traits: Tobacco Specific Nitrosamines in Burley K. Sarala, T.G.K. Murthy , C.V.N Rao and P.V. Venugopala Rao
13	Biotech-7	Development of tobacco specific microsatellite markers K. Siva Raju and K. Palanichami
14	Biotech-8	Molecular mapping of genes responsible for production of solanesol and nicotine in tobacco K. Sarala, T.G.K Murthy, K. Siva Raju and C.V. Narasimha Rao

Sl. No	Institute Code	Title of the project and Investigator(s)
CROP PRODUCTION		
1	AC-1	Permanent manurial trial R. Subba Rao and P. Harishu Kumar
2	Ag. Eng.5	Design and development of tobacco leaf stringing machine M. Sannibabu and I. Srinivas
3	ARIS ENT-1	Information system on agricultural pests of coastal Andhra Pradesh U. Sreedhar and H. Ravi Sankar
4	ARIS-2	Creation and maintenance of WEB pages of CTRI H. Ravi Sankar, C.V. Narasimha Rao and V. Krishnamurthy
5	ARIS-7	Information system for Flue-cured tobacco production and marketing trends in India H. Ravisankar and C.Chandrasekhararao
6	A-65	Production of organically grown tobacco P. Harishu Kumar, V. Krishnamurthy, K. Siva Raju, M. Anuradha, S. Kasturi Krishna, P. Venkateswarlu and G. Raghupathi Rao
7	A-66	Effect of foliar nutrition of K under S and Mg fertilization on yield and burn related potassium in FCV tobacco P. Harishu Kumar, S. Kasturi Krishna, M. Anuradha and V. Krishnamurthy
8	A-67	Effect of Bio-compost on the yield of FCV tobacco under graded levels of N in Vertisols P. Harishu Kumar, R. Subba Rao, S. Kasturi Krishna and V. Krishnamurthy
9	A-68(a)	Production technology for higher bio-mass and seed oil yield P. Harishu Kumar, R. Subba Rao, S. Kasturi Krishna and C.V. N. Rao
10	A-68(b)	Studies on varietal variation in seed oil production in tobacco (Vertisols) P. Harishu Kumar, S.V. Krishna Reddy and K. Siva Raju
11	A-68(c)	Production technology for seed yield of HDBRG: NPKS requirements P. Harishu Kumar, R. Subba Rao, S. Kasturi Krishna and K. Siva Raju
12	A-68(d)	Influence of leaf removal on seed yield of HDBRG tobacco P. Harishu Kumar, S.V. Krishna Reddy, M. Anuradha and K. Siva Raju
13	A-69	Influence of plant population, nitrogen and topping levels on yield and quality of FCV tobacco advanced breeding line CY-135 R. Subba Rao, P. Harishu Kumar and P.R.S. Reddy
14	A-69(a)	Influence of plant population, nitrogen and topping levels on yield and quality of FCV tobacco advanced breeding line CY-139 R. Subba Rao, P. Harishu Kumar and P.R.S. Reddy

Sl. No	Institute Code	Title of the project and Investigator(s)
15	A-70	Integrated rainwater and nutrient management in tobacco based cropping system under rainfed Vertisols S. Kasturi Krishna, S.V. Krishna Reddy, P. Harishu Kumar and V.Krishnamurthy
16	A-71	Nutrient management in soybean – mustard sequence as an alternative system to FCV tobacco in Vertisols of A.P. P. Harishu Kumar, S. Kasturi Krishna and C.Chandrasekhararao
17	Ag.Extn-33	Assessment of identified slow moving technologies in NLS tobacco growing zones of Andhra Pradesh Y. Subbaiah and S.K. Naidu
18	ARIS-8	Research Projects Monitoring and Evaluation System (RPMES) H. Ravisankar, J.A.V. Prasad Rao, and C.V. N. Rao
19	ARIS-9	Expert system for different diseases of major crops in Andhra Pradesh H. Ravisankar and C.A. Raju
20	Ag.Extn-32	Post-harvest technologies for empowerment of farm women K. Suman Kalyani
21	A- 72	Evaluation of *Rustica* tobacco types for oil production under conserved soil moisture condition in Vertisols of Andhra Pradesh P. Harishu Kumar, R. Subba Rao and K. Siva Raju
22	A -72 (A)	Development of seed production technology in tobacco P. Harishu Kumar, S.V. Krishna Reddy and K. Siva Raju
23	A -73	Effect of foliar nutrition of boron on quality leaf production in FCV tobacco under Vertisols conditions P. Harishu Kumar, S. Kasturi Krishna and C.Chandrasekhararao
24	A- 74	Productivity enhancement of soybean-bengalgram through integrated nutrient management in rainfed Vertisols of Andhra Pradesh S. Kasturi Krishna, S.V. Krishna Reddy, P. Harishu Kumar and V.Krishnamurthy
25	CTRI Nursery -1	Efficacy of different micro irrigation nozzles in wetting tobacco nursery with appropriate soil aeration techniques M. Sannibabu
26	Ag.Extn.F.S	Development of farming systems through inter-dependable entrepreneurship under irrigated and unirrigated conditions of black soils of East Godavari district M. Sannibabu, S. Kasturi Krishna and P. Venkateswarlu
27	Ag.Engg-6	Developing and constructing solar barn at CTRI Farm, Katheru M. Sannibabu

Sl. No	Institute Code	Title of the project and Investigator(s)
28	Agrl. Extn-34	Evaluation of tobacco portal system Y Subbaiah and S.K. Naidu
29	Ag.Extn-35	Analysis of the personality traits, success quotient and basic needs of tobacco scientists K. Suman Kalyani, S.K .Naidu and P. Harishu Kumar
30	Ag.Extn-36	Stress analysis of tobacco farmers and changing scenario of the cropping pattern K. Suman Kalyani and S.K. Naidu
31	ARIS-10	Decision support system for quality evaluation of flue-cured tobacco H. Ravi Sankar and V. Krishnamurthy
32	A -75	Evaluation of tobacco hybrids for leaf biomass and seed yield P. Harishu Kumar, C.V. Narasimha Rao, K. Siva Raju and R.V.S. Rao
33	ARIS-11	Designing algorithms for data classification H. Ravi Sankar
34	Agrl. Extn-38	FLD on Cy 135 in NBS areas of Andhra Pradesh S.K. Naidu, K. Suman Kalyani and K. Sarala
35	Agrl. Extn-39	Trend analysis of cost of production and price behaviour of FCV tobacco in SLS area of Andhra Pradesh Y. Subbaiah and S.K. Naidu
36	Agrl. Extn-40	Critical analysis of the empowerment of farm women in tobacco growing agency area of East Godavari district K. Suman Kalyani and S.K. Naidu
CROP CHEMISTRY AND SOIL SCIENCE		
1	AC-1	Permanent manurial experiment J.A.V. Prasad Rao
2	Ag.SS-2	Soil fertility Investigations : Soil fertility survey of tobacco growing soils of India : a) Soil fertility evaluation of FCV tobacco soils of Periyapatna Taluk, Mysore district, Karnataka V. Krishnamurthy and C.Chandrasekhararao
3	OC-10	Evaluation of smoke constituents in materials from some plant breeding experiments C.V. Narasimha Rao
4	PR-1	Monitoring of pesticide residues in tobacco samples collected from different areas C.V. Narasimha Rao

Sl. No	Institute Code	Title of the project and Investigator(s)
5	OC-21	Studies on tobacco specific nitrosamines (TSNAs) in Indian tobaccos and tobacco products C.V. Narasimha Rao
6	BC-8	Electrophoretic characterization of tobacco cultivers K. Siva Raju and K. Nageswara Rao
7	SSMB-7	Plant growth-promoting *Rhizobacteria* (PGPR) in tobacco based cropping systems D.V. Subhashini and C.Chandrasekhararao
8	Phy-68	Response of light intensity in relation to nitrogen fertilization in flue-cured Virginia tobacco M. Anuradha, K. Nageswara Rao, K. Siva Raju and V. Krishnamurthy
9	SS-23	Investigations on lead and cadmium contents in Indian tobaccos C. Chandrasekhararao and P.R.S. Reddy
10	BC -10	Development of molecular markers for *Fusarium* wilt in tobacco K. Siva Raju and K.N. Subrahmanya
11	SS-25	Investigations on phosphorus and potassium characteristics of FCV tobacco growing soils of Prakasam and Nellore districts. C.Chandrasekhararao, V Krishnamurthy and P.R.S. Reddy
12	SSMB- 8	*Fluorescent pseudomonads* in tobacco disease management D.V. Subhashini
13	SS -26	Determination of critical level of zinc for FCV tobacco in soils of NLS area P.R.S. Reddy and C.Chandrasekhararao
14	BC-11	Biochemical characterization of tobacco seed oil K. Siva Raju, C.V. Narasimha Rao, R.V.S. Rao and V. Krishnamurthy
15	PHY- 70	Carbohydrate metabolism as influenced by nitrogen and potassium nutrition in flue-cured tobacco grown in NLS K. Nageswara Rao, M. Anuradha, C.V. Narasimha Rao and V. Krishnamurthy
16	PHY-71	Chloride nutrition in flue-cured tobacco M. Anuradha, K. Nageswara Rao, C.Chandrasekhararao and V. Krishnamurthy
17	PHY-72	Dynamics of potassium absorption, utilisation and re-translocation in FCV tobacco K. Nageswara Rao, M. Anuradha and V. Krishnamurthy
18	PHY-73	Sucker control in flue-cured tobacco grown in NLS K. Nageswara Rao and M. Anuradha

Sl. No	Institute Code	Title of the project and Investigator(s)
CROP PROTECTION		
1	P.Orb-1	Studies on broomrape of tobacco C.A. Raju
2	P-78	Studies on wilt disease of tobacco C.A. Raju
3	E-53	Integrated pest and disease management: CORESTA collaborative study on insect host plant resistance studies U. Sreedhar
4	EC-58	Studies on persistency and dissipation of insecticides in tobacco U. Sreedhar, C.V. Narasimha Rao and J.V. Prasad
5	E-59	Evaluation of trap crops against budworm, (*H.armigera*) in FCV tobacco U. Sreedhar
6	E-61	Screening of different tobacco germplasm against stem borer, Scrobipalpa heliopa Low P. Venkateswarlu, R.V.S. Rao, S. Gunneswara Rao and J.V. Prasad
7	E-62	Development and validation of weather based forewarning system for major pests of FCV tobacco J.V Prasad, U. Sreedhar and K.C. Chenchaiah
8	E-63	Assessment of avoidable yield loss due to insect pests in FCV tobacco under Northern light soil conditions J.V. Prasad and P. Venkateswarlu
9	E-64	Studies on field persistence and efficacy of nuclear polyhedrosis viruses of *Spodoptera litura* and *Helicoverpa armigera* in FCV tobacco J.V. Prasad and S. Gunneswara Rao
10	E-65	Studies on stem application of insecticides for management of tobacco aphid, *Myzus nicotianae* U. Sreedhar and J.V. Prasad
11	E-66	Efficacy of botanicals against insect pests of tobacco and groundnut under field conditions P. Venkateswarlu, K. Siva Raju, S. Gunnewara Rao and J.V. Prasad
12	E-67	Studies on the efficacy of vegetable oils against *Callosobruchus chinensis* and *Sitophilus oryzae* with special reference to tobacco seed oil as grain protectant S. Gunneswara Rao, J.V. Prasad and P. Venkateswarlu
13	E-68	Studies on the efficacy of organic solvent leaf extracts against oviposition, feeding and growth and development of tobacco caterpillar, *Spdoptera litura* P. Venkateswarlu, K. Siva Raju and J.V. Prasad

Sl. No	Institute Code	Title of the project and Investigator(s)
14	E-69	Development, validation and refinement of IPM module for Burley tobacco U. Sreedhar and R. Subba Rao
15	E-70	Studies on the ecological role of *Nesidiocoris tenuis*, an omnivorous mired bug in tobacco ecosystem J.V Prasad, S. Gunneswara Rao, U. Sreedhar and K. Siva Raju
16	E-71	Life table studies of *Spodoptera exigua* on certain types of tobacco and *Nicotiana* species S. Gunneswara Rao and J.V. Prasad
17	E-72	Efficacy of various aqueous leaf extracts against tobacco stem borer, *Scrobipalpa heliopa* Lower P. Venkateswarlu, K. Siva Raju and S. Gunneswara Rao
18	E-73	Studies on compounds with insecticidal value from wild *Nicotiana* species against the major pests of FCV tobacco J.V Prasad and S. Gunneswara Rao
CTRI RESEARCH STATION, JEELUGUMILLI		
1	JL.Br-2.1	Evolving flue-cured tobacco varieties having high yield and better quality suitable for NLS area of Andhra Pradesh T.G.K. Murthy
2	JLN-1	Maintenance of germplasm of *Natu* tobacco T.G.K. Murthy
3	JLN-2	Developing new varieties of irrigated *Natu* tobacco for A.P. T.G.K. Murthy
4	JL.Br-3	Developing hybrid FCV tobacco suitable for Northern Light Soils (NLS) of Andhra Pradesh T.G.K. Murthy, R.V.S. Rao and K. Sarala
5	JL.Br-4	Evaluation of flavourful exotic lines for their suitability in NLS area of Andhra Pradesh T.G.K. Murthy, R.V.S. Rao and C.V. Narasimha Rao
6	Br. C-2(4)	Evaluation of advanced breeding lines for yield and tar content under Northern Light Soil condition K. Sarala, C.V. N. Rao, T.G.K. Murthy and R.V.S. Rao
7	JLA-22	Evaluation of drip irrigation system on NLS grown FCV tobacco M. Sannibabu
8	JLA-23	Effect of level and time of potassium application on yield and quality of tobacco in Northern Light Soils of Andhra Pradesh S.V.Krishna Reddy, S. Kasturi Krishna, P. Harishu Kumar and J.A.V.Prasad Rao

Sl. No	Institute Code	Title of the project and Investigator(s)
9	JLA-24	Technology for production of flavourful tobacco: Effect of foliar spray of Zn, Mg and topping levels on yield and quality of cv. Kanchan in irrigated Alfisols of A.P. S.V. Krishna Reddy, S. Kasturi Krishna, P. Harishu Kumar and P.R.S. Reddy
10	JLA-25	Evaluation of appropriate micro irrigation system for FCV tobacco crop in Alfisols M. Sannibabu
11	JLA-26	Integrated approach in flue-curing barn to economise energy and improve leaf quality M. Sannibabu
12	JLA-30	Effect of *Rhizobium* and PSB inoculation on blackgram yield and its residual effect on succeeding FCV tobacco (Kanchan) under irrigated Alfisols S.V. Krishna Reddy, S. Kasturi Krishna and C.Chandrasekhararao
13	JLA-31 (Mega Project)	Studies on tobacco based Crop Production system 1) Effect of cropping systems on nitrogen requirement of tobacco 2) Effect of cropping systems and ratios of organic manures and nitrogen requirement of tobacco S.V. Krishna Reddy, S. Kasturi Krishna and C.Chandrasekhararao
14	JLA-C-1	Quantification of aroma in tobacco in terms carbonyls and other gases by anemometric method M. Sannibabu and K. Siva Raju
15	JLA-32 JLA-32 (a)	Studies on feasibility and economic viability of intercropping in FCV tobacco under irrigated Alfisols (NLS) conditions Studies on feasibility and economic viability of intercropping/relay cropping in FCV tobacco under irrigated Alfisols (NLS) conditions S.V. Krishna Reddy, S. Kasturi Krishna, C.Chandrasekhararao, K. Siva Raju and P.Harishu Kumar
16	SS-27	Crop growth modeling in FCV tobacco in NLS C.Chandrasekhararao, M Anuradha, K. Siva Raju, S. Kasturi Krishna and H. Ravisankar
17	JLA-33	Moisture and nutrient depletion pattern under NLS conditions S. Kasturi Krishna, S.V.Krishna Reddy, C. Chandrasekhararao, M.Anuradha and V. Krishnamurthy
BTRC, Jeddangi		
1	By.Br-1	Evaluation of advanced Burley breeding lines for productivity and quality P.V. Venugopala Rao, T.G.K. Murthy, R.V.S. Rao and R. Subba Rao

Sl. No	Institute Code	Title of the project and Investigator(s)
2	By.Br-2	Evaluation of Burley tobacco hybrids suitable for Burley growing areas of Andhra Pradesh P.V .Venugopala Rao, T.G.K. Murthy, R.V.S. Rao and R. Subba Rao
3	By.Br-3	Developing high yielding Burley cultivars with low TSNA levels T.G.K. Murthy, P.V. Venugopala Rao, R.V.S. Rao, C.V. Narasimha Rao, R. Subba Rao and K. Sarala
4	AB-27	Effect of spacing and nitrogen levels on yield and quality of Burley tobacco hybrid JBH-1 R. Subba Rao and P. Harishu Kumar
5	AO-1	Studies on the influence of plant population and nitrogen level on yield and quality of Oriental tobacco. R. Subba Rao and P. Harishu Kumar
6	AO-2a	Studies on N and K interaction effects on Oriental tobacco production and its quality P. Harishu Kumar, R. Subba Rao and C.Chandrasekhararao
7	AO-2b	Response of Oriental tobacco types to N and K fertilization under different agro-climatic conditions P. Harishu Kumar and G. Raghupathi Rao
CTRI RESEARCH STATION, GUNTUR		
1	A-42	Effect of FYM, N, P and K on tobacco leaf yields in permanent manurial trial on FCV tobacco P. Harishu Kumar and G. Raghupathi Rao
2	A-50	Effect of FYM, N, P and K on tobacco leaf yields in permanent manurial trial on *Natu* tobacco P. Harishu Kumar and G. Raghupathi Rao
3	Br-14	Development of FCV tobacco varieties suitable for cultivation in SBS of AP A.V.S.R. Swamy
4	EG-6	Performance of different spray schedules on the incidence of major insect pests on tobacco G. Raghupathi Rao
5	EG-7	Influence of diversified cropping system on host preference and cross over by major insect pests during *kharif* and *rabi* seasons G. Raghupathi Rao
6	EG-9	Evaluation of imidacloprid application method for the control of sucking pests of FCV tobacco G. Raghupathi Rao

Sl. No	Institute Code	Title of the project and Investigator(s)
7	EG-10	Evaluation of high pressure sprayer for the management of insect pests of FCV tobacco G. Raghupathi Rao
8	EG-11	Studies on population dynamics and management of tobacco aphid G. Raghupathi Rao
CTRI RESEARCH STATION, KANDUKUR		
1	K Br-5	Evaluation of new line N-98 for yield and quality under SLS conditions P. V. Venugopala Rao, R. Sreenivasulu, V. Venkateswarlu and J.V. Prasad
2	EK-11	Management of insect pests of tobacco by plant extracts K.C. Chenchaiah
3	EK-12	Management of cigarette beetle of tobacco by plant extracts and inorganic salts K.C. Chenchaiah
4	K Br-6	Breeding FCV tobacco variety for yield and quality under SLS conditions A.R. Panda, V. Venkateswarlu, K.C. Chenchaiah, P.V. Venugopala Rao, T.G.K. Murthy, K.N. Subrahmanya, A.V.S.R. Swamy and C.V. Narasimha Rao
5	EK-13	Evaluation of IPM modules for insect pests of FCV tobacco under SLS conditions K.C. Chenchaiah
6	AK-18	Studies on the influence of quality of irrigation water on growth and production of healthy seedlings from tobacco nurseries under SLS conditions R. Srinivasulu and C.Chandrasekhararao
7	K Br-7	Evaluation of FCV tobacco hybrids for yield and quality under SLS conditions A.R. Panda
CTRI RESEARCH STATION, HUNSUR		
1	BR-12	Germplasm maintenance of *Nicotiana tabacum* varieties/lines K.N. Subrahmanya and M.M. Shenoi
2	BR-17	Imparting resistance to brown spot in the high yielding FCV tobacco varieties/advanced lines suitable for KLS K.N. Subrahmanya and M.M. Shenoi
3	BR-18	Breeding for resistance to *Fusarium* wilt disease in flue-cured Virginia tobacco for Karnataka light soils K.N. Subrahmanya and M.M. Shenoi

Sl. No	Institute Code	Title of the project and Investigator(s)
4	P-3.2	Screening of tobacco germplasm against root knot nematode S. Ramakrishnan and K.N. Subrahmanya
5	N-1.1	Survey for plant parasitic nematodes infecting tobacco S. Ramakrishnan
6	N-15	Studies on root-knot – wilt complex in FCV tobacco crop S. Ramakrishnan and M.M. Shenoi
7	P-18	Testing the bio-efficacy of 'Kocide 101' (Copper hydroxide 77%) against fungal diseases in FCV tobacco nursery M.M. Shenoi
8	A-35	Evaluation of vermicompost for its efficacy in FCV tobacco production M. Mahadevaswamy
9	A-36	Integrated Nutrient Management for FCV tobacco in KLS M. Mahadevaswamy
10	BR-19	Development and evaluation of F1 hybrids of FCV tobacco suitable to Karnataka Light Soil region K.N. Subrahmanya, M.M. Shenoi, M. Mahadevaswamy and S. Ramakrishnan
11	N-16	Plant growth Promoting *Rhizobacterium* (PGPR), *Pseudomonas fluorescens* mediated suppression of root-knot nematode in FCV tobacco nursery S. Ramakrishnan and M.M. Shenoi
12	N-17	Bio-intensive management of root-knot nematode and soil-borne fungal diseases in FCV tobacco nursery S. Ramakrishnan and M.M. Shenoi
13	P-19	Further studies on *Fusarium* wilt and wilt complex in FCV tobacco crop M.M. Shenoi and S. Ramakrishnan
14	P-20	Studies on Soreshin disease *(Rhizoctonia)* in FCV tobacco nursery in KLS M.M. Shenoi
CTRI RESEARCH STATION, VEDASANDUR		
1	G.S-1	Evaluation and maintenance of germplasm K. Palanichamy
2	B-38	Breeding for insect resistance against caterpillar (*Spodoptera litura*) attack in chewing tobacco: Pre-release bulk trial K. Palanichamy

Sl. No	Institute Code	Title of the project and Investigator(s)
3	B-48	Studies on heterosis breeding in chewing tobacco (*N. tabacum*) K. Palanichamy
4	B-49	Synthesis of broad-based gene pool in chewing tobacco (*N. tabacum*) enhancing selection gain K. Palanichamy
5	BA-48	Spacing and nitrogen requirement for the advanced breeding lines of chewing tobacco under Vedasandur conditions M. Kumaresan, V. Krishnamurthy and K. Palanichami
6	BA-49	Spacing and potassium requirement for the country cheroot tobacco genotypes under Bhavani conditions M. Kumaresan and K. Palanichamy
7	BA-50	Spacing and potassium requirement for the chewing tobacco genotypes under Vedaranyam conditions M. Kumaresan and K. Palanichamy
8	A-98	Phosphorus management in chewing tobacco under Vedasandur conditions M. Kumaresan, P. Harishu Kumar and C.Chandrasekhararao
9	B-50	Breeding for high seed and oil yield in tobacco K. Palanichamy and C.V. Narasimha Rao
10	BA-51	Spacing and nitrogen requirement for the advanced breeding lines of chewing tobacco under Vadasandur conditions M. Kumaresan and K. Palanichamy
CTRI RESEARCH STATION, DINHATA		
1	A-10	Permanent manurial experiment with *Motihari* tobacco R.L. Arya and S. Roy
2	A-66	Studies on sources, levels and time of nitrogen application of *Jati* tobacco variety cv. Manasi R.L. Arya, S. Amarnath, S. Roy and C.Chandrasekhararao
3	A-67	Studies on sources of organic manures on nitrogen levels in *Jati* tobacco R.L. Arya, S. Amarnath, S. Roy and C.Chandrasekhararao
4	A-68	Studies on nitrogen requirement of *Jati* tobacco variety Manasi in relation to different sequential cropping systems R.L. Arya, S. Amarnath, S. Roy and C.Chandrasekhararao

Sl. No	Institute Code	Title of the project and Investigator(s)
5	B-17	Dialliel analysis in *Motihari* tobacco (*N.rustica*) S. Amarnath
6	A-69	Studies on effect of plant population and fertility levels on seed yield of *Jati* tobacco cv. Manasi R.L. Arya, S. Roy, S. Amarnath and C.Chandrasekhararao
7	DBP-1	Screening for resistance against brown spot and hollow stalk in germplasm accessions of *Jati* (*N. tabacum*) & *Motihari* (*N. rustica*) tobacco in North Bengal S. Amarnath and S. Roy
8	PP-7	Management of bacterial wilt in *Motihari* tobacco and biochemical and molecular characterization of pathogenic isolates S. Roy, S. Amarnath, R.L. Arya and K. Siva Raju
9	PP-8	Role of biocides against damping-off of seedlings and growth promotion activity in *Jati* and *Motihari* tobacco nurseries S. Roy, S. Amarnath and R.L. Arya

RAC, QRT, IMC AND IRC MEETINGS

RESEARCH ADVISORY COMMITTEE

Dr. M. Mahadevappa Former Chairman, ASRB, Samarasa, 1576,I Cross, Chandra Layout, Bangalore – 560 040. Karnataka	Chairman	Dr. V. Krishnamurthy Director, CTRI, Rajahmundry - 533 105. Andhra Pradesh	Member
Dr. R. Lakshminarayana Principal Scientist (Retd.), CTRI, D.No.23-11-12/1, Ramakrishnarao Pet, Rajahmundry – 533 105. Andhra Pradesh	Member	Dr. K.C. Jain Asst. Director-General (CC), Indian Council of Agril. Research, Krishi Bhawan, New Delhi - 110 114.	Member
Dr. Shrikanth Kulkarni Prof. & Head, Dept. of Pathology, University of Agril. Sciences, Krishi Nagar, Dharwad - 580 005. Karnataka	Member	Sri T. Ramasiva Gupta Member, IMC of CTRI, Thullur Post & Mandal, Guntur Dist., Andhra Pradesh	Member
Dr. B. Rosaiah Assoc. Director of Research, Regional Agril. Res. Stn., (ANGRAU), Anakapalle - 531 001. Andhra Pradesh	Member	Sri I. Kurma Rao Member, IMC of CTRI, 4-C, Golden Towers, Patamata, Vijayawada, Andhra Pradesh	Member
Dr. B.K. Patel Head, BTRS (Retd.), Anand Agril. University, Anand Campus, Anand -388 110. Gujarat	Member	Dr. C.V. Narasimha Rao Principal Scientist, CTRI, Rajahmundry - 533 105. Andhra Pradesh	Member-Secretary

QUINQUENNIAL REVIEW TEAM

Dr. S.A. Patil — Chairman
Vice-Chancellor,
University of Agril. Sciences,
Dharwad - 580 005
Karnataka.

Dr. B.N. Patel — Member
Research Scientist (PP),
Anand Agril. University,
Anand - 388 110,
Gujarat.

Dr. N. Ramakrishnan — Member
Ex-Head, Div. of Entomology,
99, Anandvan,
Maharashtra Co-operative
Group Housing Society,
Pocker A-6, Pashchim Vihar,
New Delhi - 100 033.

Dr. B.R. Hegde — Member
Director of Research (Retd.),
UAS, Bangalore
347, 7th Cross,
10th Main, NTI Layout,
Vidyaranyapura,
Bangalore - 560 097.
Karnataka

Dr. B.N. Chowdhary — Member
Former ADG (Ag. Extn.), ICAR,
B/41, Kamala Nagar,
Kotra Sultanabad,
Bhopal, Madhya Pradesh.

Dr. J.A.V. Prasad Rao - Secretary
Principal Scientist,
CTRI,
Rajahmundry - 533 105.
Andhra Pradesh

INSTITUTE RESEARCH COMMITTEE (IRC) MEETINGS

The Institute Research Committee meetings (IRC) of CTRI were held at the Institute during 9-12th July, 2007. Eminent scientists, Dignitaries, Scientists from Research Stations, Tobacco Board officials and officials from tobacco trade & industry attended the meetings. New project proposals and results emanated from the continuing projects were discussed in detail and the technical programme for 2007-08 was finalised.

Dr. J. Suresh Babu, IAS, Chairman, Tobacco Board lighting the lamp to inaugurate the IRC Meetings

A view of the delegates in IRC Meeting

INSTITUTE MANAGEMENT COMMITTEE

Dr. V. Krishnamurthy
Director & Chairman

Dr. K.C. Jain Asst. Director General (CC), Indian Council of Agricultural Research, Krishi Bhawan, New Delhi – 110 114	MEMBER	Dr. S. Amarnath Principal Scientist & Head-in-Charge, CTRI Research Station, Dinhata – 736 135, West Bengal	MEMBER
Director of Agriculture Govt. of Andhra Pradesh, Opp. L.B. Stadium, Basheerbagh, Hyderabad. Andhra Pradesh	MEMBER	Dr. M. Mahadevaswamy Sr. Scientist CTRI Research Station, Hunsur- 736 135 Karnataka	MEMBER
Director of Agriculture Govt. of Karnataka No.1, Seshadri Road, Bangalore – 560 001 Karnataka	MEMBER	Dr. K. Nageswara Rao Sr. Scientist & Head i/c, CTRI Research Station, Jeelugumilli – 534 456 Andhra Pradesh	MEMBER
Director of Research (Agriculture) ANGRAU, Rajendranagar, Hyderabad – 500 407 Andhra Pradesh	MEMBER	Sri Dama Ankaiah Naladalapur Village V.V. Palem Mandal, Prakasham Dist. Andhra Pradesh	MEMBER
Finance & Accounts Officer, NAARM, Rajendranagar, Hyderabad – 500 407 Andhra Pradesh	MEMBER	Sri Kanneboina Nageswara Rao H.No.16-15-207, Yadav Street, Old Guntur, Guntur Andhra Pradesh	MEMBER
Dr. Harveer Singh Principal Scientist Directorate of Oilseeds Research, Rajendranagar, Hyderabad – 500 507 Andhra Pradesh	MEMBER	Sr. Administrative Officer, CTRI, Rajahmundry - 533 105. Andhra Pradesh	MEMBER- SECRETARY

PARTICIPATION OF SCIENTISTS IN CONFERENCES, MEETINGS, WORKSHOPS AND SYMPOSIA

Sl. No.	Participant (s)	Programme attended	Date and place
1.	Dr.V.Krishnamurthy Dr.P. Harishu Kumar Dr. A.R.Panda	Review Meeting on "Improvement of Quality & Productivity of Indian Tobacco"	15.4.2007, Tobacco Board, Guntur
2.	Dr. T.G.K. Murthy	37th Annual group meeting of AICRP (Soybean)	April 28-30, 2007, UAS, Dharwad
3.	Dr. M. Kumaresan	One day Workshop on "Share your experiences on seed production, marketing, trading, intellectual property rights and its implementation"	28.4.2007, SBI, Coimbatore
4.	S. Gunneswara Rao	XVI Bio-control Workers Group meeting on "Biological control of crop pests and weeds"	May 18-19, 2007, ANGRAU, Hyderabad
5.	Dr. T. G. K. Murthy	The First Training-cum-Workshop on "IP and Technology Management in ICAR system"	May 28-30, 2007, NAARM, Hyderabad
6.	Dr. C. V. Narasimha Rao	Training programme on "The Right to Information Act" conducted by Institute of Public Administration	June 15-16, 2007, Bangalore
7.	Dr.K.Sarala	Meeting of Board of Studies Government Autonomous College	26.6.2007, Rajahmundry
8.	Dr. V. Krishnamurthy	Inaugural function of IRC and Chaired the Technical Session on Crop Production	27.6.2007, NRC Oil Palm, Pedavegi
9.	Dr. V. Krishnamurthy	Attended the meeting with CNTC delegation from Zheijang province, China organized by Tobacco Board	28.6.2007, Hyderabad
10.	Dr. V. Krishnamurthy	Meeting of all commodities Boards under the Dept. of Commerce, convened by MOS (Commerce) at the MS Swaminathan Research Foundation	30.6.2007, Chennai
11.	Dr. V. Krishnamurthy Dr. C.V. Narasimha Rao	Fifth Meeting of Tobacco and Tobacco Products Sectional Committee, FAD-4	6.8.2007, BIS, New Delhi

Sl. No.	Participant (s)	Programme attended	Date and place
12.	Dr. V. Krishnamurthy	ZREAC Meeting of North Costal Zone for *Rabi* Season, 2007	7.8.2007, Zilla Parishad, Srikakulam
13.	R. Subba Rao	ZREAC Meeting of Godavari Zone for *Rabi* Season, 2007	August 9-10, 2007, Kakinada
14.	Dr. V. Krishnamurthy Dr. C. A. Raju Dr. P. Harishu Kumar Dr. R. V. S. Rao Dr. J.A.V. Prasada Rao Dr. P.R.S. Reddy Dr. P.V.Venugopala Rao Dr. T.G.K. Murthy Dr. J. V. Prasad Dr. K. Nageswara Rao Dr. A. R. Panda R. Sreenivasulu Dr. M. Mahadevaswamy K. N. Subrahmanya Dr. S. Amarnath Dr. S. Roy Dr. R. L. Arya Dr. A. V. S. R. Swamy Dr. M. Kumaresan	XVIII All India Network Research Project on Tobacco (AINRPT) Workshop	August 11-12, 2007, Anand
15.	Dr. G. Raghupathi Rao	ZREAC meeting of Krishna Zone for *Rabi*, 2007	August 13-14, 2007, Guntur.
16.	Dr. U. Sreedhar Dr.K.Sarala	National Seminar on" Advances in environmental biotechnology"	August 17-18, 2007, Vuyyuru
17.	Dr.V.Krishnamurthy Dr.K.Sarala	Interaction meeting between Director, CTRI, Chairman Tobacco Board with Scientists of M/s Metahalix Life Sciences Private limited	17.8.2007, Bangalore
18.	Dr.V.Krishnamurthy	Attended TII Farmers' Awards Ceremony organized by Tobacco Institute of India	23.8.2007, Mysore
19.	Dr. C. V. Narasimha Rao C.V. Krishna reddy	Training on Intelligent Reporting System (IRS)	August 30-31, 2007, NAARM, Hyderabad.
20.	Dr. U. Sreedhar	Meeting with AQSIQ Chinese Delegates to discuss on "Pests and Diseases"	14.9.2007, New Delhi

Sl. No.	Participant (s)	Programme attended	Date and place
21.	S. Gunneswara Rao	Educational Seminar	18.9.2007, Rajahmundry
22.	Dr. S. Amarnath	Scientific Advisory Committee Meeting of KVK, Cooch Behar	18.9.2007, UBKV, Pundibari
23.	E.Vijaya Prasad	Training programme on 'Plant Protection Techniques in Cashew Crop'	24.9.2007, Billananduru
24.	Dr.K.Sarala	Seminar on "Biotechnology – Its implementations"	10.10.2007, Rajahmundry
25.	R. Sreenivasulu M. Sanni Babu Dr. C.Chandrasekhararao	10th Inter-regional Conference on Water & Environment	October 17-20, 2007, New Delhi
26.	Dr. Y. Subbaiah	Annual Zonal Workshop of KVKs (Zone V)	October 24-27, 2007, KVK, Nandurbar
27.	S. Gunneswara Rao Dr. K. Suman Kalyani	15th District level Children's Science Congress	27.10.2007, Kakinada
28.	Dr. V. Krishnamurthy	72nd Annual Convention of the Indian Society Soil Sciences (ISSS)	4.11.2007, BAU, Ranchi
29	Dr. P. Harishu Kumar	International Symposium on "Organic farming and renewable sources of energy for sustainable agriculture"	November, 19-21, 2007, Udaipur
30	Dr. K. Sarala	National Seminar on "Transgenic technology- Human Welfare"	November, 23-24, 2007, Tenali
31.	Dr. S. Ramakrishnan	National Seminar on "Molecular plant pathology and biotechnology for sustainable Crop Production"	November 28-29, 2007, Mysore
32.	Dr. D. V. Subhashini	48th Annual Conference of Association of Microbiologists of India	December 18-21, 2007, Chennai
33.	Dr. V. Krishnamurthy Dr. P. Harishu Kumar Dr. C.Chandrasekhararao Dr. K. Siva Raju Dr. M. Anuradha Dr. J.V. Prasad Dr. S. Kasturi Krishna Dr. S.V. Krishna Reddy	95th Indian Science Congress	January 3-7, 2008, Andhra University, Visakhapatnam

Sl. No.	Participant (s)	Programme attended	Date and place
	Dr. T. G. K. Murthy Dr. Y. Subbaiah H. Ravishankar Dr. B. Krishna Rao R. Sreenivasulu Dr. P.V.Venugopalarao Dr. K. Nageswara Rao Dr. K. Sarala		
34.	Dr. U. Sreedhar	International Conference on "Agrochemicals protecting crop, health and natural environment"	January 8-11, 2008, IARI, New Delhi
19.	Dr. B. Krishna Rao	National Training course on 'Water management in agriculture'	30.01.2007 to 17.02.2008 at ANGRAU, Hyderabad
19.	M. Sannibabu	Scientific Advisory Committee (SAC) meeting of Bhagavatula Charitable Trust KVK	30.1.2008, BCT, KVK Haripuram Farm
20.	Dr. V. Krishnamurthy	Mid-term review Meeting of ICAR Regional Committee-II	5.2.2008, CIFRI, Barackpore, Kolkata
21.	Dr.C.Chandrasekhar Rao Dr.U.Sreedhar	Inputs Committee Meeting of Tobacco Board	8.2.2008, Bangalore
22.	Dr. V. Krishnamurthy	Meeting of Food and Agriculture Division Council (FADC) & Science Based Agricultural Transformation Towards Alleviation of Hunger and Poverty in SAARC Countries	5.3.2008, New Delhi
23.	Dr. V. Krishnamurthy	123rd meeting of Tobacco Board	15.3.2008, Bangalore
24.	Dr.V.Krishnamurthy	67th meeting of the Registration Committee for growers and others	31.3.2008, Directorate of Auctions, Bangalore

WORKSHOPS, SEMINARS AND FARMERS' DAYS ORGANISED

The meeting of the Institutional Bio-safety Committee (IBSC) of CTRI was held at Rajahmundry on 28.05.2007.

Chairman and Members in the IBSC Meeting

An Exhibition stall depicting the tobacco production technologies was arranged in the premises of CTRI RS, Guntur on 11th June, 2007 in connection with the *Rythu Sadassu*, organized by the Government of Andhra Pradesh. About 3000 farmers from Guntur division have participated along with top Govt. officials & representatives.

The Pre-Institute Research Committee (IRC) Meetings were held on 26th and 27th June, 2007 at CTRI, Rajahmundry.

The Institute Research Committee (IRC) Meetings of CTRI were held from 9 - 12 July, 2007 at this Institute. Scientists of CTRI, its Research Stations, AINRP (T) Centres, Tobacco Board officials and representatives of trade and industry participated in the meetings. The progress of research work carried out during the year 2006-07 was reviewed and the technical programme for the crop season 2007-08 was discussed and finalized.

A tree plantation day was organized at CTRI Research Station, Dinhata on 4th August, 2007. Teak, Gambhar and Kadam sapling were planted in the premises of the Stations.

KVK of CTRI organized a State Level Seminar on "Soy Products Promotion and Entrepreneurship Development" in collaboration with the American Soy Association, New Delhi at CTRI, Rajahmundry on 6.8.2007.

Dignitaries on the dais in the Seminar on Soybean

The XVIII Tobacco Workshop of the All India Network Research Project on Tobacco was held at the Anand Agricultural University, Anand from 11-12 August, 2007. Eminent Scientists from different parts of the country participated in the Workshop. The biennial progress of ongoing research programmes of 2005-07 and the technical programme for the crop season 2007-08 were discussed and finalized.

Golden Jubilee Celebrations and Farmers' Day programme were organized at CTRI Research Station, Hunsur on 29.08.2007. Padmashree Dr. M. Mahadevappa, Member, ICAR Governing Body, New Delhi, Dr. K. C. Jain, ADG (CC), ICAR, New Delhi, Dr. V. Krishnamurthy, Director, CTRI, Rajahmundry, Sri G. T. Devegowda, Hon'ble Minister for Cooperation and Mysore District-in-charge, Govt. of Karnataka, Sri C. H. Vijayashankar, Hon'ble MP, Loksabha were the

Director, CTRI unveiling the Pylon at CTRI RS, Hunsur

dignitaries. More than 700 farmers and members from Tobacco Board and Trade attended and graced the occasion. An agricultural exhibition was organised to mark the occasion and progressive farmers as well as Former Officers' in-charge were honoured.

Training programme on 'Soil and Water Analysis' was conducted to the Field Officers of Tobacco Board during 3-14 September, 2007 at CTRI, Rajahmundry.

The Hindi Workshop was inaugurated by Dr. V. Krishnamurthy, Director on 22.12.007.

Inauguration of Hindi Fortnight

The 3rd Meeting of 10th IJSC meeting was held on 15.10.2007 at CTRI, Rajahmundry.

The Quarterly Institute Research Committee (IRC) Meetings were held on 12.11.2007 to review the progress of research work being handled/ completed by individual scientists.

Training in different disciplines of tobacco was given to Sri P. Kiran, Agronomist, M/s. Alliance One Tobacco Ltd., Guntur during November, 2007

The Field IRC was conducted at CTRI Research Station, Jeelugumilli on 20.12.2007 to review the progress of the field experiments at NLS farm, Jeelugumilli during 2007-08 crop season.

A field visit to CTRI, Black Soil Farm, Katheru was arranged on 27.12.2007 to review the progress of research project works and to assess the crop situation during 2007-08 crop season.

The Half-Yearly IRC meeting of CTRI was held on 28.01.2008 to review the progress of on-going project works and new project proposals of CTRI Research Station, Hunsur.

The Brainstorming Session on "Energy Conservation and Mechanization in Flue-cured Tobacco Production" organized by Indian Society of Tobacco Science was held on 29.01.2008 at CTRI, Rajahmundry to review the status of different technologies and to draw the action plan for the future. Scientists from CTRI, officials from Tobacco Board and representatives of tobacco trade & industry have participated in the event.

A State Level Seminar on "Improved Technologies for Higher Productivity on Cashew" was organized by KVK of CTRI in collaboration with the Directorate of Cashew nut and Cocoa Development, Cochin held at CTRI, Rajahmundry on 08.02.2008.

Tobacco Variety Release Committee (TVRC) meeting for Tamil Nadu was held on 19.2.2008 at CTRI Research Station, Vedasandur and recommended the release of the chewing tobacco variety Sangami for cultivation in Bhavani, Salem and Erode districts of Tamil Nadu.

Diamond Jubilee Celebrations of CTRI Research Station, Vedasandur, Tamil Nadu were celebrated on 20.2.2008 on completion of sixty years of service to the farming community in the region. A Farmers' Day was also organized coinciding with the celebrations.

Workshop on "FCV Tobacco Production Technology" to Tobacco Growers and Technical Staff was organized by the Tobacco Board in collaboration with CTRI on 27.2.2008 in which about 75 tobacco growers from NBS and CBS regions have participated. Dr. V. Krishnamurthy, Director, S. K. Naidu, Dr. K. Nageswara Rao, Dr. K. Sarala, Dr. S. Kasturi Krishna, Dr. J.V. Prasad and Dr. K. Suman Kalyani, Scientists interacted with the farmers and Tobacco Board field staff.

DIAMOND JUBILEE CELEBRATIONS OF CTRI

The Diamond Jubilee Celebrations of CTRI were held on 01.12.2007 at Rajahmundry. The Chief Guest of the function, Dr. P. L. Gautam, Deputy Director General (CS), ICAR, New Delhi inaugurated the Diamond Jubilee Celebrations by lighting the lamp in presence of Dr. K.C. Jain, Assistant Director General (Commercial Crops), ICAR. Dr. V. Krishnamurthy, Director, CTRI and the Former Directors, Dr. N. C. Gopalachari, Dr. M. S. Chari, Dr. K. Nagarajan and Dr. K. Deo Singh. Dr. K. C. Jain, Assistant Director General presided over the function. On this momentous occasion, Diamond Jubilee Stupa was unveiled by Dr. P.L Gautam, Hon'ble DDG (CS), ICAR. The newly constructed Glass House and Water Storage Tank were also inaugurated by Dr. P.L. Gautam and Dr. K. C. Jain, respectively. The CTRI Staff, Heads of Regional Research Stations, Retired Scientists, Officers, Staff from all Cadres, officials from Tobacco Board, Tobacco Trade, Industry and Tobacco Farmers from different agro-climatic zones of the country have participated in the function. The Former Directors of CTRI, Dr. N. C. Gopalachari, Dr. M.S. Chari, Dr. K. Nagarajan and Dr. K. Deo Singh and nine progressive tobacco farmers from all parts of the country i.e. Sri Siddiqi Rehaman, West Bengal; Sri H. J. Muthuraj, Karnataka; Sri B. Venkateswara Reddy, Nellore district; Sri P. Nagaiah & Sri K. Venkata Ramana Reddy, Prakasam district; Sri D. Rama Mohan Rao, Krishna district; Smt. K.Sita, West Godavari district; Sri K. Veeranjaneyulu, Khammam district and Sri S. C. Vanchimuthu, Vedasandur, Tamil Nadu were felicitated on this auspicious occasion. Seven books/booklets/ leaflets viz., 1) Diamond Jubilee Souvenir (1947-2007), 2) Improved Production Technology for FCV Tobacco in Andhra Pradesh - A Pocket Guide, 3) Modern Production Technology for Tobacco Cultivation in Southern Light Soils (in Telugu), 4) CTRI in the Services of Farmers: Leaflets (in Telugu) 5&6) Safe use of Crop Protection Agents in Tobacco (in English and Telugu) and 7) Micro-sprinklers for Tobacco Seedling Production.

Unveiling the Diamond Jubilee Stupa

Inauguration of the Diamond Jubilee Celebrations

A view of the audience

GLIMPSES OF CTRI DIAMOND JUBILEE CELEBRATIONS

Felicitation to Former Directors of CTRI

Inauguration of Water Storage Tank

Felicitation to Progressive Farmers from different tobacco growing regions

DISTINGUISHED VISITORS

Date	Name	Address
CTRI, Rajahmundry		
06.04.2007	Sri N. Mohan Padmanabhan	Dy. Chief, The Hindu Business Line, Kolkata
30.07.2007	Mr. Nirlei Joacir Storch	M/s Profigen Seed Company, Brazil
01.11.2007	Mr. Ray Faasen	Regional Director (Agronomy), M/s Alliance One International, Thailand
21.11.2007	Mr. Kamaruzaman Bin Mohamed Nor, Mr. Jusoh Bin Abdul Murad Bin Baker Mr. Abdul Razak Bin Mahusin	Members of the Malaysian delegation
	Mr. K.M. Nachappa	Agronomist, M/s Universal Leaf (Asia)
18.02.2008	Dr. S. Ayyapan	Deputy Director-General (Fisheries), ICAR, New Delhi
25.02.2008	Dr. P.L. Gautam Sri R. K. Jain	Deputy Director General (CS), ICAR Director, DARE, New Delhi
CTRI RS, DINHATA		
14.03.2008	Mr. Prithwiraj Paramanik	ADO (Farm) DSF, Cooch Behar
CTRI RS, HUNSUR		
21.07.2007	Sri Viswanath Chaudhary	M/s Surya Nepal Pvt. Ltd., Nepal
16.07.2007	Srilankan Delegation	Government officials, farmers and Trade personnel from CTC, Srilanka
01.08.2007	Mr. Carlos	M/s Souza Cruz, Brazil
02.08.2007	Mr. Nirlei Joacir Storch	M/s Profigen Seed Company, Brazil
10.09.2007	A six member Chinese Delegation	Chinese delegation representing Chinese Government and Tobacco Trade
18.09.2007	Ms.Aarti Rele	Vice-President (R & D), M/s Godfrey Philips India Ltd., Mumbai
03.10.2007	Mr. Alain Schacher	Regional Leaf Manager, M/s British American Tobacco Asia Pacific Region
03.10.2007	Mr. S. Janardhan Reddy	CEO, M/s ITC Ltd., ILTD Division, Guntur
04.10.2007	FCV tobacco farmers from Andhra Pradesh	Forty FCV tobacco farmers from SLS & SBS regions of Andhra Pradesh

31.10.2007	FCV tobacco farmers from Andhra Pradesh	Thirty six FCV tobacco farmers from NLS & CBS regions of Andhra Pradesh
19.11.2007	Mr. G.M.K.Raju & Mr.Shankar	M/s ITC Ltd., Kolkata

DDG (CS) visiting Katheru Farm along with the Director and officials from Govt. of A.P.

Sri N. Mohan Padmanabhan with the Director

Visit of Mr. Ray Faasen to CTRI

Malaysian delegation with the Director and Scientists of CTRI

Mr. N.J. Storch in the Physiology Laboratory

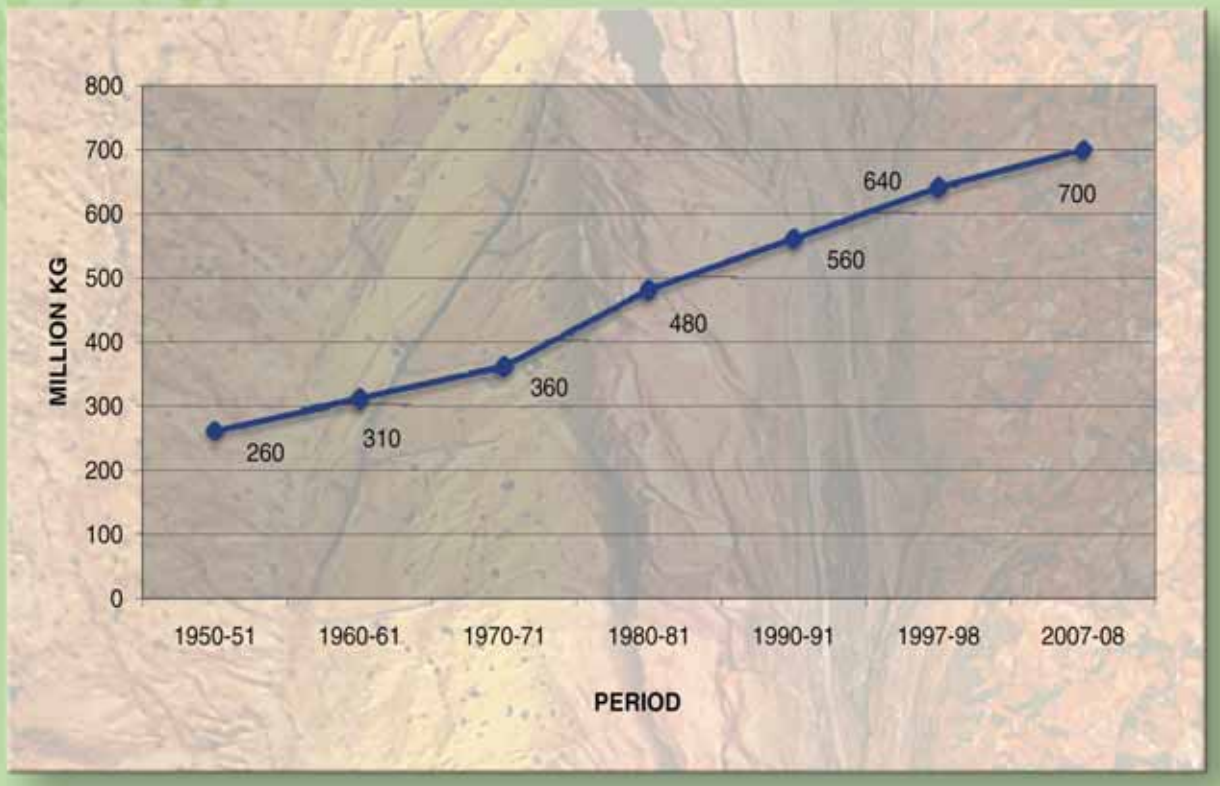
Visit of Chinese delegation to CTRI RS, Hunsur

PERSONNEL

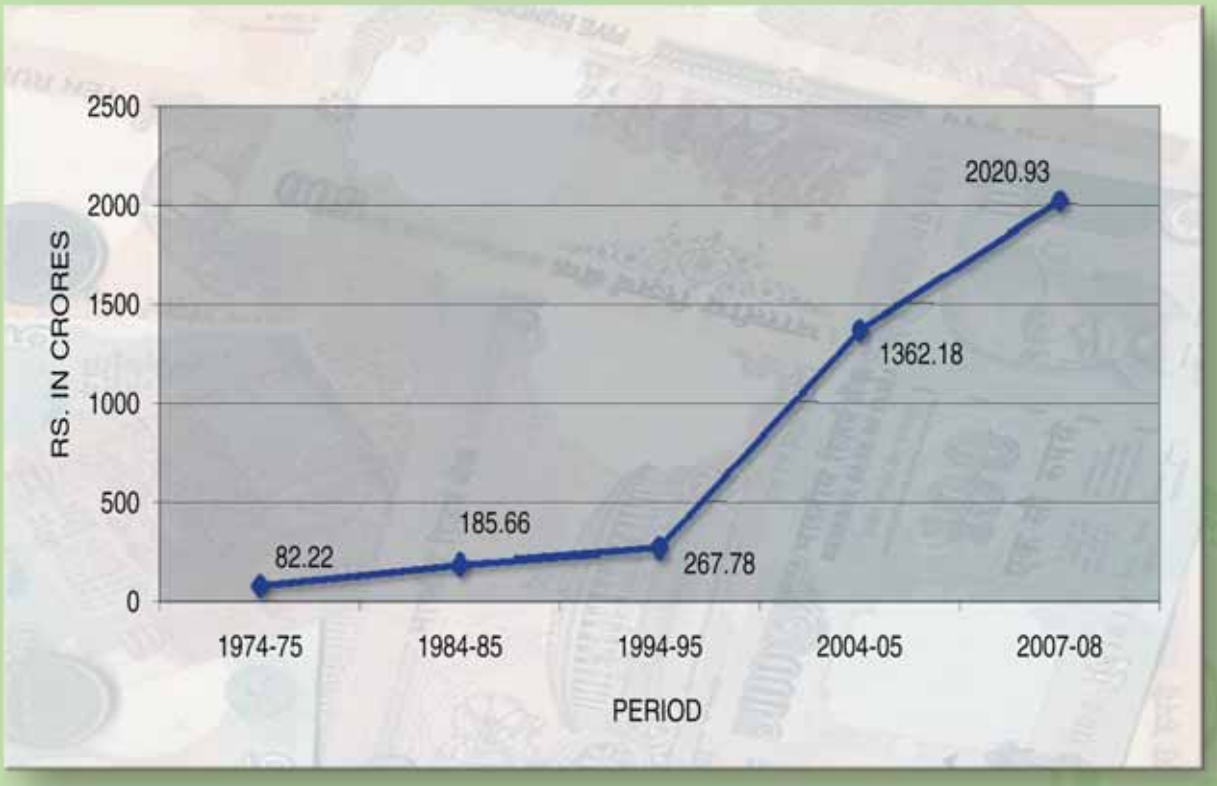
(As on 31-3-2008)

Director	:	**Dr. V. Krishnamurthy**
Heads of Divisions/ Stations/Sections		
Crop Improvement	:	Dr. R.V.S. Rao
Crop Production	:	Dr. P. Harishu Kumar
Crop Protection	:	Dr. C.A. Raju
Crop Chemistry & Soil Science	:	Dr. J.A.V. Prasad Rao
CTRI Research Station, Guntur	:	Dr. G. Raghupathi Rao
CTRI Research Station, Kandukur	:	Dr. A.R. Panda
CTRI Research Station, Hunsur	:	Dr. M.M. Shenoi
CTRI Research Station, Vedasandur	:	Dr. A.V.S.R. Swamy
CTRI Research Station, Dinhata	:	Dr. S. Amarnath
CTRI Research Station, Jeelugumilli	:	M. Sanni Babu (up to 10.5.2007)
		Dr. K. Nageswara Rao (from 10.5.2007)
BTRC, Jeddangi	:	R. Subba Rao (up to 09.05.2007)
		Dr. P. Harishu Kumar (from 09.05.2007)
RMC Unit	:	Dr. C.V. Narasimha Rao
AINRP(T)	:	Dr. P.R.S. Reddy
Computer Cell	:	Dr. U. Sreedhar
Seed Production	:	Dr. R.V.S. Rao
Krishi Vigyan Kendra	:	Dr. Y. Subbaiah
Library	:	Y.V. Suryanarayana (up to 30.6.2007)
		N. Syam Prasad (from 01.7.2008)
Agricultural Extension	:	S.K. Naidu
Engineering Section	:	Dr. B. Krishna Rao
CTRI Farm, Katheru	:	N. Prabhakara Rao
Senior Administrative Officer	:	G.G. Harakangi (up to 16.10.2007)
Senior Administrative Officer I/c	:	A. Muthuraman (from 16.10.2007)
Finance & Accounts Officer	:	N. Venkata Rao (up to 30.06.2007)
Assistant Finance & Accounts Officer	:	P.V.S. Bharathi (from 01.7.2007)

TOBACCO PRODUCTION TRENDS IN INDIA (1950-2008)



EXPORT OF TOBACCO AND TOBACCO PRODUCTS FROM INDIA



Diamond Jubilee Stupa
(1947-2007)