वार्षिक प्रतिवेदन
ANNUAL REPORT
2006 - 2007


TRAY SEEDLINGS


HARVESTING


GRADING

केन्द्रीय तम्बाकू अनुसंधान संस्थान

(भारतीय कृषि अनुसंधान परिषद)

राजमन्द्री - ५३३ १०५, आन्ध्र प्रदेश

CENTRAL TOBACCO RESEARCH INSTITUTE

(Indian Council of Agricultural Research)

Rajahmundry - 533 105, Andhra Pradesh

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CTRI
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Contents

Preface

Indian occupies 3rd place in the World tobacco production with 700 million kg while China and Brazil take first and second positions, respectively. During 2005-06, India produced 230 million kg of FCV tobacco and about 470 million kg of non-FCV tobacco; 145.96 million kg of FCV tobacco was produced in Andhra Pradesh from an area of 1.17 lakh ha and 82.91 million kg in Karnataka from an area of 0.74 lakh ha. FCV tobacco was marketed at an average price of Rs. 47.47 per kg in Andhra Pradesh and Rs. 55.94 in Karnataka. In 2006, the exports of unmanufactured tobacco increased by 2% and exports of tobacco products viz., cigarettes and bidis declined by 35%. In order to augment the exports and consolidate our position in the international market, there is an urgent need to develop market intelligence system to explore the new markets. Simultaneously, improving productivity and meeting the international quality requirements should be our guiding principles in future research endeavours.

I feel happy to inform that due to the concerted efforts of our plant breeders, six new high yielding varieties viz., Kanthi, Hemadri and Siri (FCV tobacco), Bhairavi (Natu tobacco), Abirami and Kaviri (Chewing tobacco) were released during 2006-07. There is very good demand for the seed of these newly released varieties among the farmers. However, the low productivity in some areas like Southern Light Soils (SLS) and Karnataka Light Soils (KLS) and increasing input cost, including labour wages and labour scarcity are the basic issues of concern, which require immediate attention of the researchers. Thus, the situation warrants concerted efforts in the following thrust areas of research: Improving productivity and quality; Reducing the cost of cultivation; Integrated Nutrient Management; Production of hybrid tobacco; DNA finger-printing of tobacco varieties; Development of microsatellite markers specific to tobacco; Molecular mapping of tobacco traits (nicotine, solanesol and TSNA); Reducing harmful substances in leaf and smoke; Greater emphasis on alternative uses of tobacco; Developing remunerative cropping systems and Developing labour and time-saving devices for sustaining the crop and the tobacco growers in the long run.

I express my sincere thanks to Dr. Mangala Rai, Secretary, DARE and the Director-General, ICAR for his unstinted support and encouragement for the overall development of the Institute which is going to celebrate its Diamond Jubilee in 2008. I am also thankful to Dr. G. Kalloo, Former Deputy Director-General (CS), Dr. S.P. Tiwari, Deputy Director-General (Education & CS), Dr. K.C. Jain, Assistant Director-General (CC), ICAR, Dr. M. Mahadevappa, Chairman and Members of the Research Advisory Committee and staff of the Institute for their valuable guidance and support in the endeavours to improve the productivity and quality of the tobacco crop and the net profit of the growers.

The various activities and salient achievements of the CTRI during the period are presented in the report. I hope this report will provide useful information to all the stakeholders in tobacco.

V. Krishnamurthy

(V. KRISHNAMURTHY)
Director


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प्रमुख अनुसंधान गतिविधियाँ

फसल सुधार

आंध्र प्रदेश में व्यावसायिक खेती के लिए किस्म विमोचन के आवसर पर आंध्र प्रदेश राज्य बीज उप समिति द्वारा तीन बेहतर एफ.सी.वी. किस्में, क्रमशः कांति (सी.वाई.79, हेमाद्री (।। 1624), सिरी (सी.वाई.135) और एक देसी तंबाकू किस्म भैरवी (एन.जी.73) जारी की गई। तमिलनाडु में कृषि के लिए तंबाकू किस्म विमोचन समिति द्वारा दो चबाऊ तंबाकू किस्म जैसेकि अभिरामी एवं कावेरी जारी की गई।

उत्पादन एवं गुणवत्ता मूल्यांकन के लिए कर्नाटक में फ़यूजेरियम म्लानि रोग प्रतिरोधी कार्यक्रम के लिए प्रजनन से बारह अग्रिम प्रजनन वंशावलियां व्युत्पन्न की गई।

ग्यारह बर्ली तंबाकू वंशावलियों में आर.ए.पी.डी./एस.एस.आर. विभिन्नता का अध्ययन किया गया एवं डी.एस.एन.ए. जांच के लिए संकरण द्वारा मानचित्रण जीव संख्या का विकास किया गया।

वर्ष 2005-06 मौसम के दौरान अधिसूचित किस्मों का कुल 18,449 किलोग्राम शुद्ध बीज का उत्पादन किया गया एवं संस्थान तथा तंबाकू बोर्ड द्वारा 18,800 किलोग्राम शुद्ध बीज बिक्री किया गया।

फसल उत्पादन

आंध्र प्रदेश की वर्टीसोलों में जांची गई फसल प्रणालियों में से, मक्का-तम्बाकू प्रणाली उच्च हरे एवं संसाधित पत्ता उप्तादन में महत्वपूर्ण रही। उसके बाद उथली-तम्बाकू का स्थान रहा जबकि सोयाबीन-तम्बाकू प्रणाली में निम्न स्तर का तम्बाकू उत्पादन देखा गया।

चबाऊ, चिरूट एवं सिगार तम्बाकू के 145 किस्मों एवं अन्य 15 किस्मों के मूल्यांकन के आधार पर, तमिलनाडु में 1500 किलोग्राम प्रति हेक्टेयर से अधिक उच्च बीज उत्पादन देने वाली 19 आशाजनक वंशावलियों की पहचान की गई। सोलनेसोल में प्रोटीन एवं बीज उत्पादन (958 किलोग्राम प्रति हेक्टेयर) के एच.डी.बी.आर.जी. तम्बाकू को प्रथम दर्जा प्रदान किया गया जबकि आंध्र प्रदेश में निकोटिन उत्पादन के लिए चबाऊ तम्बाकू किस्म ए-145 को प्रथम दर्जा प्रदान किया गया।

कर्नाटक की हल्की मृदा में, संसाधित पत्ता उत्पादन में 6.2 प्रतिशत की वृद्धि एवं उच्च श्रेणी समानता में करीब 7.5 प्रतिशत वृद्धि सहित ट्रे नर्सरी पौधों की प्रौद्योगिकी आर्थिक रूप से उपयुक्त एवं अंकुरणक्षम पाई गई।

कर्नाटक की हल्की मृदा में एफ.सी.वी. तम्बाकू की उत्पादकता की वृद्धि में समेकित पोषक प्रबंधन प्रक्रियाओं से जुडी जैविक एवं अजैविक नाईट्रोजन का 25:75 का अनुपात आशाजनक पाया गया। आंध्र प्रदेश के वर्टीसोल में बिना टिकाकरण वाले उडद की तुलना में राइज़ोबियम के दोहरे टीकाकरण एवं उडद में पी.सी.वी. उपचार से तम्बाकू के संसाधित पत्ता

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उत्पादन में 9.70 प्रतिशत एवं श्रेणी सूचकांक में 12.08 प्रतिशत की वृद्धि हुई। आंध्र प्रदेश की उत्तरी हल्की मृदा में नाइट्रोजन एवं पोटाशियम 1:1.5 के अनुपात में यानि 100 किलोग्राम नाइट्रोजन प्रति हेक्टेयर एवं 150 किलोग्राम पोटाशियम प्रति हेक्टेयर के उपयोग से एफ.सी.वी. तम्बाकू का अधिकतम संसाधित पत्ता उत्पादन (2972 किलोग्राम प्रति हेक्टेयर) दर्ज किया गया।

आंध्र प्रदेश की दक्षिणी हल्की मृदा परिस्थितियों के अंतर्गत कृषि तालाबों से एक जीवन रक्षक सिंचाई करने से संसाधित पत्ता उत्पादन में 23.5 प्रतिशत की वृद्धि हुई जिसके परिणामस्वरूप शुद्ध आय में 9,000 रुपए की वृद्धि हुई।

फसल रसायन एवं मृदा विज्ञान

फ़्यूजेरियम म्लानि के लिए डी.एन.ए. सूचकों पर किए गए अध्ययनों से, 500 बी.पी. युक्त प्रतिरोधी सूचक की पहचान की गई।

धूप संसाधन के दौरान, हरा पत्ता से पीली अवस्था के बीच सोलनेसोल की मात्रा में 12.4 से 95.5 प्रतिशत की वृद्धि देखी गई। पीली अवस्था की तुलना में रंग निर्धारण अवस्था में यह वृद्धि करीब 50 प्रतिशत तक दर्ज हुई।

जैसेकि सोलनेसोल से जुडे कोमारिन न्यूक्लियस (coumarin nucleus) ने एंटी-डाइबेटिक गतिविधि दर्शाई थी इसलिए प्रयोगशाला में इसमें कुछ और परिवर्तन किए गए। चायनीस हमस्टर वी-79 से निकलने वाले बहु-औषधीय प्रतिरोधी म्युटेंट कोशिका वंशावली से एस.डी.बी. एथाइलिनडाइएमाइन निरोधी कॉलनी फारमेशन तैयार किया गया एवं इस पर जैव मूल्यांकन जारी हैं।

फसल संरक्षण

पहली बार ओरोबैंकी से प्रतिरोधी के रूप में कुछ जंगली निकोटिना प्रजातियों की पहचान की गई।

प्रयोगशाला की परिस्थितियों के अंतर्गत लनटाना का मेथनॉल सार (2%) एवं केलोट्रोपिस के पत्तों ने स्पोडेप्टेरा लिटुरा के वृद्धि एवं विकास को दबा दिया। कच्चे आम के पत्तों से 1,000 पी.पी.एम. की दर से निकाला गया पोलिफेनोलॉस एस.आई.एन.पी.वी. को तीन दिनों तक खेत एवं प्रयोगशाला दोनो ही जगहों पर यू.वी. लाइट द्वारा निष्क्रियण होने से बचाया जा सकता है। 0.25 प्रतिशत तम्बाकू तेल ने मक्का एवं चना को क्रमशः धान वीविल (rice wevil) (साइटोफिलस ओरिगी), पल्स बीटल (कल्लोंसोब्रुचस चिनेनसिस) से तीन महीनों तक सुरक्षित रखा।

तम्बाकू में ज्वार उपांत फसल के रुप में, 30 डी.ए.पी. पर इमीडाक्लोप्रिड 50 ग्राम ए.आई. प्रति हेक्टेयर की दर से प्रयोग, एस.आई.एन.पी.वी. एवं एच.ए.एन.पी.वी. के प्रयोग से युक्त समेकित नाशीजीव प्रबंधन सारणी प्रभावी पाई गई। कर्नाटक में मक्का से सस्यावर्तन करने से फ़्युजेरियम म्लानि रोगों से होने वाली हानि में कमी आई।

EXECUTIVE SUMMARY

Germplasm Resource Management

A total of 2,345 germplasm lines including 14 new germplasm accessions imported recently from USA and Brazil are maintained in the Gene Bank of CTRI, Rajahmundry for utilization in various ongoing research programmes aimed at developing high yielding varieties with better quality, resistance to pests and diseases and higher levels of phytochemicals. Catalogue on FCV and non-FCV tobacco germplasm was documented.

Out of the 455 germplasm lines screened, 146 lines showed resistance to TMV. Also, germplasm accessions, lines with no infestation of aphids (C 110 and CU 1097), whitefly (V.373, CU 1097) and budworm (C110, CU 1097, V 373, Hema x CU1097, VT 1158 X V 373) were identified.

Wide genetic variability for solanesol content was observed among wild *Nicotiana* species. Five accessions (*N.* sp. TW 69: 2.55%; *N.* sp. TW 72 3.2%; *N.* sp. TW 133: 2.7%; *N.* sp. TS 221: 4.7%; *N.* sp. AusTRCF 317535: 3.90%) having solanesol content were identified.

Tobacco Cultivar Development

The varietal development programme resulted in productivity enhancement with concomitant improvement in quality. Three improved FCV varieties viz., Kanthi (Cy 79), Hemadri (II 1624), Siri (Cy 135) and one Natu tobacco variety, Bhairavi (NG 73) were released by the AP State Seed sub-committee on varietal release for commercial cultivation. Two chewing tobacco varieties, Abirami and Kaviri were released for commercial cultivation by the Tobacco Variety Release Committee for Tamil Nadu.

Significant success has been achieved in identifying promising material for the development of varieties/hybrids suitable for different agro-ecological situations in the country. In Vertisols, a high yielding pipe line variety, Cy 149 proved its superiority over check, VT 1158 in station bulk trial with 26 % increase in cured leaf yield, besides having desirable leaf quality traits.

In a CTRI-ITC collaborative trial flue-cured tobacco hybrids, CH 1 and CH 2 showed standard heterosis of 16 to 20% for cured leaf over Kanchan in NLS and KLS and included in IVT under AINRP(T). Among the hybrids evaluated in the replicated yield trial at Guntur, GH-32 and GH-16 showed higher cured leaf yields of 3,028 and 2,843 kg/ha, respectively with higher bright grade outturn and grade index. Burley hybrid, YBH-1 proved its superiority for leaf yield (20% increase) with lower levels of TSNA over the parent Banket A-1.

One natural variant of Kanchan, coded N-7 was significantly superior to the parent with 21%, 23% and 17% increase in green leaf, cured leaf and grade index, respectively in NLS. In the bulk trial conducted at Kandukur, N 98 recorded higher green leaf yield, cured leaf yield and bright leaf yield over the check varieties. In KLS, twelve advanced breeding lines derived from breeding for *Fusarium* wilt disease resistance programme were identified for yield and quality assessment. Under the inter-institutional collaborative programme, three advanced breeding lines and two hybrids recorded higher total cured leaf yield and bright grade outturn over the check, variety Kanchan at Hunsur.

Biotechnology in Tobacco Improvement

A set of 38 microsatellite primers specific to tobacco were designed and validated in different species of *Nicotiana* and lines of tobacco. Somaclones/wild species with tolerance

to leaf curl, CMV and *Orobanche* were identified. In the studies on DNA markers for *Fusarium* wilt, a marker with 500 bp linked to the resistance was identified.

Tobacco Seed Production

About 21,000 kg of pure tobacco seed of different varieties was produced and distributed to the farmers.

Crop Production Technology

Viable crop production technologies with optimum irrigation and fertigation schedules with emphasis on INM, judicious topping, plant position grading and cropping systems for different tobacco growing regions were developed. Technologies were evolved for preventing soil erosion and promoting soil conservation.

Closer spacing of 0.7 x 0.5 m and application of 45 kg N/ha were found to be optimum for the FCV advanced breeding lines Cy 135 and Cy 139 for higher cured leaf production at Rajahmundry. In Vertisols, soil application of vermicompost @ 2.5 t/ha increased the cured leaf, bright leaf and grade index over control.

In NLS the N:K ratio of 1:1.5 (100 kg N/ha: 150 kg K_2O/ha) recorded maximum cured leaf of 2,972 kg/ha and two foliar sprays 0.5% $ZnSO_4$ + 0.5% $MgSO_4$ at 35 and 45 days after planting (DAT) and topping at 24 or 28 leaves recorded higher GLY, CLY and GI.

Application of prilled potassium nitrate was found on par with SOP in terms of yield and quality of flue-cured tobacco in NLS and KLS. It was observed that crop growth rate in FCV tobacco was active between 45-75 days. Net assimilation rate showed increasing trend up to 70 days.

In SLS, one life saving irrigation utilizing water harvested from farm ponds improved yields by 23.5% in cured leaf and 20.2% in bright leaf. This translated into the increase in the net income by Rs. 9,000/ha.

The bulk trial conducted at Hunsur to evaluate the field performance of tray nursery seedlings indicated an increase of 6.2% in cured leaf yield and about 7.5% increase in top grade equivalent in variety Kanchan. The technology was also found economically feasible and viable. In KLS, application of vermicompost @ 4 /ha + recommended NPK dose was found promising in increasing productivity as well as reducing the root-knot incidence as compared to recommended practice of FYM application @ 8 t/ha + NPK. The bulk trial revealed that application of vermicompost @ 2 t/ha and 4 t/ha increased the yield by 8.0% and 12.9%, respectively, and the plant-hole application at the time of planting was found more effective.

For the burley tobacco variety Swetha, closer spacing of 0.7 x 0.5 m recorded significantly higher yield of 4.8 and 11.1%, respectively, over 0.8 x 0.5 and 0.9 x 0.5 m spacing. Nitrogen level at 120 kg/ha was found optimum.

In West Bengal, for the newly released *Jati* tobacco variety, Manasi, a fertilizer level of 150 kg N/ha + 50 kg K_2O/ha was beneficial in terms of higher nutrient composition in leaves and increase in the available nutrient status of the soil. Basal application of 125 kg N/ha in the form of calcium ammonium nitrate (CAN) was found beneficial in terms of quantitative and qualitative production besides fetching higher monetary returns in *Jati* tobacco.

It is concluded from the experiments at Jeelugumilli, Hunsur and on-farm trials at NLS area that the Turbofan fixing at the top of the barn as a ventilator and operating during curing saves 400-500 kg fuel and 20 hours curing time per charge.

Cropping Systems for Sustainable Production

Maize – tobacco cropping system gave significantly higher green and cured leaf yields followed by fallow –

tobacco in Vertisols. In the north Bengal region, Jute – Aman paddy – Tobacco cropping sequence was found to be a more profitable cropping sequence.

Bio-ecological and Pathological Studies on Pests and Diseases

In *Motihari* tobacco nursery, the bacterial wilt infection usually remained latent in the seedlings and the symptoms were expressed in plants at 20-50 days after transplanting (DAT) following favourable predisposing factors like temperature (20-30 °C) and RH (80-90%)

Minimum temperature had a significant negative influence on the number of adult aphids and also on the extent of damage by the pest during this date of planting.

Integrated Pest and Disease Management

Crop protection technologies were developed laying emphasis on integrating bio-pesticides and botanical formulations for minimizing the use of synthetic pesticides. Thus, the levels of organo-chlorine pesticide residues in FCV tobacco samples from different regions are within Guidance Residue Levels(GRL) for tobacco prescribed by CORESTA.

Stem application of imidacloprid @ 1: 40 or thiamethoxam @ 1: 20 was able to check aphid infestation on FCV tobacco and supported higher natural enemy activity as compared to foliar spray of the insecticides. Clothianidin 50 WDG @ 22.5 g a.i./ha effectively checked aphids on FCV tobacco.

Bio-pesticides *viz.*, *Nomuraea rileyi*, *Baeuvaria bassiana* and *B.t kurstaki* were equally effective against *Spodoptera exigua* in tobacco nurseries. Aqueous leaf extracts of neem, *Pongamia* and *Calotropis* at 4% were highly effective and were on par with chlorpyriphos 0.05% against *Spodoptera litura* and leaf curl virus on tobacco.

Studies on the effect of planting pattern of trap crops on trapping of budworm in FCV tobacco showed that planting of Tagetes (single whorl) and *Rustica* tobacco as border in East-West direction was found to be effective.

Infestation of budworm, tobacco caterpillar, leaf curl and tobacco aphid was less in IPM plot as compared to biological control and chemical control in burley tobacco. Border crop of Sorghum served as reservoir of natural enemies. In SLS, the IPM Module (need based biological and chemical control) gave higher green leaf, cured leaf and bright leaf yields.

In KLS, an integrated wilt management module comprising seven tips including chemical control with carbendazim or copper hydroxide which gave a CBR of 1: 1.2 and 1:1.39, respectively is recommended. Kocide 101 (copper hydroxide 77%) confirmed to be an effective fungicide for the control of several soil-borne fungal diseases in nursery which include damping-off, blight, black shank, anthracnose and frog eye-spot. The bio-intensive module for nursery diseases management with soil solarization, neem cake amendment and application of *Aspergillus niger* enriched FYM gave a C:B ratio of 1:8.2. Application of *Pseudomonas fluorescens* (pf1 strain) @ 1g/plant hole in combination with *Aspergillus niger* enriched FYM @ 100 g/plant at planting caused 74.5 and 49% reduction in *Fusarium* wilt and root-knot index, respectively. Resultant increase in total cured leaf and bright grade leaf yield was 26 and 54.5%, respectively, over untreated check.

In West Bengal, bacterial wilt disease in *Jati* and *Motihari* tobacco nurseries and field crop can effectively be controlled by the application of powdered lime @ 560 kg/ha after land preparation and keeping the land fallow for a period of 20-30 days.

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Soil Fertility, Water Quality and Nutrient Management

Grouping of the soil regions into micro-zones based on soil fertility, climate and leaf quality helped in arriving at proper fertilizer management modules for each micro-zone. Soil fertility assessment of Hassan district of Karnataka revealed that the soils under FCV tobacco cultivation are acidic in reaction, low in organic carbon, high in available P and medium in available K status indicating good response to N and K fertiliser application. Southern Light Soils have high AR^{K}_{o} values; hence they have more readily available potassium compared to Southern Black Soils(SBS). Potential buffering capacity (PBC^{K}) values were more in Southern Black Soils compared to Southern Light Soils(SLS); hence they have more replenishing capacity compared to Southern Light Soils. The labile form of potassium (K_L), potassium on specific sites (K_X) and potassium on non-specific sites (K_O) are high in SBS compared to SLS which is a reflection of quantity parameter.

In NLS tobacco leaf, iron and manganese are in the range of sufficiency. Zinc is also in the range of sufficiency in majority of the locations, but found to be in the border line in a few locations. However, the crop did not manifest any symptoms of deficiency.

Alternative Uses of Tobacco and Reduction of Harmful Substances

In the studies on alternative uses of tobacco, HDBRG tobacco ranked first for solanesol and protein production, while A 145 ranked first for nicotine production, both under conserved moisture conditions and irrigated conditions in Vertisols. The cross, GT 7 x A 145 recorded 33.38% increased seed yield over A 145 and 96.71% over GT 7 at 150 kg N/ha level. As the coumarin nucleus appended to solanesol had shown anti-diabetic activity, *in vitro*, its further modification/variation was carried out and the compounds were prepared. SDB ethylenediamine which is known to inhibit the colony formation of multi-drug resistant mutant cell-line derived from Chinese hamster V-79 was prepared and the biological evaluation is in progress.

In order to develop varieties with lower levels of harmful constituents present in tobacco leaf and smoke, breeding material/ genetic stock from the Division of Crop Improvement were monitored for the smoke constituents and Tobacco Specific Nitrosamines (TSNAs) and also attempts were made to reduce the harmful substances by manipulation of agro-technologies. Levels of nicotine (2.93%), nornicotine (0.05%) and TSNA (0.75 ppm) were higher in FCV tobacco samples from NLS when compared to SLS (nicotine: 1.75%, nornicotine: 0.04% and TSNA: 0.38 ppm) and KLS (nicotine: 1.18%, nornicotine: 0.03% and TSNA: 0.35 ppm). Nitrate content was more in KLS (1.25 mg/g) and SLS (1.54 mg/g) samples as against 1.10 mg/g in NLS samples. Air-curing the burley tobacco leaf in the curing barns without midrib reduced the TSNAs when compared to tobacco cured with midrib. Application of *Azotobacter* along with 75% of recommended dose of nitrogen and 25% organic + 75% inorganic N resulted in 29.1 and 18.4% reduction in TSNAs, respectively, when compared to 120 kg N/ha, cured with midrib.

Agricultural Extension and Information Technology

The Institute plays a key role in the transfer of technology in close liaison/ collaboration with other stake-holders viz., Tobacco Board, ITC, GPI, VST etc. and tobacco production technologies were communicated to the farming community by organising 67 training programmes, 2 *Kisan melas*, 23 field visits and broadcasting 44 radio talks and telecasting 2 TV shows.

Software development for Expert system on pests and diseases; Information system for FCV tobacco production; Decision support system for FCV leaf quality evaluation and Information system on agricultural pests of coastal Andhra Pradesh were completed.

INTRODUCTION

Tobacco is an important industrial crop cultivated in many countries and accounts for US $ 30 billion global export-import trade annually. At present, India is the 3rd largest producer and 5th largest exporter of tobacco in the world. In India, tobacco is cultivated in about 4 lakh hectares of area (0.27% of the net cultivated land in the country) covering different styles/types of tobacco viz., cigarette, bidi, chewing, hookah, cheroot, cigar-wrapper, cigar-filler etc., with an annual production of 700 million kg. Nearly 270 million kg of Flue-cured tobacco is produced from 2 lakh hectares in the states of Andhra Pradesh and Karnataka and to a lesser extent in Orissa and Maharashtra. Bidi tobacco is cultivated in 1.20 lakh hectares, mostly in the states of Gujarat, Karnataka, Uttar Pradesh and Andhra Pradesh with an annual production of 200 million kg. Tamil Nadu, Bihar and West Bengal are the other states producing tobacco in the country.

Now, total exports of tobacco from the country are valued at Rs 1,713 crores, accounting for 4% of India's total agri-exports. Even though, India is the third largest producer of tobacco, the country's share in the global trade is less than 1%. Contribution of tobacco and tobacco products to central excise revenue is about Rs 9,100 crores which is more than 12% of the national excise revenue collection. Cigarettes account for nearly 80% of the total revenue collected from tobacco products. Nearly 36 million people are engaged directly or indirectly in tobacco cultivation, processing, manufacturing, marketing and other allied activities.

The total tobacco production in the world is in the range of 5,500 – 7,300 million kg. China tops the list with an annual production of around 2,000 million kg of tobacco. The production in US was reduced by 58% during 2005 compared to 1998. Brazil has increased the production in the last five years, reaching a peak of 700 million kg in 2004. Due to recent developments in Zimbabwe, there has been considerable reduction in tobacco production (73 million kg during 2005). In Brazil and Malawi, cost of production has gone up necessitating the MNCs to look for cheaper source for tobacco like India.

India is one of the leading exporters of tobacco, occupying fifth place in overall exports of tobacco after Brazil, USA, China and Malawi. The country accounts for about 6 % by volume and 0.7% by value of the world tobacco import/export trade. In the case of FCV tobacco, its share is about 4.6% and burley tobacco exports account for 2.6%. The bulk of the exports (80-85%) continue to be FCV only. During 2005-06, there was an increase in the Indian tobacco exports by about 2% in quantity and 4% in terms of value, when compared to 2004-05. Exports of tobacco and tobacco products from India increased by 8% in quantity terms and 21% in Rupee terms during 2006-07 over the previous year. UK, Germany, Belgium and the erstwhile USSR are the major importers of Indian FCV tobacco accounting for more than 60% of our exports. Zimbabwe, Brazil, Turkey, China and Indonesia are the competitors to India in the export market. As tobacco is a non-food luxury crop, its exportability depends upon producing quality leaf at a reasonably competitive price. Zimbabwe and Brazil are meeting these demands as they are producing more flavourful leaf with higher productivity levels. These countries enjoy the support from the Government as their National economy is linked to tobacco production and export.

Indian tobacco is considered as 'value for money' and further reduction in cost of production will make it more competitive in the international market.

In view of the enormous employment potential, internal revenues and foreign exchange earnings, tobacco crop will continue to play a significant role in the national economy.

India has the potential to be a major player in the global market through export of value-added products. There is vast scope for export of non-FCV tobacco types/products, which needs to be explored. Apart from the conventional uses, commercial exploitation of phytochemicals from tobacco will go a long way in sustaining the crop.

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 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 (phyto-chemicals)
- 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

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

For further enhancing the productivity and quality of Indian tobacco so as to make it more remunerative, globally competitive and to sustainable following challenges need immediate attention.

- Developing varieties/hybrids with divergent genetic background to achieve average productivity of more than 2,000 kg/ha in FCV tobacco; more than 3,000 kg/ha in non-FCV tobacco and sustaining the productivity
- Producing flavourful and superior quality filler FCV tobacco to meet the export demands
- Breeding cultivars with higher nutrient-use-efficiency and high photosynthetic efficiency
- Development of varieties tolerant to biotic and abiotic stresses through conventional and biotechnological approaches
- Gene pyramiding for developing durable resistance to biotic stresses and for stabilizing productivity
- Developing molecular markers for selection and maintaining varietal integrity
- Increasing factor productivity to reduce the cost of production
- Reduction of harmful substances through genetic and agronomical manipulation
- IPM modules for major pests and diseases to reduce agrochemical residues below the Guidance Residue Levels (GRL).
- Developing tobacco as a source of value-added phytochemicals, seed oil, enzymes, vaccines, manures etc.
- Conservation and utilization of rainwater through watershed technology for higher crop productivity in low and erratic rainfall zones
- Utilisation of micro-irrigation systems for enhancing water-use-efficiency and crop productivity
- Identification of alternative fuels for curing in lieu of fire wood and coal. Improving the fuel-use-efficiency of the barn and utilization of renewable energy sources like solar energy
- Identification of crops/cropping systems more remunerative than tobacco
- Exploiting rhizosphere microflora for improving soil health, fertilizer economy and disease management

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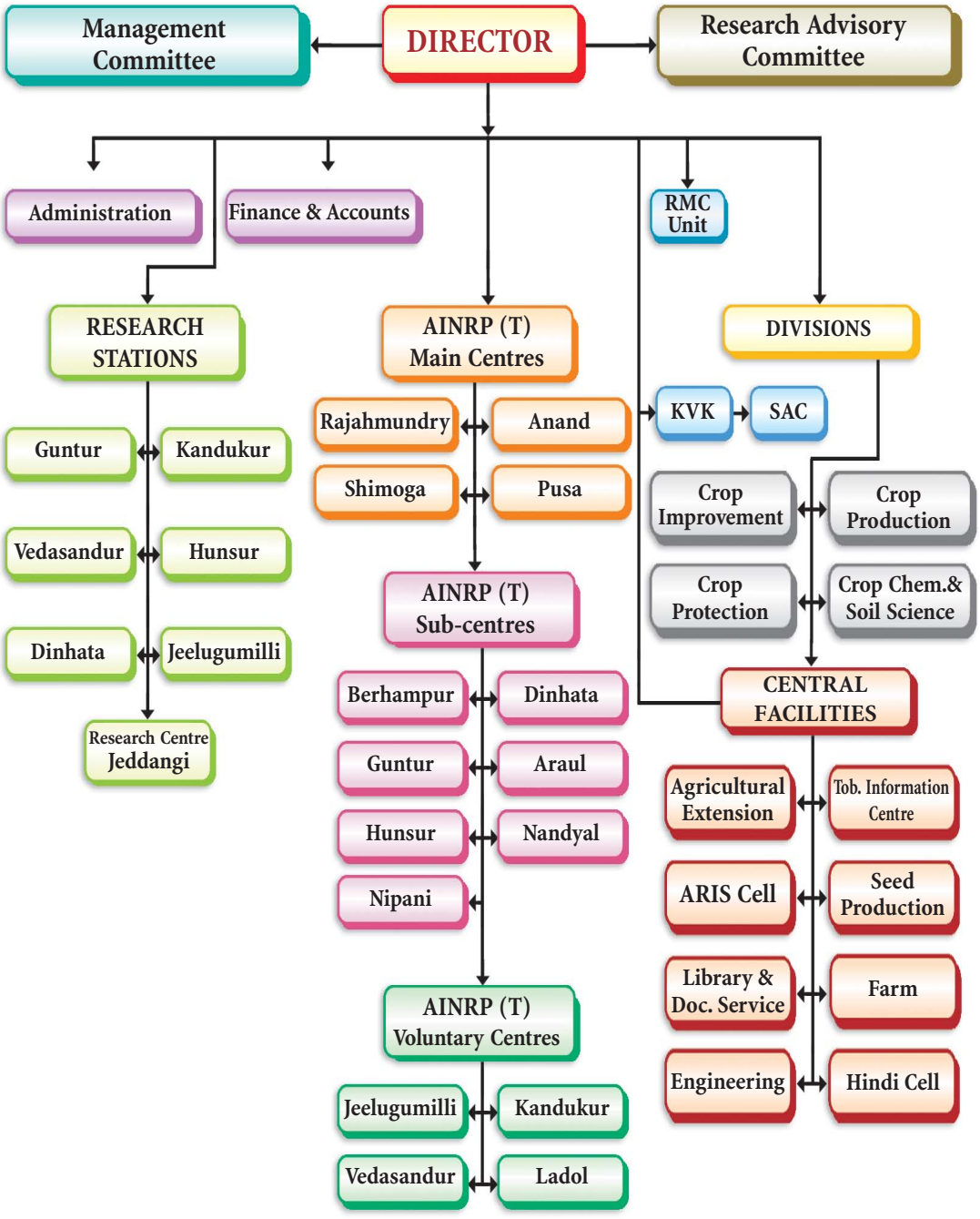
STAFF POSITION AS ON 31.03.2007

Sl. No	Category	Sanctioned Strength	In Position	Vacancies
1.	Scientific	70+1* *RMP	42+1	28
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+1 92	 05 53 91	 — 02 01
3.	Ministerial	77	72	05
4.	Supporting S.S.Gr.IV S.S.Gr.III S.S.Gr.II S.S.Gr.I	 19 40 65 57	 17 38 63 45	 02 02 02 12
5.	Casual workers on Temporary Status in position	136		

FINANCIAL STATEMENT FOR THE YEAR 2006-07

Head of Accounts	Rupees in lakhs	
	Budget Grant	Expenditure
Non Plan	1147.00	1144.75
Plan	125.00	111.99
KVK	59.15	54.12
AP Cess Fund Schemes	2.40	2.14
Pension & Retirement benefits	253.93	238.73
"P" Loans & Advances	15.00	9.25
"R" Deposit Schemes	12.51	6.23
Revolving Fund Scheme	60.33	61.91
Internal Resource Generation	37.31	20.74
Total	1712.63	1649.86
Revenue Receipts	110.47	---

ORGANISATIONAL STRUCTURE



Research Achievements

1. GERMPLASM RESOURCE MANAGEMENT

CTRI, Rajahmundry

Germplasm acquisition, maintenance, multiplication, evaluation and utilization

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

Acquisition

Eighteen multiple disease/ root-knot nematode resistant tobacco germplasm accessions were acquired from USA (4) and Brazil (14).

All the lines were sent to CTRI RS, Hunsur for off-season multiplication and preliminary testing.

Conservation

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

Maintenance

Out of the total genetic stocks (2,345) available at CTRI, 1,281 genetic stocks (FCV varieties: 531 and non-FCV: 750) were rejuvenated and selfed seed collected.

Twenty-seven CMS lines of different sources were crossed with respective maintainer parents.

Seed supply

A total of 971 varieties/species of seed materials were supplied to 31 organizations for research purpose.

Screening for pests and diseases (in collaboration with the Division of Crop Protection)

Resistant lines identified

TMV: Out of the 455 germplasm lines, 146 lines showed resistance

Stem borer : Exotic FCV variety, CSIRO – 3T and the indigenous scented variety Rajkhand – 3 (12.5% infestation)

Budworm : Lines C 110 x VT 1158, CU 1097 X VT 1158 and I-514 X 1099/2/4 were found promising

Aphids : C 110, CU 1097 (No infestation)

Whitefly :V.373, CU 1097 (No infestation)

Budworm : C110, CU 1097, V 373, Hema x CU1097, VT 1158 X V 373 (No infestation)

Caterpillar : C 110, CU 1097, V 373, showed 0.28, 0.2 & 0.8 plant infestation. Hema x CU1097 (showed 1.00 on 1-5 scale)

Evaluation

1. Alternative uses of tobacco (In collaboration with the Division of Crop Chemistry and Soil Science)

Seed oil: Oil content in 76 released varieties of all tobacco types varied from 22-39 %, the highest being recorded in the bidi cultivar, GT-8. Out of the 97 germplasm entries, higher oil content was recorded in chewing types of Tamil Nadu, PV-7 (39.25%) and HV 85-5 (39.93%) and the Turkish type chemical mutant (41.46%).

2. Yield and quality

VT 11 (3rd year): Among the four germplasm lines and advanced interspecific cross (*N. gossei x N. tabacum)* derivatives evaluated, two interspecific cross derivatives, 54-30-21 and 55MX1-15 recorded significantly higher cured leaf yields with an increase of 15 and 13% over better check, VT 1158.

VT-12: Among the twelve germplasm introductions evaluated for leaf yield, Coker 319 found to be significantly superior to best check, VT 1158 for green leaf yield. For cured leaf and bright leaf yields and grade index, however, none of the germplasm lines were superior to VT 1158 and the line Coker 319 showed significant improvement over Hema for these traits.

Hybrid Replicated Evaluation Trial

Twelve hybrids, including 4 exotic and 8 produced at CTRI were evaluated for yield and quality of cured leaf along with checks. Two hybrids, MS 1158 x Cy 142 and MS 1158 x Cy 139 were significantly superior with 10 and 9% increase in cured leaf yield over VT 1158.

Documentation

Catalogues on FCV and non-FCV tobacco germplasm were prepared.

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.*

Acquisition of new germplasm

National plant database, USA was requested for seed of those 13 species which were not able to grow and establish at Rajahmundry condition.

Maintenance

During the season, 60 *Nicotiana* species comprising 136 accessions and two subspecies were maintained in pots or experimental micro plots. Three non-flowering species were maintained under *in vitro.* This has been the largest collection of wild *Nicotiana* species maintained at the Institute. Forty four of the collections were rejuvenated at Katheru farm. Also, one autotetraploid *N. longiflora* and five species hybrids viz., *N x umbratica-nesophila, N. benthamiana-repanda, N x repanda-sylvestris, N x excelsior-plumbaginifolia* and *N. x gossei-glauca* were maintained for further use.

Evaluation

Solanesol content: Fifty species (80 accessions) were used for estimation of solanesol content in collaboration with the Division of Crop Chemistry and Soil Science. Air-cured leaf of theses species exhibited very wide genetic variability for solanesol content. The content varied from <0.05% in N. *benthamiana* and N. *trigonophylla* to 4.7% in one of the accessions of *N. sp.* TS 221/ EC554900. Pronounced intra-specific variation was observed for solanesol content. Most of the high solanesol species belong to the sub-genus *Petunioides* and especially, sections Suaveolentes and Alatae.

Species with high solanesol content (%)

1.	TW 69 (*N. hesperis*)	2.55
2.	TW 72 (*N. kawakamii*)	3.20
3.	TW 133 (*N. suaveolens*)	2.70
4.	N. sp. TS 221 Aus TRCF 317535	4.70
5.	AusTRCF 317535 (*N. suaveolens)*	3.90

The solanesol content in wild species during 2005-06 season was, in general, higher than that observed during 2004-05 season, thereby indicating environmental influence on the trait. Identification of high solanesol containing species/ accessions in this study indicates the scope for exploitation of wild *Nicotiana* species for phytochemical production.

Molecular characterization: Thirty-five species were utilized for isolation of total DNA in collaboration with Biochemist for analysis of molecular variation in genus *Nicotiana*, besides testing the species relationships. RAPD and AFLP markers were used for determining affinities among the *Nicotiana* species.

Reaction to *Orobanche:* Five species (*N. repanda, N. longiflora, N. gossei, N. bigelovii, N. rotundifolia)* and an amphidiploid of cross, (*N. repanda x N. sylvestris)*, were screened artificially against *Orobanche* (in collaboration with the Plant Pathology section). The infestation in the species was least in *N. repanda* (5.8%) followed by *N. rotundifolia* (8.0%) and maximum in N. *gossei* (80%). The amphidiploids of *N. repanda x N. sylvestris* also showed low infestation (10.5%) while autotetraploid *N. longiflora* (ITB 520) showed 25% infestation. The infestation in the controls Hema and VT 1158 was around 80% with numerous spikes around each plant, while only 0.1 to 5.9 spikes per plant were recorded in wild species. Screening of 40 of the wild species under natural conditions of high infestation in experimental plots also revealed similar trends of low infestation in wild relatives. Twenty two accessions were not infested.

Germplasm enhancement

Wide interspecific hybrid plants of cross (*N. sylvestris x N. repanda) x N. tabacum* were totally female sterile and had very low pollen fertility. Using these hybrids as male parents and *N. tabacum* as female parent, hybrids were produced for further utilization.

Morphological variants were identified in *N. excelsior, N. gossei and N. knightiana*. There was no chromosomal variation in these variants. The sterile natural hybrids between *N. excelsior x N. plumbaginifolia* had chromosome numbers varying between 24 and 30 while the fertile *in-vitro* derived plant had chromosome numbers of 27 and 28.

Seed distribution

Seed samples of 28 wild species were supplied to 10 researchers from various Universities/ Institutes during the year.

CTRI Research Station, Jeelugumilli

Maintenance of FCV germplasm

(T. G. K. Murthy)

Seventy three dark-cast FCV tobacco germplasm lines were rejuvenated. Twenty lines of FCV developed at Rajahmundry, were added to germplasm. Cured leaf yield, potential of these lines, in general, was lower than Kanchan.

Maintenance of irrigated *Natu* germplasm

(T. G. K. Murthy)

Sixty six germplasm lines belonging to irrigated *Natu* were maintained.

CTRI Research Station, Hunsur

Germplasm maintenance of *Nicotiana tabacum* varietal lines

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

Four new genotypes were added to the gene bank during the year. Active stock of 604 germplasm accessions is maintained. Under the periodical seed multiplication programme, 260 germplasm accessions were regenerated.

CTRI Research Station, Dinhata

Maintenance and evaluation of tobacco germplasm

A total of 229 lines of *N. tabacum* (*Jati*: 53; Cigar Wrapper: 94 and Cigar Filler: 82) and 175 lines of *N. rustica* (*Motihari*) tobacco were maintained.

CTRI Research Station, Guntur

Maintenance and evaluation of *Natu*, HDBRG and Burley germplasm

(A.V.S.R. Swamy)

A total of 150 *Natu*, HDBRG, Burley, Oriental and *Jati* tobacco germplasm lines were maintained and

evaluated for morphological and yield characters.

CTRI Research Station, Vedasandur

Evaluation and maintenance of germplasm
(K. Palanichamy)

Eighty five chewing and 60 cigar and country cheroot tobacco germplasm accessions were maintained.

Cytoplasmic male sterile lines of chewing tobacco varieties viz., Bhagyalakshmi, Meenakshi, Abirami, Maragadam, PV 7, I 115, VTK 1, VR 2 and Vairam were maintained by crossed with their respective fertile counter parts.

2. TOBACCO CULTIVAR DEVELOPMENT

CTRI, Rajahmundry

Breeding for Yield Improvement

Evolving superior varieties of FCV tobacco through Hybridization

Sub project Br 2 (a) VII: Evaluation of advanced breeding lines for yield and quality
(P.V. Venugopala Rao)

Replicated trial

The lines viz., V-4262, V-4263, V-4269, V-4270, V-4272, V-4278 and V-4280 were evaluated along with check varieties VT-1158 and Hema. Lines V-4263 and V-4278 found to be significantly superior and recorded 23% and 10% increase in cured leaf than better check VT 1158.

Evaluation of advanced breeding lines for yield and quality
(K. Sarala, R.V.S. Rao, P.V. Venugopala Rao and T.G.K. Murthy)

Nine advanced breeding lines were evaluated along with three checks, Hema, Cy 79 and VT 1158. Cy 156 and Cy 166 recorded significantly higher leaf yields of all types than controls Hema and VT 1158. The increase in cured leaf yield over VT 1158 was 16% in Cy 156(1881 kg/ha) and 19% in Cy 166(1923 kg/ha). Based on the over all performance of lines during individual years and on the basis of pooled analysis, the lines Cy 159, Cy 163 and Cy 156 were promoted for testing under AINRP (T) trials (Table 1).

The line Cy 135 was named as Siri (Fig.1, Tables 2 & 3) and released by Andhra Pradesh State Seed Sub-committee on Varietal Release on 2.6.2006 for commercial cultivation in black soils of Andhra Pradesh.

Fig.1 : Siri

Table 1: Performance of breeding lines under RBD (Pooled data of 2003-06)

(Yield: kg/ha)

S.No.	Line/Entry	Curedleaf	Brightleaf	GradeIndex
1	Cy 159	2180**(9)	1148**(12)	1718**(8)
2	Cy 163	2219**(11)	1139**(12)	1732**(9)
3	Cy 156	2234**(12)	1163**(14)	1748**(10)
4	Hema	1888	962	1483
5	VT 1158	2001	1027	1588
	Mean	2027	1056	1595
	S. Em.	54	34	45
	CD at 5%	150	93	125
	C.V.%	8.04	9.56	8.47

** Significantly superior over VT 1158. Figures in the parentheses are percent increase over VT 1158

Table 2: Leaf yields of breeding lines in bulk trial

(Yield: kg/ha)

S. No.	Line/Entry	Green leaf	Cured leaf	Bright leaf	Grade Index
1	Siri (CY 135)	16896(13)	2414(13)	1352(17)	1068(20)
2	CY 139	16508(10)	2358(10)	1297(12)	1012(14)
3	VT 1158	14952	2136	1153	888

Table 3: Leaf yields under On-farm trial

(Yield: kg/ha)

S. No.	Line/Entry	Cured leaf	Bright leaf	Low grades
At Katavaram				
1	Siri (CY 135)	2475 (23)	1980 (24)	495(23)
2	VT 1158	2000	1600	400
At Vadiseleru				
1	Siri (CY 135)	2500(40)	1980(55)	520
2	VT 1158	1790	1280	510

Figures in the parentheses are percent increase over VT 1158

Developing hybrid tobacco suitable for Black Soils of Andhra Pradesh

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

Replicated yield trials

Experiment 1: Eight CMS parents (MS 85P, AP1-8E, MSSPGT-28E, 6-6msG, MSH-5S, MS34G, MS BP and MS DelU), four male parents (Cy 79, Cy 139, Cy 142 and L 1358) and the 32 CMS hybrids produced by crossing these parents were evaluated, for two seasons. Two CMS hybrids, AP 1-8 x Cy 142 and 6-6ms x Cy 142 recorded significantly higher mean standard heterosis (23-41%) for different yield components over VT 1158 (Table 4).

Table 4: Yield characteristics of promising CMS hybrids (Pooled data of 2003-05)

(Yield: kg/ha)

S.No.	Entry	Green leaf	Cured leaf	Bright leaf	Grade index
1	AP1-8 X Cy 142	14558* (41)	2287* (39)	1060* (40)	1590* (39)
2	6-6ms X Cy 142	12239* (19)	2065* (26)	1018* (35)	1526* (33)
3	**VT 1158 (C)**	**10305**	**1644**	**755**	**1143**
4	HEMA (C)	9474	1437	615	1050
	Grand Mean	9681	1611	748	1173
	S.Em.±	601	79	42	60
	C.D.(0.05)	1666	219	116	167
	C.V.(%)	15.2	12.01	13.68	12.58

Figures in the parenthesis are percent increase over Control, VT 1158; * Increase significant over check VT-1158.

Replicated yield trial 1: Thirty two hybrids were developed by crossing eight CMS parents (MS 85, AP1-8, MSSPGT-28, 6-6ms1158, 6-6Rms, CMS 10, MS B and MS Del.) with four male parents (Cy 79, Cy 139, Cy 142 and L 1358) in L x T mating design. Heterosis for yield in these hybrids over best parent varied from 9 to 17% for cured leaf yields. Hybrids 6-6 ms x Cy 142, AP 1-8 x Cy 142, 6-6R x Cy 142 were found promising for cured leaf yield.

Replicated yield trial 2 (2nd year): The eight CMS hybrids which were developed by crossing two CMS t with four promising fertile parents viz. MS 19s x Cy 79, Cy 139, Cy 142 and L 1358 75-30msg, were evaluated. Standard heterosis in hybrids varied from 19 to 30% for cured leaf yield. The hybrids, MS 19 x CY 139, 75-30 MS x CY 139, MS 19 x CY 79, 75-30 MS x CY 79, 75-30 MS x Cy 142 were identified as the most promising.

Replicated yield trial 3 with fertile hybrids (3rd year): Two lines, VT 1158 (intra-specific) & 312-1S4 (inter-specific) were crossed with Cy 79, Cy 139, Cy 142 and L 1358. The resultant 8 F_1 hybrids were evaluated consecutively for three seasons along with VT 1158 and Hema (checks). The hybrids, 312-1 S4 x Cy 139, 312-1 S4 x Cy 142 and 312-1 S4 x Cy 79 recorded 18-23% increase in cured leaf than VT 1158 and identified as the most promising.

Breeding for Disease Resistance

Incorporation of disease resistance-Resistance for Tobacco Mosaic Virus (TMV)

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

BC_1 generation of six crosses involving Cy-135 (crosses V-4298 and V-4299), N-98 (crosses V-4304 and V-4307), Cy-142 (cross V-4294) and Cy-139 (V-4297) as recurrent parents were artificially inoculated with TMV. The resistant plants were backcrossed and BC_2 Seed was collected.

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 230 single plant-to-row progenies and 10 *inter-se* crosses in F_8-

F_9 generation 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 maintained.

Screening for resistance to tobacco aphid

The mean aphid infestation score recorded in susceptible cultivars varied from 3.90 (CM-12) to 5.0 (Lanka Spl.) (on 0-5 scale). In 232 interspecific cross derivatives tested, the scores varied from 1.0 to 5.0. In 66 families the score was less than 1.0.

Out of 33 resistant derivatives tested under artificial inoculation at CTRI RS, Guntur which is endemic to aphid infestation, 2 lines, G 566 and G 567 were identified as promising.

In the yield evaluation, three advanced derivatives, 147MX1-21, 54-30-21 and 55MX1-15 which showed 10-18% yield advantage over VT 1158 in RYTs were tested in IVT.

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, internode length, phyllotaxy, earliness, leaf colour, number of leaves, size and shape of auricle & petiole, curability, flower colour, fertility, etc. For all these traits promising interspecific cross derivatives were identified.

Evaluation of cross derivatives for yield and quality

Trial VT 11: Six advanced interspecific cross derivatives (*N. tabacum x N. gossei*) were evaluated for yield characters over two years. Lines, 54-30-21, 147MX1-21 and 55MX1-15 showed superiority over check cultivars and were forwarded to AINRP (T) multilocation trials.

Trial TBL: 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 (312-1) were evaluated along with checks Hema and VT 1158. Increase in yield in the test entries varied from 15-22% for cured leaf and 32-47% for bright leaf. Only one line, 55MX1-2-11 showed significant superiority over VT 1158 for grade index with 25% increase.

Screening against white fly/leaf curl damage

Nine derivatives of interspecific crosses, *N. gossei x N. tabacum* and *N. umbratica x N. tabacum,* were screened against white fly and leaf curl in a pot culture experiment. Leaf curl infection was low in the interspecific cross derivatives viz. 133-31LP1 (6%), 44-26L (20%), 39-11LP2 (21%) and 7-9LP3 (35%) as compared to 80% in susceptible checks.

Screening for resistance to tobacco caterpillar

Thirty four cross derivatives were screened in nursery and at adult plant stage under artificial inoculation. Lines, 53MX1-19, 137MX1, 178-3-5, and 56-12 showed no damage whereas, lines, 53MX1-7 (10%) and 178-3-1-12 (15%) showed low damage and the moderate level of resistance in 178-3-1-12, 60-14-1 and 144MX1-19 was confirmed.

Various materials generated under the project viz., autotetraploids induced in lines1099/2/4, VT 1158 and CM-12 and their selfed derivatives; cytoplasmic male steriles including eu- and alloplasmic sources; asynaptic line; translocation heterozygotes; variegated mutants and cream coloured seed variant were maintained for further studies.

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)

Evaluation of advanced breeding lines in replicated yield trials

RYT-5 (third year)

Ten dark cast advanced breeding lines (7 intervarietal and 3 interspecific cross derivatives were evaluated with checks Kanchan and CM-12 in a RBD for three years, On the pooled basis, lines RT-13 and 56-3 proved their significant superiority over best check, Kanchan with 18 and 13% in cured leaf yield and 18 and 11% in grade index (Table 5). Entry RT 13 is proposed for AINRP (T) trials and the line 56-3 for testing at Kandukur and Rajahmundry.

RYT 6:

Ten dark-cast advanced breeding lines were evaluated along with checks Kanchan and CM-12 in a RBD for two years, in succession. Lines, RT 86-1, RT 100-1 and RT 102-2 recorded significantly higher mean yields over Kanchan with 17-26% in cured leaf and 15-28% in grade index. Based on overall performance, lines RT 86-1, RT 100-1 and RT 102-2 are proposed for further studies.

CTRI-ITC collaborative trial:

Under a collaborative effort, nine entries comprising 2 hybrids and 7 advanced breeding lines developed by ITC ILTD, Rajahmundry, were evaluated for two seasons. The hybrids CH 1 and CH 2 (Fig. 2 and 3) were found most promising with 17 and 16 % and 20 and 17% increase in cured leaf yield and grade index, respectively over Kanchan (Table 6). Based on the superior performance, the two hybrids, CH 1 and CH 2 were proposed for initial varietal trial under AINRP (T).

Evaluation of pure line selections in variety Kanchan (2nd year)

Among the 10 Kanchan variants evaluated, N-7 was found promising with 23% mean increase in cured leaf yield over Kanchan during the second year of the trial.

Fig.2: CH 1

Fig.3: CH 2

Table 5: Performance of advanced breeding lines

(Yield: kg/ha)

Genotype	Green Leaf yield	Cured Leaf yield	Grade Index
RT-13	14417**	2597**	1409
CM-12 (KA) (C)	6569	1215	621
Kanchan (C)	*11861*	*2132*	*1156*
Grand Mean	9712	1750	930
S.Em. ±	480.5	91.3	116
C.D.(0.05)	1409	268	192
C.V.(%)	8.57	9.04	12.15

Table 6: Yield characteristics of tobacco hybrids (Pooled 2004-06)

(Yield: kg/ha)

S.No	Genotype	Green Leaf	Cured Leaf	Grade Index
1.	CH 1	17014* (15)	2859* (17)	1494* (20)
2.	CH 2	15655 (6)	2834* (16)	1456* (17)
3.	Kanchan	14743	2435	1242
	Grand Mean	14468	2461	1253
	S.Em.±	474.2	84.9	59.6
	C.D.(0.05)	1314	235.5	165.1
	C.V.(%)	8.03	8.46	11.64

* Significant over best check, Kanchan at 5% level

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)

A research programme on hybrid tobacco breeding was initiated so as to break the existing yields barriers in NLS. Under this project, three replicated yield trials, comprising 16 CMS hybrids, 16 fertile hybrids and 15 CMS hybrids were conducted to identify promising hybrids.

Evaluation of CMS hybrids (3rd year)

Sixteen CMS hybrids were evaluated along with 2 check varieties, CM-12 and Kanchan for the three years, in succession. On pooled basis, the CMS hybrid, 6-6RMS x JS 78 (Fig.4) showed significant superiority over parent Kanchan cured leaf yields and grade index with 26.3 and 31.2% increase, respectively. Based on overall superior performance, the hybrid, 6-6R MS x JS 78 is proposed for further studies. In respect of chemical quality, nicotine was slightly high and correspondingly reducing sugars were low in the hybrid, 6-6 R x JS 78.

Evaluation of fertile hybrids (2nd year)

Sixteen fertile F_1 hybrids were evaluated along with 2 checks CM-12 and Kanchan for two seasons. On pooled basis, the following hybrids were found to show significantly higher standard heterosis than the best check, Kanchan: 325X1-5 x Kanchan (27%), 312-I L x Kanchan (26%), VT1158 x 312-1 (21%), 312-I x FCH 194 (18%) for cured leaf yield.

Evaluation of CMS hybrids and parents

Fifteen hybrids were produced by crossing five newly developed CMS lines (MSB, 16-29 ms, MS-58, MS1158 and 139MS) with 3 promising male parents (Kanchan, JS 62 and JS 78) in a Line x Tester mating design. All the 23 genotypes were evaluated in RBD for identifying combining ability of the parents and heterotic crosses. The following crosses were found most promising with significantly higher

Fig.4: NLSH-1

standard heterosis than the best check Kanchan: MS58 x JS 78 (44%), MS 1158 x JS 62 (33%), MS58 x JS62 (25%), 139 ms x JS 78 (21%), 139 ms x Kanchan (21%) and MS 1158 x Kanchan (16%) for cured leaf yield.

Evaluation of flavourful exotic lines for suitability in NLS of Andhra Pradesh

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

Bulk trial: Nine exotic flavourful varieties were grown along with the check variety Kanchan in progeny bulks. SC 58 and Va 115 were found to be early types (total 140 days as against 185 of Kanchan). Cured leaf yield of Coker 319 was comparable with Kanchan while others showed lower yields.

Carbonyl content in the flavourful lines: The composite cured leaf (middle picks) samples were analysed for total carbonyl content (mg/100g). It varied from 355 mg in Coker 319 and F 106 to 552 in BS. Flavour profiles of these lines are being estimated in collaboration with M/s ITC-ILTD Ltd.

Natu Tobacco

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

(T. G. K. Murthy)

Four promising advanced breeding lines were assessed in a bulk trial. Among them, Sel. 47 recorded highest cured leaf yield of 1720 kg/ha compared to 1350 kg/ha in check, Kommugudem (Table 7).

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

Fifteen progenies derived from the crosses involving Beinhart 1000-1 and L.1128 (SR) as brown spot disease resistance donors were screened for their reaction to disease in 'hot spot' area. All the progenies recorded disease index below 15, while the susceptible check Bhavya showed mean PDI of 45.4 (range: 34.4 to 60.1). Twelve promising progenies having desired cured leaf qualities have been identified for assessing the yield and quality under replicated trial.

Breeding for quality improvement

Nine advanced breeding lines viz., FCH 196 to FCH 204 were assessed for yield and quality under a replicated trial (Fig.5). Of which five lines recorded

Fig.5 : YIELD PERFORMANCE OF LINES

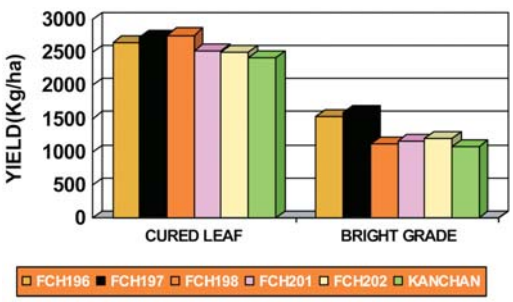


Table 7: Evaluation of natu tobacco lines (Yield: kg/ha)

Entry	Melimi leaf	Gulla leaf	Total curedleaf
9-14	745	100	845
Sel.45	1200	320	1520
Sel.46	1120	230	1340
Sel.47	1330	390	1720
Kommugudem (C)	1100	250	1350

>2,500 kg/ha yield and exhibited superiority over the standard check Kanchan for total cured leaf production. The yield increase over Kanchan ranged from 4 to 15%.

On artificial stem inoculation with *Phytopthora parasitica* var. *nicotianae* the black shank disease causing fungus, it was found that except two, other advanced breeding lines, have moderate to high disease resistance.

Breeding for resistance to *Fusarium* wilt disease in Flue Cured Virginia Tobacco for Karnataka Light Soils

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

Forty five progenies in F_5/F_6 generations derived from the crosses involving Dixie Bright 101 and Speight G.33 as *Fusarium* wilt disease resistance donors were screened for their reaction to the disease in sick field. Selections were made in nine progenies that recorded lower disease incidence (around 10%) as against >60% in susceptible check Bhavya. Among the twenty six selections made, twelve have been identified for preliminary yield assessment under replicated trial and for simultaneous screening against disease.

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

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

Among the 17 hybrids evaluated, Rathna x Coker 48, Rathna x Kanchan, Kanchan x Golden Cure, Rathna x Yellow Special, Kanchan x NC.12, Rathna x NC.12, Kanchan x Coker 48 as well as Speight G.28 x Rathna have recorded 10-27% standard heterosis for cured leaf yield (Table 8). Five hybrids, involving Rathna as one of the parent, recorded standard heterosis for all yield parameters. The cured leaf quality assessment indicated that the hybrids involving Coker 48, NC.12 and Newdel with either Rathna or Kanchan produced riper leaves having desired physical characteristics

Collaborative Trial

Evaluation of advanced breeding lines/ hybrids (collaborative trial with M/s ITC Ltd., ILTD Division)

Four advanced breeding lines and two hybrids were assessed and all the test lines recorded higher cured leaf yield over Kanchan. All the entries recorded more than 2,400 kg /ha cured

Table 8: Standard heterosis exhibited by hybrids

	Standard heterosis (%)			
	Cured leaf yield		Bright grade yield	
	Kanchan	Rathna	Kanchan	Rathna
Rathna/Kanchan	-	15	17	39
Golden Cure	14	8	-	17
Newdel	6	2	-	31
NC 12	11	11	-	33
PCT 8	7	-	26	-
Coker 48	3	27	-	11
Yellow Spl.	14	13	18	-

leaf yield and were on par with check Kanchan. Based on the over all performance of the entries, in respect of yield and quality under the trial, V.89 followed by V.91 and V.82 were found to be superior.

CTRI Research Station, Guntur

Development of FCV tobacco varieties suitable for cultivation in Southern Black Soils of Andhra Pradesh

(A.V.S.R. Swamy)

Evaluation of F_1 hybrids: Thirteen F_1 hybrids, which were developed using the parents viz. Cy-135, Cy-79, V-3703, KST-26, II-1624, Rathna, Hema, G x 1-1#4, Kanchan and Bhavya, were evaluated. The hybrid, GH-32 produced maximum cured leaf yield of 3,028 kg/ha with higher grade index of 2709 kg/ha. Other promising hybrids GH-16, GH-21 and GH-11 produced cured leaf yields of 2,843, 2,509 and 2,457 kg/ha with higher grade index and bright leaf yields. Yield improvement in the hybrids ranged from 10- 70 % over the standard check Hema.

Hybrid programme using CMS lines

Hybrids were developed by crossing the CMS lines, Delcrest x D.C. (W.F), CMS Speight G28, CMS Jayasri, CMS Hicks and CMS HR-62-9 with Hema and II-1624. Among the hybrids developed, CMS Speight G28 x II-1624 and CMS Jayasri x II-1624 out yielded with cured leaf yields of 1,999 and 1,921 kg/ha, respectively with higher bright leaf yields and grade index .

Bulk Trials

Bulk trials were conducted with seven entries viz. Hemadri (II-1624), V-4064, Hema, Cy-79 VT-1158, V-4064 and (Siri) Cy-135 for assessing their yield and quality. The lines, Cy-139 and V-4064 recorded maximum cured leaf yield of 2,028 and 1,951 kg/ha, respectively compared to the check Hema (1,668 kg/ha).

Evaluation of breeding lines developed for Aphid resistance

Fourteen F_4 breeding lines developed using two CORESTA Lines (parents) T-I-601, and T-I-1068 crossed with Natu Spl. and VT-1158 i.e. T-I-601 x Natu Spl., T-I-1068 x Natu Spl. and T-I-1068 x VT-1158 and named as CAR selections were assessed for yield. CAR 3#7 out yielded all other FCV lines with 2,228 kg/ha cured leaf yield and CAR 1#6 among Natu lines gave 2,223 kg/ha cured leaf yield.

Natu Tobacco

Bulk trials: Bulk trials were conducted with the entries, Prabhat, Natu Spl., Viswanath, NG-73, HDBRG-1 and HDBRG-2 for assessing yield and quality. The entries II-1873 and NG-73 (Bhairavi) recorded maximum cured leaf yields (2,279 and 2,123 kg/ha), among the entries.

Hybrids: Crosses, Abirami x HDBRG-1, Abirami x HDBRG-2 and Abirami x NG-73 were made for developing hybrids and better recombinants that yield higher quantities of solanesol and other phytochemicals. These three hybrids recorded cured leaf yields of 2,057, 1,196 and 1,485 kg/ha, respectively, compared to the check Abirami 762 kg/ha.

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. Venugopala Rao, T.G.K. Murthy, K.N. Subrahmanya, A.V.S.R. Swamy and C.V.N. Rao)

Thirty four Hybrids developed by crossing 17 germplasm selections with two varieties Hema and VT1158 in Lx T fashion were evaluated along with parent to estimate general and specific combining abilities.

Promising General and Specific combiners for yield characters

General	Specific
NC3150	NC-12 / Hema
Wild Fires Orinaco	Strain-205 / Hema
Strain -205	DR-1 / VT1158
Salt Improved Gold	Oxford-101/ VT 1158
DR-1	Wild Fires Orinaco / Hema
NC-6129	NC-6129 / VT 1158

Performance of high potash (COR – lines) lines

Six high potassium lines were evaluated along with three checks viz. Hema, VT 1158 and CY-79 in a RBD. None of the varieties were significantly superior to control for all the yield characters except COR-16 which recorded significantly superior yield over check variety CY-79 for cured leaf yield. The potassium content in the composite leaf sample of COR- lines was higher than the checks.

Burley Tobacco Research Centre, Jeddangi

Evaluation of advanced burley breeding lines for productivity and quality

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

Out of 54 F_3 progenies studied, 39 selections were made based on the morphological characters like leaf size, shape and colour, stem, veins, number of leaves, inter-nodal length etc. for evaluation in progeny row trial. Fourteen advanced breeding lines (WB-1 to WB-14) were selected for testing under a replicated trial.

Evaluation of Burley tobacco hybrids suitable for burley growing area of Andhra Pradesh

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

A replicated evaluation trial was conducted for three years in succession with fifteen F1 burley hybrids and five parents. The fertile Burley hybrid Banket A1 X 324 C (YBH-1) recorded 1,795 kg/ha cured leaf yield, 23% increase over the ruling burley cultivar Banket A1, on pooled basis.

Based on the over all performance, the hybrid YBH-1 (Fig.6) is proposed for testing in the bulk plots in farmers' fields during the ensuing season.

Hybrid bulk trial

Evaluation of Burley Hybrid BA1 x 324C: A hybrid bulk trial was conducted with the hybrid Banket A1 x 324C, Banket A1, Burley-21 and 324C. The hybrid produced a cured leaf yield of 1,920 kg/ha with 20% improvement over the BA1. The chemical quality

Fig.6: YBH - 1

characteristics were found to be within the acceptable limits. In the trader's evaluation, the cured leaf sample of the hybrid was rated as 1st by three traders and 2nd by one trader. The traders opined that the leaf quality of the hybrid was good and acceptable.

Incorporation of Male sterility into Burley Varieties: The BC1 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 parent viz., Banket A1, Burley-21 and BSRB-2.

CTRI Research Station, Vedasandur

Breeding for insect resistance against caterpillar attack in chewing tobacco

(K. Palanichamy)

Two caterpillar resistant selections of chewing tobacco viz., HV.2000-2 and HV.2000-6 (Figs.7 and 8) developed through backcross breeding involving HV.86-2 and Abirami as the recurrent parents, respectively were evaluated in bulk plots along with the respective susceptible parents HV.86-2 and Abirami at CTRI Research Station, Vedasandur as well as in three out-station centres in farmers' fields in the inland chewing tobacco tract for the third consecutive year.

Fig.7: HV 2000 - 2

Fig.8: HV 2000 - 6

At CTRI Research Station, Vedasandur, both the selections recorded higher cured leaf yields of 3,505 and 3,875 kg/ha as compared to 3,177 and 3,382 of their respective susceptible parents, the yield increase being 10.3 and 14.6%, respectively. In terms of mean yields over the locations (including CTRI RS, Vedasandur) these selections were superior recording mean cured leaf yield of 3401 and 3524 kg/ha, an increase of 11.1 and 11.9%, respectively over their respective susceptible parents.

Both the selections exhibited complete resistance to caterpillar attack (first *instar* larvae, under artificial and natural conditions (1.6–3.6% incidence).

Studies on heterosis in chewing tobacco (*N. tabacum* L.)

(K. Palanichamy)

Eleven promising F_1 hybrids of chewing tobacco were evaluated at CTRI Research Station, Vedasandur in RBD and in bulk trials at four outstation centres in growers' fields in the coastal Vedaranyam area of Tamil Nadu. At Vedasandur, hybrids F_1- 6 (Abirami x KV 1) was significantly superior in whole leaf yield (2,801 kg/ha) with 16.27% increase over the best check, Bhagyalakshmi. Hybrids, F_1-5 (Vairam x Abirami); F_1-2 (PV 7 X Abirami) and F_1-6 (Abirami x KV 1) were significantly superior to Abirami with 3,841, 3,735, 3,632 kg/ha total leaf yield, respectively when compared to Abirami (3,231 kg/ha) with standard heterosis of 18.88, 15.60 and 12.41%, respectively.

In the bulk trials at the outstation centers, the hybrids exhibited differential performance between locations. While F1-9 and F_1-1 occupied the first two positions with 4,498 and

4,346 kg/ha of total leaf yield at Muthunaickenpatty, compared to 3,649 kg/ha of the best check Abirami, the standard heterosis being 23.27 and 19.10%. F_1-5 and F_1-9 occupied the top two ranks with 4,549 and 4,519 kg/ha compared to 3,923 kg/ha of the best check, the standard heterosis being 13.72 and 12.98% over Abirami at Kosavapatty. In the heavy soils of Alukuli, F_1–6 (Vairam x Abirami) and F_1-5 (Abirami x KV1) performed better with 2,962 and 2,887 kg/ha compared to 2,354 kg/ha of Vairam the standard heterosis being 25.83 and 22.60%, respectively. In the coastal sandy area of Ayakkaranpulam, only F_1-6 (Abirami x KV1) was comparable to the best check Kaviri. All the hybrids are comparable to the checks in chewing quality. The general crop performance was better in Muthunaickenpatty and Kosavapatty of Dindigul district as compared to that in the coastal sandy regions of Ayyakkaranpulam and in the relatively heavy soil regions of Alukuli in Erode District.

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

(K. Palanichamy)

Based on desired level of expression for yield component attributes such as stem girth, leaf length, breadth and thickness, 53 selections have been made from 9 families, for further studies.

CTRI Research Station, Dinhata

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

Two early maturing *Motihari* tobacco cultivars viz. Tangua Manda and RT-Bulk were evaluated in farmers field at four locations including at the Research Station. Cultivar Tangua Manda recorded 26.2 and 22.9 % higher cured and first grade leaf yield, respectively, over control Bitri with identical quality leaf out turn.

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

(S. Amarnath)

Morphological and yield characters in 28 F_1s and their parents were recorded and analysis of the data for combining ability is under progress. Most of the F_1s showed negative heterosis for plant height (23) and number of leaves (11) in contrast to green (10), cured (8) and first grade (8) leaf yields. Heterosis values for leaf length, leaf breadth and number of leaves were 29.6, 35.8 and 33.3%, respectively, which were of lower magnitude. However, values for characters like plant height, green, cured and first grade leaf yields were 85.2, 83.4, 102.9 and 89.7% respectively, which were of higher magnitude.

3. BIOTECHNOLOGY FOR TOBACCO IMPROVEMENT

Tissue Culture Studies in Tobacco

Micropropagation of elite lines and other selections

(K. Sarala and T.G.K. Murthy)

Micropropagation of elite lines

Interspecific hybrids viz., Bhavya x *N. gossei*, *N. repanda* x *N. tabacum* and *N. gossei-glauca* besides non-flowering species, *N. africana* and R0 generation transgenic lines of Hema and Jayasri, available in the lab were maintained under *in vitro* condition. Seven species viz. *N. gossei*, *N. tomentosiformis*, *N.longiflora*, *N. undulata*, *N. Kawakamii*, *N. otophora* and *N.suaveolens* were micropropagated. Fertility was restored in seed sterile *N. excelsior-plumaginifolia* natural hybrid.

Micropropagation of haploids and dihaploids

In order to identify promising homozygous lines either for hybrid breeding programmes or for varietal improvement, plantlets regenerated from the anthers of seven elite crosses (Hema x JS-80, Hema x JS-95, 325X1-5 x JS 62, VT-1158 x CY.142, VT-1158 x CY.139, H-39 x H-40 and H-40 x H-39) were micropropagated and around 110 Plantlets were transferred to pots. Efforts were made to reconstitute dihaploids from promising haploids. Plantlets were generated from mid vein explants of six hapliod plants derived from the cross, 325X1-5 x JS 62 and three of H39 X H40 (Fig.9).

Development of virus tolerant tobacco lines under *in vitro*

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

Thirty one S_5 and 15 S_4 generation somaclone lines were artificially tested for leaf curl resistance. In general, the incidence of leaf curl in somaclones was very low. Twenty one S5 and thirteen S4 somaclones recorded 100% tolerance to leaf curl.

Forty S_5 and one S_4 somaclone of VT1158 and three S_4 somaclone lines of Kanchan were screened for CMV resistance. Initially, 2-4 plants in most of the clones and all the plants in control were found to have mild symptoms of CMV due to natural infection. Remaining healthy plants in all the clones were inoculated with CMV. As the time progressed, somaclones recovered. No such recovery was observed in control. Number of plants free from CMV symptoms was recorded at the end of the season. All the plants in 32 lines were found to be free from CMV.

Thirty S_5 and 29 S_4 somaclone lines were tested for their yield performance at Katheru farm. Among them, 12 S_5 lines and 12 S_4 somaclone were promising. Nine somaclones (NLCR, NM, NLCR-4, NLCR-5, NLCR-7, NLCR-8, NLCR-10 and NLCM) of Kanchan were tested for their yield performance at CTRI RS, Jeelugumilli. The lines NM, NLCM, NLCR-1, NLCR 4, NLCR-5, NLCR 7 and NLCR 10 were found to give higher yields.

Fig.9: Haploid plants in pots

Viral gene sequencing

PCR primers specific to coat protein (cp) gene of tobacco leaf curl virus were used to specifically amplify a sequence of 725bp from the total DNA isolated from the tobacco plants, collected from NBS region, 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 (Fig.10).

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. The virus showed 97% sequence similarity with Croton yellow vein mosaic virus, 96% with Tobacco leaf curl virus isolate TbLCV-Kar2 coat protein and whitefly transmitted Indian begomovirus from *Phyllanthus niruri* coat protein.

Maintenance, evaluation and characterization of tobacco transgenics

(K. Sarala, J.V. Prasad and K. Siva Raju)

Four transgenic lines, two each in Hema (HT-1 and HT-2) and Jayasri (JT-1 and JT-2) backgrounds, were planted under 'Containment A' screen house condition for their maintenance (Fig.11). Before planting, transgenic nature of the plants was confirmed by

Fig.11: Trangenics in the screen house

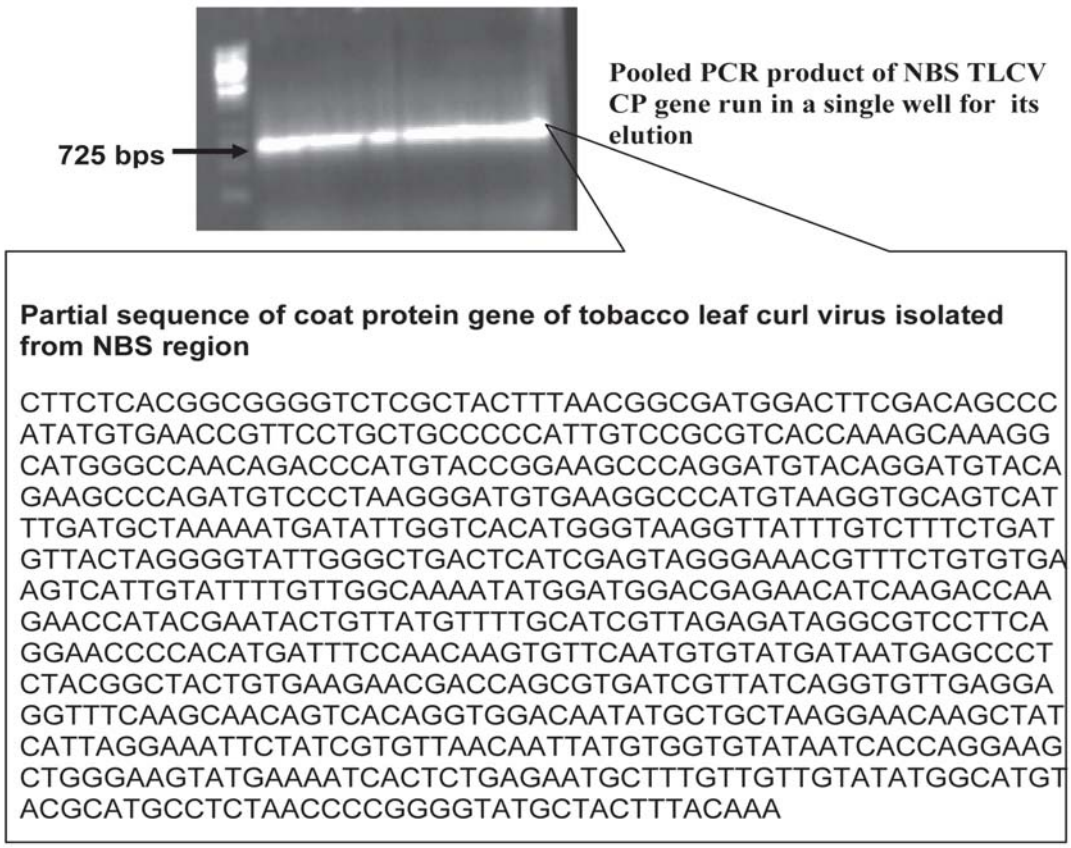


Fig.10: Viral gene sequencing

their ability to resist kanamycine under tissue culture. These transgenics contains Cry1A (b) (toxic to *Helicoverpa armigera*) and Cry 1C (toxic to *Spodoptera litura*) genes.

The transgenic lines were artificially screened against *Spodoptera litura* and *Helicoverpa armigera* larvae. *Spodoptera litura* (24-36%) and *Helicoverpa armigera* (2-44%) larvae consumed less leaf area in trasgenics than in controls, 78-94% and 75-80%, respectively. Larval weight of *Spodoptera litura* was more in control (0.4-0.6g) than in transgenics (0.06-0.26g). *Helicoverpa* larvae reached IIIrd instar stage in control and IInd instar in most of the transgenic plants. 'Cry1Ab Bt Instant-check' strips were used to detect the expression of Cry1 Ab gene in transgenic tobacco plants.

Transplastomic lines having Cry 9 Aa2 gene were received from Central Potato Research Institute, Shimla for their evaluation.

Molecular Mapping of tobacco traits: Tobacco specific nitrosamines in burley

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

Twelve out of 14 germplasm lines confirmed low TSNA levels. Molecular diversity of eleven selected lines was studied through RAPD using 25 primers. Maximum genetic similarity value (0.857) was found between VA-510 and BSRB-II and minimum (0.352) between Sota-6506 and Harrow velvet followed by T-117 and Sota-6506 (0.417).

The UPGMA based dendrogram depicting genetic relationships showed three major clusters. Banket A1, By-64, Ky-10, Harrow Velvet, Burley resistant and T-117 clustered into one, By Sota-51, VA-510, BSRB-II, and By-21 into another cluster and Sota-6506 into a third. Based on the similarity coefficients, the following crosses were identified for molecular mapping studies: Banket A1 (high TSNA) x Sota-6506(low TSNA), Banket A1 (high TSNA) x VA-510 (low TSNA), BSRB-II (high TSNA) x Sota-6506 (low TSNA), By-21(high TSNA) x Harrow Velvet (low TSNA).

Development of tobacco specific microsatellite markers

(M. Seshu Madhav, K. Siva Raju and K. Palanichamy)

Development of microsatellite markers from the nuclear genome

In order to develop nuclear microsatellite markers, to use in marker aided selection for desired qualitative and quantitative traits, a highly efficient microsatellite enriched tobacco genomic library was prepared. The genomic DNA was isolated from FCV variety Jayasree and was enriched with di- and tri-nucleotide microsatellites. From the enriched nuclear DNA, fragment size range of 1.5- 2.0 kb was gel eluted, cloned in to pGEM-T easy vector and transformed in to *E. coli* strain DH10B. The titer of genomic library was 1x 10^{25} colonies /ml with 98 % inserts. Screening of library was done with PCR using primary, secondary and tertiary pools. The positive clone's plasmid DNA was isolated and used for sequencing. 700 positive clones were sequenced, a total of 5, 65, 000(bp) sequences was generated. Using these sequences a total of 490 Simple Sequence Repeat (SSR) motifs were identified. Among those, 148 (Group I and group II) SSR motifs were identified for designing microsatellite primers (Table 9). So far, 38 microsatellite primers have been designed and validated in different species of *Nicotiana* and different lines of tobacco. Thirty primers produced expected size of amplicons with varied number of alleles. These STMS markers are being used for tagging of solanesol, nicotine and TSNA.

Table 9: SSR motiffs Identified in tobacco genome

Clone ID #	Motif	No .of Repeats	SSR start (bp)	SSR end (bp)	Seq Length (bp)	Designed Microsatelite
A7-1	ttc	7	154	174	993	TM-1
A11-1	ct	6	368	379	996	
B6-1	tc	16	100	131	995	TM-2
B6-2	aac	15	247	291	995	TM-3
C3-1	ac	14	126	153	1016	TM-4
C3-2	ac	10	213	232	1016	
C3-3	ac	9	235	252	1016	
C3 -4	ca	45	290	379	1016	TM-4-1
C5-1	ctt	5	450	464	990	
C10-1	ag	10	136	155	994	TM-5
C11-1	tc	18	569	604	991	TM-6
C12-1	ag	11	386	407	994	TM-7
C12-2	aca	10	231	260	994	TM-8
D10-1	gt	28	199	254	641	TM-9
D10-2	gt	9	314	331	641	
H5 -1	tc	20	461	500	994	TM-10
D11-1	ttc	5	229	243	991	

Distribution of SSR in Tobacco genome

- In di nucleotide repeats (AG)10 and (TC)6 are predominant followed by (GA) 8 and (CT)6·
- In tri nucleotide repeats(TTC)7 and (GAA) 6 are predominant followed by (AGA)11 and (CTT)5·
- All tetra, penta and hexa repeat motif length which repeating 6 times are present only one time·
- Repeat elements are mostly simple and Imperfect types rarely compound and extended compound repeats are present

Development of microsatellite markers from the organelles genomes

Using sequences of chloroplast and mitochondria of tobacco, 12 chloroplast SSRs and 7 Mt SSRs were designed and valided across the species of *Nicotiana* (Table 10).

Molecular mapping of genes responsible for production of solanesol and nicotine in tobacco

(M. Seshu Madhav, T.G. K. Murthy, K. Siva Raju, K. Sarala and C.V.Narasimha Rao)

Diverse parents for both traits i.e. solanesol and nicotine content were selected based on the available data and confirmed their chemical data by retesting. Assessment of molecular diversity by STMS/RAPD markers among all the contrasting lines showed the MSM – 30 marker (newly developed tobacco microsatellite) is polymorphic among the diverse parents of solanesol and nicotine. Survey for more polymorphic primers is in progress.

Electrophoretic characterization of tobacco

(K. Siva Raju and K. Nageswara Rao)

Randomly amplified polymorphic DNA (RAPD) technique was used for the development of molecular markers and

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Table 10: SSR motifs identified in chloroplast genome of tobacco

Sequence	Motiff	No of repeats	SSR start (bp)	SSR end (bp)	Primer Name
1-15	at	5	7818	7827	TBCSSR-1
1-144	ta	5	76007	76016	TBCSSR-2
1-184	at	5	94356	94365	TBCSSR-3
1-189	ga	4	96090	96097	
1-190	ga	4	96102	96109	
1-193	ga	4	97169	97176	
1-211	ag	4	105264	105271	
1-276	ag	4	146147	146154	
1-295	ct	4	157838	157845	
1-321	at	5	168912	168921	TBCSSR-4
1-389	taaa	3	384	395	TBCSSR-5
1-390	tttc	3	4299	4310	TBCSSR-6
1-391	tttg	3	7951	7962	TBCSSR-7
1-392	ctat	3	32927	32938	TBCSSR-8
1-393	ttta	3	33452	33463	TBCSSR-9
1-394	aaat	3	61272	61283	TBCSSR-10
1-395	aaac	3	76137	76148	TBCSSR-11
1-396	tttaa	3	15881	15895	TBCSSR-12

to study the genetic variability among the cultivars and breeding lines grown in West Bengal. The varieties included in the present study were (1)Dharla (2) CV RT Bulk (3) Tangua Manda (4) Manda (5) Bitri (6) D.D.473 (cultivars of *N. rustica)* (7) CV J-1 (8) *Jati* Podali (9) *Jati* Chama (10) Chhotamani and (11) Manasi (cultivars of *N. tabacum)*

A total of 152 amplified fragments were produced by 18 primers in the cultivars of both species, of which 135 were polymorphic with 92.46% of polymorphism. The polymorphic index content (PIC) score varied from 0.297 to 0.495 for different primers. The primer OPP6 was the most informative primer with 0.297 PIC score. The fragment with 300 bp amplified by the primer OPL16 was specific to the variety Dharla whereas, the band with 900 bp amplified by the primer OPL17 was specific to the variety Dharla and the accession cultivar RT bulk.

Dendrogram constructed using an UPGMA and SAHN algorithm from the Jaccard's similarity matrix data from all the marker profiles consisting of 152 polymorphic fragments (Fig.12).

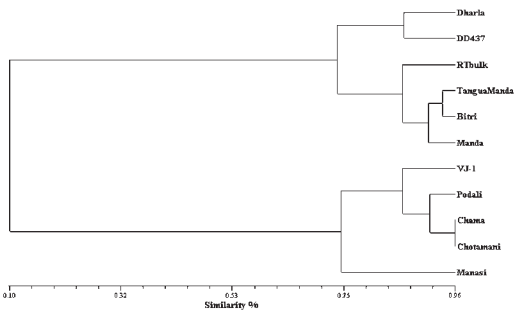


Fig.12 : Dendrogram

The genetic similarity among the cultivars of both the species varied between 7.2 and 14.2%. Between the species, the variety Cv. J-1 of *N. tabacum* and Cv. RT bulk of *N. rustica* showed minimum genetic similarity whereas the variety Dharla of *N. rustica*

and Chama of *N. tabacum* showed maximum similarity of 14.2%. Among the cultivars of *N. rustica*, the genetic similarity varied between 64.8 and 93.8% with an average genetic similarity of 79.3% whereas, the genetic similarity among the cultivars of *N. tabacum* varied between 68 and 96.2% with an average genetic similarity of 82%. Unweighted pair group method on arithmetic averages (UPGMA) method of clustering analysis, the 11 varieties were separated into two main clusters based on species specificity.

Isozymes of Peroxidase resolved on 8% polyacrylamide gel electrophoresis showed a maximum of 7 loci. There was no common band between the two species. The band with Rf value 0.56 in the cultivars of *N. rustica* showed very close similarity with the band having Rf value 0.54 present in the cultivars of *N. tabacum*. Among the varieties of *N. rustica*, the accession Manda and Bitri showed similar banding pattern. The banding pattern of Cv RT Bulk was different from other varieties of *N. rustica*. The variety Dharla showed five bands with Rf values 0.43, 0.56, 0.63, 0.68 and 0.72 whereas, one of its parent, variety DD437 showed an additional band with Rf value 0.09 and the bands with Rf value 0.63 and 0.68 were very light in density when compared to the variety Dharla.

Among the cultivars of *N. tabacum*, the bands with Rf value 0.49 and 0.52 were present in all the accessions and varieties. The variety Manasi and the breeding line CV J-1 showed similar banding pattern whereas varieties Chama and Chhotamani showed similar pattern. The band with Rf value 0.45 was present in the line CV J-1 and in the variety Manasi.

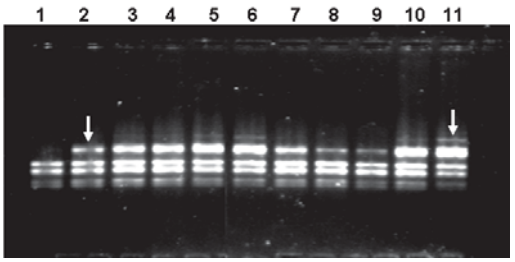
Isozymes of polyphenol oxidase showed a total of 7 bands in the varieties of *N. rustica* and 4 bands in the varieties of *N. tabacum*. The bands with Rf values 0.13, 0.26, 0.52 and 0.6 were present in all the varieties. The band with Rf value 0.05 was present in the varieties Cv RT Bulk, Tangua Manda and Manda. The band with Rf value 0.19 and 0.4 were present in all the varieties of *N. tabacum*. The band with Rf value 0.49 was present in the varieties Cv J-1, Podali and Chama whereas it was present in others with low density. The band with Rf value 0.57 present in the varieties Cv J-1, Podali and Chhotamani whereas it was present in low density in Chama and Manasi. The variety Cv J-1 showed similar banding pattern with that of its parent Podali whereas the banding pattern in Manasi was similar to that of its parent Chama except the band with Rf value 0.49, which was in very low density when compared to Chama.

Low level of genetic similarity was observed among the cultivars of *N. tabacum* when compared to the cultivars and the accessions of *N. rustica.* As the commercial varieties of both the species had narrow genetic base that demands immediate effort for diversification. The germplasm accessions can be screened for diversification and can be used in the future breeding program in broadening the genetic base of the varieties.

Development of molecular markers for *Fusarium* wilt

(K.Siva Raju and K. N. Subrahmanya)

DNA was isolated from the parents and breeding lines viz., Bhavya, DB 101, Speight G 33, F1-DB101 x Bhavya, F2-DB101 x Bhavya, BC-1-Bhavya2 x DB101, BC-2- Bhavya x DB1012, f3-DB101 x Bhavya, F3-DB101 x Bhavya, F1-Bhavya x speight G33, BC-2 Bhavya x Speight G33 generations and RAPD analysis was carried by 30 RAPD primers (Fig.13). Two primers gave a marker for *Fusarium* wilt resistance which will be confirmed in the ensuing season.



1.Bhavya, 2. DB101, 3. Speight G33, 4. F1, DB101 x Bh, 5. F2, DB101 x Bh, 6. BC2, Bh x DB101, 7. F3, DB101 x Bh, 8.F3, DB101 x bhS, 9.F1,Bh x SG33, 10. BC1, Bh x SG33 and 11.BC2, Bh x SG33

Fig.13: Developed RAPD marker for *Fusarium* wilt

Miscellaneous

Nineteen isolates of *Pseudomonas fluorescens* were isolated from the rhizosphere of banana and designated as Pfbr 1 to Pfbr 19. (*Pseudomonas fluorescens* from banana rhizosphere). All the 19 isolates of *Pseudomonas* were found to be fluorescent. Some of the isolates were able to produce HCN, siderophores and solubilized the tricalcium phosphates which helps in the plant growth promotion. Ten selected isolates were able to control polyphagus fungal plant pathogens like *Phytophthora*, *Fusarium* and *Rhizoctonia* whereas unable to control *Sclerotium rolfsii.* The biocontrol efficacy of these isolates will be tested *in vivo* in pot culture and the promising isolates will be tested in the fields.

The genetic similarity among the selected 10 isolates varied between 0.43 and 0.78. Unweighted pair group method on arithmetic averages (UPGMA) method of clustering analysis, the 9 isolates were separated into two main clusters and isolate Pfbr 1 was independently linked to the main cluster. The cluster 1 consists of 7 isolates which are grouped into two sub clusters. Subcluster 1 was formed by the isolates Pfbr 2, 9, 4, 6 and 8 whereas the second subcluster is formed by Pfbr 3 and 5, which were low siderophore producing isolates. The second cluster is formed by isolates Pfbr 7 and Pfbr 10 which were low HCN and low P solubizers respectively. Thus, high and low P soluble isolates separated from one another. Some more primers will be used to develop specific markers to the selected isolates for maintaining the biocontrol agents.

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, S. Kasturi Krishna, V. Krishnamurthy and J.A.V. Prasad Rao)

Application of farm yard manure @ 7.5 tonnes/ha exhibited its significant superiority in production of cured leaf, bright leaf and grade index over no farm yard manure. Among the inorganic fertilizers, application of nitrogen @ 22.4 kg/ha recorded significantly higher yields of cured leaf, bright leaf and grade index with an increased yield of 27, 24 and 27%, respectively over no nitrogen. Application of potash recorded significantly higher leaf yields of all kinds over no potash during the year under report. The interaction of organic (FYM) and inorganic nitrogen was significant in production of cured leaf. Application of FYM @ 7.5 tonnes/ha in combination with 22.4 kg N/ha recorded significantly higher yield over FYM alone and absolute control (No FYM and no nitrogen).

Permanent manurial trial

(J.A.V. Prasad Rao)

Tobacco leaf lamina samples of 2004-05 season were analysed for N, P, K, reducing sugars, nicotine, total ash and insoluble residue. Leaf burn was also determined. Composite samples (stalk, root, midrib and inflorescence) were analysed for N, P & K and their uptake was computed. Soil samples of the 2004-05 crop season (0-22.5 and 22.5-45.0 cm) were analysed for pH, EC, organic carbon, available P, available K and chlorides.

Application of FYM increased the leaf nitrogen, nicotine and total ash and decreased the reducing sugars in the leaf as compared to no FYM application. As regards the inorganic sources of major nutrients, no clear-cut differences were noticed in the leaf chemical composition in the leaf in this season. FYM application increased the uptake of all the major nutrients over no FYM application. Among the inorganic sources, N-application showed a profound effect on the uptake of major nutrients and thus, the treatments containing N increased the uptake of all the three major nutrients when compared to the control and all the other combinations without N in both No FYM and FYM treated plots. Application of FYM resulted in an increase in the organic carbon and available phosphorus in the soil.

Influence of plant population densities, 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)

Closer spacing of 0.7 x 0.5m, (28,571 plants/ha) exhibited its significant superiority over wider spacing of 0.7 x 0.7 m with an increased yield of 24.9, 36.7 and 36% in cured leaf, bright leaf and grade index, respectively. No statistical variation was observed in any of the yield characters viz., cured leaf, bright leaf and grade index due to various levels of nitrogen. However, 45 kg N/ha recorded 10% increase in yield over the lower level of 100 kg N/ha (2,202 kg /ha). Topping the crop at bud elongation stage did not show any statistical variation when compared to no topping in production of FVC tobacco in all the leaf yield characters. However, marginal increase in cured leaf yield and grade index were recorded in the topped crop.

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Influence of plant population densities, 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)

Among the plant spacings, closer spacing of 0.7 x 0.5m(28,571 plants / ha) recorded significantly higher yield over the wider row spacing of 0.7 x 0.7 m with an increased yield of 29, 46 and 27.6% in cured leaf, bright leaf and grade index respectively. Application of nitrogen @ 45 kg/ha recorded significantly higher cured leaf and bright leaf yield over the other levels of 30 and 60 kg N/ha. Topping did not show any statistical variation in production of FCV tobacco.

Effect of foliar nutrition of boron on quality leaf production in FCV tobacco under Vertisol conditions

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

Vermicompost application @ 2.5 tones alone or with boron foliar application @ 0.1% or 0.2% significantly recorded higher cured leaf over FYM or control with or without boron application. Though the leaf K concentration did not vary much, K recovery from lamina showed increased values both under FYM and vermicompost application along with boron foliar nutrition compared to no FYM application alone or with boron foliar application (Table 11).

Micronutrient distribution in different types of Indian tobaccos

(J.A.V. Prasad Rao)

FCV tobacco leaf lamina samples collected priming-wise (8 primings) from Devarapalli, Koyyalagudem, Jangareddygudem-I and Jangareddygudem-II platforms of the NLS area were analysed for iron, manganese, zinc and copper. Soil samples were also collected from NLS area and analysed for the available Fe, Mn, Zn and Cu contents (DTPA-TEA extractable).

Of the four micronutrients in the leaf, iron and manganese are in the range of sufficiency. Zinc is also in the range of sufficiency in majority of the locations, but is found to be in the border-line in a few locations. However, the leaf copper content is found to be low as compared to the earlier studies. Nevertheless, no symptoms of deficiency of this micronutrient were noticed on the field crop. This lower copper level is suggestive of further studies on this micronutrient.

Table 11: Effect of boron spray and organic manures on K uptake by whole leaf

Sl. No.	Treatments	Cured leaf	K (%)	K content in midrib (kg/ha)
1.	No FYM	1888	2.42	45.68
2.	No FYM + 0.1 % B	1886	2.47	46.68
3.	No FYM + 0.2 % B	1939	2.49	48.28
4.	2.5t FYM alone	2024	2.27	45.95
5.	2.5 t FYM + 0.1%B	2154	2.79	60.10
6.	2.5 t FYM + 0.2% B	2245	2.37	53.21
7.	2.5t VC	2341	2.50	58.53
8.	2.5t VC + 0.1 % B	2409	2.67	64.32
9.	2.5t VC + 0.2 % B	2466	2.38	59.69

FYM - Farm yard manure; VC - Vermicompost; B - Boron

As regards the soil available micronutrients, all these micronutrients are present in the range of sufficiency, except zinc in some locations. However, the crop has not manifested any symptoms of deficiency warranting a deep probe to fix up the critical levels of Zn and Cu for the cv. Kanchan.

Studies on deficiency and toxicity of plant nutrients in flue-cured tobacco

(M. Anuradha and K. Nageswara Rao)

In the present study, the deficiency and toxicity symptoms of essential plant nutrients were developed under controlled conditions using Hoagland solution in flue-cured tobacco variety Kanchan and a bulletin was published. The deficiency and toxicity of nutrients caused reduction in plant growth accompanied by typical abnormalities.

Deficiency/ Toxicity of nutrients	Symptoms
Deficiency	
Nitrogen	Yellowing of the lower leaves followed by drying up and burning of the leaves
Phosphorus	Dark green leaves and leaves form an acute angle with the stalk
Potassium	Leaves become cup shaped from the underside and lower leaves show typical mottling and chlorosis at tips and margins
Calcium	Tips of the younger leaves show peculiar hooking downwards
Magnesium	Lower leaves of the plants become chlorotic between the veins
Sulphur	Light green colour of the plant as a whole
Iron	Interveinal chlorosis of young leaves
Zinc	Decrease in inter nodal length and formation of white spots on the lower leaves
Manganese	Chlorosis between the veins, resulting in a checkered appearance of the leaf
Copper	Stunted growth, distortion and bleaching of leaves leading to cell death and necrosis
Boron	Death of growing tips followed by growth of lateral shoots; Deformation and death of tips of laterals
Molybdenum	Yellowing and curling of the leaves
Toxicity	
Nitrogen	Dark green leaves resulting in mid-day wilting of the plants because of larger transpiring area and lower root volume for absorption of water
Iron	Bronzing of leaves
Zinc	Inhibition of root elongation and chlorosis of young leaves
Manganese	Black spots on the leaves
Copper	Exhibition of iron chlorosis
Boron	Yellowing of leaf tip followed by progressive necrosis and premature dropping of leaves
Molybdenum	Plants turning to golden orange in colour
Chloride	Thick and brittle leaves with cupped margins

No visual toxicity symptoms appeared at higher concentrations of P, K, Ca, Mg, S and Zn. The specific nutrient concentrations in plants fed with excess levels of P, K, Ca, Mg, and S were, 0.81, 4.47, 2.44, 2.08 and 0.97%, respectively.

The plants showing deficiency and toxicity symptoms of specific nutrients showed very low and high concentration of that nutrient, respectively. The deficient and excess levels of nutrients affected the concentration of other nutrients also.

Deficiency and toxicity of nutrients on the concentration of other nutrients

- Nitrogen content increased due to P, K, Mg, S, Fe and B deficiency
- P deficiency increased Zn content. Fe and Mo deficiency reduced Cu content
- Excess N and Cl reduced K content and excess N and K reduced Mg content in the leaf
- Excess levels of N, K, Ca, Mg and S reduced P content and excess P reduced Zn content
- Excess Fe, B and Cl levels increased the concentration of leaf nitrogen
- Excess levels of Zn, Mn, Cu and Mo reduced P content
- Zinc content decreased due to excess levels of Mn, Cu and Mo
- Excess levels of Zn and Mo reduced the leaf K content

Deficient and excess levels of nutrients affected the total soluble protein content and activity of some of the enzymes.

Deficiency and toxicity of nutrients on the biochemistry of plant

- Soluble protein content was less in N, K, Ca, Mg, S, Fe and B deficient leaves and in the plants fed with excess levels of Fe and Cl
- Excess levels of S and Mo resulted in higher soluble protein content
- Deficiency and toxicity of nutrients affected the activity of enzymes: peroxidase and polyphenol oxidase, acid phosphatase and phenylalanine ammonialyase
- Peroxidase activity increased due to deficiency of N, K, Mg, S, B and excess levels of B, Cu, Mo, Fe, Cl. Excess of Cu, Zn, Mn and deficiency of Ca and Fe reduced its activity
- N, S, Mn and B deficiency and excess S, Mo and Cl reduced the activity of polyphenol oxidase
- Acid phosphatase activity decreased under N, P, Ca, Mg, S, B deficiency and excess of K, Fe whereas excess of Zn, B and Mo increased its activity
- Mn deficiency and excess of Cl reduced the activity of phenylalanine ammonialyase

The development of protein indicators was tried by inducing the deficiency symptoms of major nutrients in young tobacco seedlings. Variations were found in number and intensity of bands. But the differences were not so conspicuous to develop indicators for nutrient deficiencies.

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

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

A pot culture experiment was 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. Harvested leaf was cured in an electric barn and yield was recorded. Cured leaf samples were analysed for quality parameters. Results showed total leaf area, specific leaf weight, cured leaf yield and grade index were 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.

Studies on factors influencing false ripening in flue-cured tobacco

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

Pot culture experiments were conducted with three levels of nitrogen (50% recommended dose (RD), 100% RD and 150% RD) by inducing water stress and water-logged conditions in light soil and black soil using varieties Kanchan and Hema, respectively. False ripening was observed under both water stress and water-logged conditions (Fig. 14 and 15). Some pots were allowed to recover from water stress and water logging. The green leaf samples were analyzed for photosynthetic pigments, total soluble protein content and the activity of enzymes namely polyphenol oxidase, peroxidase and super oxide dismutase. Then the plants were allowed to grow. The leaves were cured in an electric barn and the samples were analysed for nicotine, reducing sugars, chlorides, nitrogen and potassium.

Fig.14: False ripening symptoms

Fig.15: Effect of water logging on root system

The results showed that total chlorophylls, total carotenoids and xanthophylls were reduced due to water stress and water logging. The reduction is more due to water stress than water-logging in light soils. Super oxide dismutase activity is more under water stress and water logging conditions and on recovery it was reduced. Increased cured leaf nicotine content and decreased reducing sugar content were observed with increase in applied nitrogen under water stress and water logging conditions. Reduction in nicotine concentration and increase in reducing sugars were observed due to water-logged than due to water stress situation. Less nitrogen and more potassium content were observed due to water logging compared to water stress.

Quality evaluation laboratory

During the period under report, 6,855 tobacco leaf lamina samples pertaining to different 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 N (Tables 12 and 13).

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

(D.V. Subhashini and C.Chandra-sekhara Rao)

Dynamics of plant growth promoting rhizobacteria in SLS

Soil samples were collected from the rhizosphere of FCV tobacco varieties viz., Hema, VT 1158, Kanthi and N 98 grown at CTRI RS, Kandukur during the

Table 12: Chemical quality parameters in FCV tobacco

(Crop season: 2005-06)

Soil type	Varieties	Nicotine (%)	Reducing Sugars (%)	Chlorides (%)
NBS	Hema	1.84-2.73	12.11 – 15.22	1.04-1.31
	VT – 1158	2.10-2.58	12.53-14.86	1.21-1.33
CBS	Hema	2.58-3.30	11.54-14.53	0.14-0.21
	VT – 1158	3.15-3.45	9.69-12.38	0.16-0.21
NLS	NLS-4	2.37-2.69	11.49-13.61	0.75-0.86
SLS	Hema	2.11	10.76	1.28
	VT – 1158	2.15	10.32	0.89
KLS	Bhavya	1.29-1.43	20.37-21.97	0.25-0.31
	Rathna	0.52-0.91	22.75-27.67	0.26-0.32
	NLS-4	0.87-1.05	23.55-24.05	0.31-0.33
	Thrupti	1.68-1.73	14.86-18.68	0.26-0.28

Table 13: Chemical quality parameters in non-FCV tobacco

(Crop season: 2005-06)

Centre	Varieties	Nicotine (%)	Reducing Sugars (%)	Chlorides (%)
Jeddangi	Banket A1	0.91-2.01	0.88-2.10	0.07-0.36
(Burley)	Burley 21	0.37-1.39	1.00-2.02	0.06-0.21
Berhampur (Pikka)	Pyruvittanam	3.89-4.89	2.92-7.30	0.43-0.98
Araul	A-119	1.51-2.42	2.87-3.61	0.42-0.84
(Bidi)	GT-5	2.05-2.89	1.04-1.29	0.50-0.80
Araul	ST-1	0.33	0.21	0.33
(*Rustica*)	SK-417	0.61	0.21	0.34
Anand	A-119	5.90	2.57	1.63
(Bidi)	GT -5	7.10	2.33	1.45
Anand	GC-1	3.04	1.62	2.67
(*Rustica*)	GCT-3	4.20	1.20	2.56
Ladol	GC-1	6.59	2.10	1.11
(*Rustica*)	GCT-3	4.84	1.90	0.89

grand growth period of the crop and were analysed for bacterial population and also biochemical tests (Table 14). The major groups of bacteria identified in rhizosphere were *Azospirillum, Pseudomonas*, *Azotobacter*, *Rhizobium*. *Pseudomonas* population was found to be more in Kanthi and less in VT 1158. Isolated rhizobacteria showed variation depending on the genotype. Nitrogen fixing microorganisms were more in Hema followed by VT 1158.

Potential of *Streptomyces* spp. isolated from TBS as a nematicide

Streptomyces strain was isolated from the rhizosphere of tobacco crop where FYM was applied continuously in permanent manurial trial of TBS to

Table 14: Morphological characters and biochemical parameters

Bacteria	Morphological characters	Biochemical tests
Pseudomonas	Moderate growth, chromogenic pigmentation, opaque optical character, beaded and irregular colony, yellow to creamy pigmentation, pin point and small in size, circular in form and convex in elevation	Amylase negative, catalase, gelatinase and urease positive
Azotobacter	Slight abundance of growth, non- chromogenic pigmentation, transparent optical character, small beaded form of colony, circular and filamentous margin with flat elevation	Catalase positive, amylase, gelatinase and urease negative
Azospirillum	Moderate growth, non-chromogenic pigmentation, transparent optical character,beaded and effuse, echinulate and rhizoid form of colony, small size circular colony with convex elevation	Amylase negative, catalase, gelatinase and urease positive
Rhizobium	Moderate to large growth, non-chromogenic pigmentation, translucent optical character, beaded and effuse form of colony with flat and umbonate elevation	Catalase, gelatinase, amylase and urease positive

study the effect of *Streptomyces* as a nematicide. *Streptomyces* isolates were inoculated at 0.25, 0.5, 1.0 and 2.0 ml concentrations onto water agar plates containing 100 *Meloidogyne javanica* eggs. It was observed that *Streptomyces* at 0.5 ml concentration showed 50% mortality whereas treatment with 1.0 ml and 2.0 ml concentration of *Streptomyces* showed 100% mortality and exhibited nematicidal effect. The *Streptomyces* effect was observed to be more with the advancement of time, as evidenced by higher mortality of nematode larvae.

Fluorescent Pseudomonads in tobacco disease management

(D.V. Subhashini)

An experiment was conducted at CTRI, main building complex to study the effect of *Pseudomonas fluorescens* in controlling damping off disease caused by *Pythium aphanidermatum* in tobacco nurseries during 2005-06. The experiment was conducted with a randomized block design with three replications on m^2 beds. The treatments were Talc based formulation of *Pseudomonas fluorescens* powder @ 1 kg, 2 kg, 3 kg per 3kg each of the tobacco seed, *Pseudomonas fluorescens* spray @ 1%, 2 % and 3%, Bordeaux mixture spray 0.5%, phytolan spray 0.3% and control (untreated check). *Pseudomonas fluorescens* talc based formulation @ 2 kg / 3 kg tobacco seed produced maximum number of healthy seedlings and dry matter production and minimum number of *Pythium* effected seedlings showing promise in damping off management in tobacco nurseries.

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)

There was a progressive and significant increase in green leaf yield (GLY) with increased N: K ratio up to

1.0:2.0. Progressive and significant increase in cured leaf yield (CLY) and grade index (GI) was noticed up to N: K ratio of 1.0:1.5. Though there was an increase in CLY and GI from 1.0:1.5 to 1.0:2.0, both were on par. 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. Interaction effects between level and time of potassium application were not significant with regard to green leaf, cured leaf and grade index.

The data on the effect of N:K ratios and No. of splits of potassium application on the quality characters and leaf potassium content during 2003-04 did not show significant effect on any of the characters except potassium content in L-position, where 1.0:0.5 ratio showed significantly less potassium than the other ratios. Application of potassium in three splits showed significantly higher nitrogen in P-position and higher potassium in L and T positions than potassium application in two splits, while other characters were not significantly different between the two treatments.

The data on the effect of N:K ratios and number of splits of potassium application on the quality characters and leaf potassium content during 2004-05 did not show significant effect on any of the characters except potassium content in L-position, where 1.0:0.5 ratio being on par with 1.0:1.0 ratio showed significantly less potassium than the other ratios. Application of potassium in three splits showed significantly higher nitrogen in X-position than potassium application in two splits and in P-position higher potassium was observed in two splits than in three splits, while other characters were not significantly different between the two treatments. It can be concluded that N:K ratios or No. of splits of potassium application did not show much influence on quality characters or potassium content of the leaf. Application of N& K in the ratio of 1.0:1.5 i.e. application of K_2O @ 172.5 kg/ha in three splits in 1:2:1 ratio (along with 115 kg N and 60 kg P_2O_5/ha) being on par with N: K ratio of 1.0: 2.0 recorded significantly higher CLY and GI as compared to N: K ratio of 1.0:0.5 and 1.0:1.0

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)

Two foliar sprays of 0.5% Zn SO_4 + 0.5% Mg SO_4 at 35 and 45 days after planting being on par with 0.5% Mg SO_4 sprays recorded significantly higher GLY compared to water spray and 0.5% Zn SO_4 spray. There were no significant differences between the treatments with regard to cured leaf. Two foliar sprays of 0.5% Zn SO_4 + 0.5% Mg SO_4 at 35 and 45 days after planting being on par with 0.5% Zn SO_4 sprays recorded significantly higher GI compared to water spray and 0.5% Mg SO_4 spray. Topping at 24 and 28 leaves both being on a par recorded significantly higher GLY, CLY and GI compared to topping at 20 and 16 leaves. Interaction effects between foliar spray and topping level were not significant with regard to green leaf, cured leaf and grade index. Thus, two foliar sprays 0.5% ZnSO4 + 0.5% MgSO4 at 35 and 45 days after planting and topping at 24 or 28 leaves recorded higher GLY, CLY and GI.

Effect of quantity and ratios of N and K fertilizers on leaf yields and quality of FCV tobacco (var. Kanchan) in irrigated Alfisols

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

During 2004-05 season the trial was conducted in a sandy loam soil of

old farm. Since, the experimental differences were not significant with the N levels and K levels during 2004-05, it was suggested in the SRC to repeat the experiment and to analyze the leaf K in 2004-2005 leaf samples. Leaf K concentration decreased from P position to T-position. However, none of the combinations could improve leaf K significantly in any position. The N: K ratio 1:1.5 (100 N: 150 K_2O) recorded the highest cured leaf of 2, 972 kg/ha and the K concentration content in the leaf in all the four positions is comparatively higher (P=3.92%, X=3.33%, L=2.30%, T=2.06%). Though yield was slightly less (2, 760 kg/ha) by 7%, under NK ratio 1:2, the leaf K concentration was high in all position P = 4.02%, X = 3.57%, L =2.37%, T=2.27%.

During 2005 – 06, the experiment was laid out in a sandy clay loam soil. The results indicated that maximum cured leaf of 1, 983 kg/ha was recorded at 100 kg N + 100 kg K_2O (1:1 ratio) closely followed by 75 kg N + 100 kg K_2O (1946 kg) and 120 kg N + 60 kg K_2O (1, 919 kg). Maximum grade point was recorded at 75 kg N + 100 kg K_2O (0.75:1.00) per hectare.

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

(M. Sannibabu and K. Siva Raju)

At CTRI RS Jeelugumilli, trials were 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 a saving of 20 hours curing time and a fuel saving of 400 kg per curing (Table 15). Even though, the treatment Turbofan in combination with oxygen gave highest saving of fuel (450 kg per curing) and 21 hours reduction in the curing time, it is not preferred as it is cumbersome and involves high cost. In the year 2005, the Turbofan was tested at CTRI RS, Hunsur and the results of four curings revealed that a saving of 25 hours in time and 500 kg in fuel could be achieved with a cured leaf recovery of 15% as against 12 % in control (Table 16).

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. Farmers reported that the power cut during curing period hampered the Turbofan operation and requested to design some mechanical rotating system.

In respect of biochemical constituents, starch, chlorogenic acid and rutin were less in the Turbofan barn over the control barn whereas the ether soluble extracts (ESE), free amino acids (FAA) and proline were higher in the turbofan barn over the control barn (Table 17).

It is concluded from the experiments at Jeelugumilli, Hunsur and on-farm trials at NLS area that the Turbofan fixing at the top of the barn as a ventilator and operating during curing saves 400-500 kg fuel and 20 hours curing time per charge.

Evaluation of drip irrigation system for time and quantum of irrigation under NLS grown tobacco

(M. Sannibabu and P. Srinivas)

As per the evapo-transpiration (ETo), the Kc and Pc values and growth phase the quantum of irrigation was fixed. For the first 40 days all the treatments were given furrow irrigations. After formation of the ridges the treatments were imposed. The quantum of irrigation was almost same in drip and alternate skip furrow irrigation (Table 18). The yield data revealed that in drip, the yields were

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Table 15: Coal and time saving under Turbofan against traditional method of curing - NLS Farm, Jeelugumilli

(Season 2004-05 and 2005-06)

Curing treatment	Season	Yellowing (hrs)	Color fixing (hrs)	Leaf drying (hrs)	Midrib drying (hrs)	Total (hrs)	Coal consumed (kg)
Turbofan	2004 - 05	56	7	34	23	121	1300
	2005 - 06	48	7	38	29	122	1400
Average		52	7	36	26	121	1350
Control	2004 - 05	57	7	48	31	143	1760
	2005 - 06	50	7	54	26	137	1800
Average		54	7	51	29	140	1780
Saving		2	--	15	3	20	430

Table 16: Studies on curing with Turbofan 2005 – CTRI RS, Hunsur, Karnataka

Treatments	Green leaf (kg)	Cured leaf (kg)	Cured leaf recovery (%)	Coal used (kg)	Curing time (hr)	Coal use-efficiency (kg/kg cured leaf)
Turbofan						
19-8-05	1965	284	14	0944	110	3.32
26-8-05	2359	446	19	1350	127	3.03
5-9-05	1898	267	14	1050	115	3.93
15-9-05	1931	265	14	1250	116	4.72
Average	2038	315	15	1149	117	3.65
Control						
2-8-05	3653	391	11	1600	139	4.09
11-8-05	3288	424	13	1700	149	4.00
Average	3470	407	12	1650	142	4.05
Saving				501	25	

Table 17: Effect of Turbofan barn on biochemical constituents of cured leaf in NLS

(2005-06)

Time of curing	Modified barn			Control barn		
	ESE (%)	FAA (mg/g)	Proline (mg/g)	ESE (%)	FAA (mg/g)	Proline (mg/g)
At loading	8.98	3.26	0.42	9.02	3.46	0.46
24 hrs	8.94	6.68	2.12	9.24	4.88	1.96
48h	10.26	6.24	2.06	10.54	6.02	2.11
End of curing	11.24	6.48	1.98	10.88	6.08	1.88

ESE: Ether soluble extracts; FAA: Free amino acids

Table 18: The quantum of irrigation water applied to different treatments at various stages of plant growth in NLS (2005-06)

Treatments	Initial phase	Active phase	Post active	Senescence 1	Senescence 2	Total quantum
Drip	36.25	24.75	93	72.5	110	336.50
Alternate Skip Furrow	36.25	51.5	75	75	112.5	350.25
All furrow	36.25	100	150	100	150	536.25

more due to irrigation efficiency and mere balance of soil moisture and soil aeration. Due to drip system, nearly 200 ha mm of irrigation water can be economized apart from higher leaf yield and quality.

The pooled data of 2003-04, 2004-05 and 2005-06 seasons revealed that 11,156 kg/ha green leaf, 1,713 kg/ha cured leaf and 1,173 kg grade index, consuming 330 ha mm of water giving a water-use-efficiency of 4. 63 kg/ha mm of water and an additional income of Rs.7, 500/- was obtained with drip irrigation as compared to normal furrow irrigation.

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

(M. Sannibabu, K. Deo Singh and K. Siva Raju)

An innovative technique was developed for the estimation of aroma through the anemometric method. Carbonyls were estimated instantaneously without destructing the leaf sample and well correlated with the values obtained in the destructive method of estimation. In the anemometric technique, 0.5 kg leaf sample was kept in a leaf chamber of 80 x 20 x 20 cm and 1 cum air was passed for 15 minutes and the air curing carrying aromatic carbonyls was dissolved in 25 ml of ethanol and then carbonyls were estimated.

Efficacy of different micro-irrigation nozzles in wetting tobacco with appropriate soil aeration techniques

(M. Sannibabu)

In the nursery season of 2005-06, an experiment was laid out in the CTRI nursery site in RBD. The mini sprinklers tested were Half Jet, Full Jet and Mini sprinklers against rose-can watering. Irrigations were given as per the treatments whenever needed. The micro jet emissions were adjusted to 1.5 lit/hour/ the time adjusted as per the pressure in the water head.

A totally new innovation using micro-irrigation in the tobacco nurseries gave a good indication of raising nursery and getting healthy seedlings with a saving of irrigation water by 50% and labor by 80%. The slow and micro-spray of water for 30-40 minutes creates a very congenial micro-climate. In the traditional system the water drawn from dug out pits supply inoculums of soil born diseases and this can be avoided in this system.

Leaf potassium management for achieving desirable smoke characteristics in FCV tobacco

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

Leaf samples collected from the field trials conducted during the 2004 – 05 crop season on the effect of different levels of potash applied through soil and foliar application were chemically

analysed for nicotine, reducing sugars, chlorides, leaf K content and smoke constituents. Nicotine and reducing sugars estimated in X, L and T position did not show specific relationship with levels of potash applied though there was a trend of decrease in nicotine content with increased level of potash application. Smoke analysis of leaf samples collected from L position showed that with increased level of potash application leaf potassium content increased and no specific trend was found with reference to smoke constituents.

In another trial conducted with different levels of potash through soil and foliar application showed that with foliar application of potassium, leaf K content increased in low soil K applied treatment compared to control (120 kg/ha). No significant differences were observed due to soil and foliar application of K with respect to quality parameters.

Studies on sucker control in FCV tobacco variety Kanchan

(K. Nageswara Rao, M. Anuradha and C.Chandrasekhara Rao)

Cured leaf samples collected from the field trial conducted at CTRI farm Jeelugumilli to test different concentrations of Decanol in combination with three levels of nitrogen were analysed for quality constituents, nicotine, reducing sugars and chlorides at X, L and T positions and nitrogen content at L position. No significant difference was found among the treatments with respect to all quality parameters at all leaf positions.

Evaluation of phosphate rock as a phosphatic fertilizer for FCV tobacco in NLS

(C. Chandrasekhara Rao and P.R.S. Reddy)

Field experiments were conducted at CTRI RS, Jeelugumilli during 2004-05 season with eight treatments replicated four times in a randomized block design to study the effect of rockphosphate (34 % P_2O_5) on yield and quality of FCV tobacco in NLS. Pooled analysis of the two years (2003-05) chemical analysis data revealed that different rock phosphate treatments did not show any significant influence on chemical quality and nutrient composition compared to DAP. From the yield data and chemical analysis data it is evident that rockphosphate is at par with DAP and hence it can be used as a phosphatic fertilizer FCV tobacco in NLS. Moreover, the calcium content in rockphosphate is of added advantage to FCV tobacco in NLS.

Crop growth modeling for FCV tobacco in NLS

(C. Chandrasekhara Rao, M. Anuradha, K. Siva Raju, S. Kasturi Krishna and H. Ravi Sankar)

Field experiments were conducted at CTRI Research Station Jeelugumilli during 2005-06 season with three dates of planting (Early, Normal and Late) in New farm and two dates of planting (Normal and Late) in old farm. During the crop growth period, observations were taken on leaf length, breadth, plant height, root length, root volume and dry matter at different stages. From the basic data, crop growth rate (CGR), net assimilation rate (NAR), leaf area index (LAI) and specific leaf weight (SLW) were computed and correlations were worked out (Table 19). Leaf samples were also collected at different stages of harvest for analysis of biochemical parameters. Yield parameters viz., green leaf yield, cured leaf yield and Grade index were collected.

Results indicated that crop yields were high in normal planting followed by early planting and late planting in both the locations. In general, crop growth followed a sigmoid curve. Crop duration was 164 days in early planting,

Table 19: Correlations between crop growth indices and weather parameters

Parameters	CGR	NAR	LAI	SLW
Min.T	-0.403**	0.110	-0.440**	-0.590**
Max.T	-0.280*	-0.485**	0.587**	0.556**
RF	-0.309*	-0.082	-0.270*	-0.440**
Sunshine hrs	0.181	-0.307*	0.629**	0.764**
Evaporation	-0.054	-0.465**	0.682**	0.748**
RH Min.	-0.201	0.333**	-0.650**	-0.830**
RH Max.	-0.107	0.391**	-0.540**	-0.660**

* P = 0.05 ; ** P = 0.01

159 days in normal planting and 139 - 144 days in late planting. Crop growth rate (CGR) was normal up to 45 - 50 days thereafter there was a sudden increase in CGR, the trend continued up to 75 days. Crop growth rate was positive up to first two picks, thereafter declined. Net assimilation rate (NAR) showed a increasing trend up to 70 days. In normal planting, CGR and NAR spread over longer periods compared to early and late planting. Leaf area index (LAI) showed continuous increase up to 107 days thereafter showed a declining trend.

Feeler trial

Effect of zinc on colour retention in NLS tobacco

(P.R.S. Reddy and C.Chandrasekhara Rao)

A bulk trial was conducted during 2005-06 season at NLS Farm, CTRI RS, Jeelugumilli with the following three treatments: No zinc spray (Control - T1), Zinc foliar spray on 35th & 45th day after planting (T2), Zinc foliar spray on 60th & 70th day after planting (T3) and Zinc foliar spray in the form of zinc sulphate (Zn $SO_4.7H_2O$) at 0.5% concentration. Kanchan variety was raised in three bulk plots with 1970 plants in each plot. Surface soils of the experiment site were moderately acidic in reaction whereas subsurface soils were slightly acidic in reaction. Electrical conductivity and chlorides were low in both soil layers and within the safe limits for growing FCV tobacco. Organic carbon status was low in both soil layers and it ranged from 0.22 to 0.27%. Available P status was high in both soil layers and ranged from 26.2 to 44.2 mg/kg. Available K status was higher in the lower layer than in the surface layer. Available Zn status was more than the critical low level of 0.5 mg/kg in both the soil layers and ranged from 1.337 to 1.905 mg/kg in surface layer and from 0.571 to 0.752 mg/kg in sub-surface layer.

Yield parameters

Cured leaf yield ranged from 1614 to 1,715 kg/ha. Grade index varied from 1,222 to 1,293 kg/ha. Zinc foliar spray on 35th and 45th day after planting resulted in 4.83% increase in cured leaf yield and 1.93% increase in grade index over control. However, zinc foliar spray on 60th and 70th day after planting resulted in 1.34% decrease in cured leaf yield and 5.49% decrease in grade index over control. Percent grade index to total cured leaf yield was maximum at 76.85% in control plot. It was relatively lower in the zinc foliar spray plots and varied from 75.71 to 76.85%. As all the variations in yield parameters due to treatments are less than 6%, it can be concluded that the treatments did not vary widely in their influence on green leaf yield or cured leaf yield or grade index.

Leaf chemical quality parameters

Spraying zinc sulphate @ 0.5% on 35th and 45th day or on 60th and 70th day after planting did not show striking influence on the leaf chemical quality parameters namely nicotine, reducing sugars and chlorides except for a slight reduction in reducing sugars in zinc sprayed plots. Weighed mean concentration of nicotine, reducing sugars and chlorides in lamina ranged from 2.62 to 2.81%, 9.68 to 11.94 and 0.58 to 0.66%, respectively.

Leaf zinc concentration

Zinc concentration in leaf from all the plots was well above the deficiency level of 10 mg/kg. It decreased with increase in leaf position form bottom to top in all the three treatments. Zinc concentration in leaf lamina showed wide variation between the treatments. It varied from 21 to 53 mg/kg with a weighed mean value of 35 mg/kg in control plot. It varied from 26 to 327 mg/kg with a weighed mean value of 78 mg/kg in the plot where zinc foliar spray was given on 35th and 45th days after planting whereas it varied from 84 to 387 mg/kg with a weighed mean value of 220 mg/kg in the plot where zinc foliar spray was given on 60th and 70th days after planting. Spraying zinc sulphate @ 0.5% on 35th and 45th day after planting increased zinc concentration in leaf in the first five picks representing 'P' and 'X ' position leaf whereas spraying zinc sulphate @ 0.5% on 60th and 70th day after planting increased zinc concentration in leaf in all the picks representing increased zinc concentration in all plant positions.

Zinc uptake by leaves in 'P' and 'X' positions (1 to 5 picks) was 51.4% of total zinc uptake in control plot whereas it was 56.31 to 66.62% in plots with foliar spray of zinc sulphate. The data clearly indicated that zinc foliar spray treatments did not show any significant influence on N, P and K concentration in leaf lamina. Further work on colour retention studies and smoke analysis is in progress.

CTRI Research Station, Guntur

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

(G. Raghupathi Rao, J.A.V. Prasad Rao and V. Krishnamurthy)

Application of FYM @ 7.5t/h in combination with the nitrogen @ 22 Kg/ha and potash @ 56 kg/ha showed significantly more cured and bright grade leaf yields respectively over the other treatments. Application of FYM @ 7.5 t/h in combination with the nitrogen @22 Kg/ha and potash @ 56 kg/ha showed significantly more cured and bright grade leaf yields respectively over the other treatments.

Developing suitable agronomic practices of FCV var: V-4064

(P. Harishu Kumar and G. Raghupati Rao)

Results of the second year trial indicated significant yield differences among the treatments for green, cured, bright and grade index. Closer spacing of 70 x 50 cm with @ 60 kg N/ha has enhanced green and cured leaf yields while 70 x 70 cm with @ 40 Kg N/ha has improved bright leaf yield and grade index.

Effect of organic manures and inorganics on leaf yields of Natu tobacco in permanent manurial trial

(G. Raghupathi Rao, Dr. J.A.V. Prasad Rao, and V. Krishnamurthy)

Higher cured leaf yield was recorded due to application of different organic manures. Application of FYM @ 15 t/ha followed by FYM @ 7.5 t/ha + neem cake to supply 30 kg N/ha improved the all the yield characters compared to no FYM.

Developing suitable agronomic practices for FCV tobacco grown in Southern Black Soils of Andhra Pradesh

(P. Harishu Kumar and G. Raghupathi Rao)

Irrigated conditions

Irrigation supplemented at 40 days after transplanting (DAT) has improved the yields of FCV tobacco. Among the various treatment combinations, spacing of 70 x 50 cm at 60 kg N/ha has enhanced green and cured leaf yields while 70 x 70 cm spacing with 40 kg N/ha has improved bright leaf yield and grade index.

Un-irrigated conditions

Similar trends were observed in the results under un-irrigated conditions. However, the yields recorded under irrigated conditions are 20% higher on an average compared to un-irrigated conditions in SBS.

Development of organically grown FCV tobacco in Vertisols of Andhra Pradesh

(P. Harishu Kumar and G. Raghupathi Rao)

Green manuring fields were under submerged conditions. The field was totally submerged with heavy rain water till the end of November and hence, the experiment was could not be conducted.

CTRI Research Station, Hunsur

Studies on FCV tobacco seedlings production in tray nursery

(M. Mahadevaswamy and M.M. Shenoi)

Tray nursery seedlings raised in coir pith medium or combination of Coir pith + FYM (1:1 and 2:1) medium were evaluated for their field performance along with conventional nursery and resetted seedlings for two crop seasons (2003-04 and 2004-05) (Figs. 16 and 17). The mean of two years data revealed that tray nursery seedlings resulted in minimum gaps (1-2%) in field compared to direct sown conventional nursery seedlings (7-8%). Because of better establishment and uniform crop growth, tray nursery seedlings resulted in 6.9 – 7.9% increase in cured leaf yield and 5.3 to 8.2% increase in Top Grade Equivalent under different media combination. The differences in yield were not statistically significant. The RKI ranged from 1.7 to 2.6 in different treatments and the values were highest in conventional nursery seedlings. The quality parameters of cured leaf did not vary significantly due to tray nursery seedlings.

Bulk trial and economics

The bulk trial on the field performances of tray nursery seedlings conducted during the crop season of 2005-06 indicated an increase of 6.2% increased in cured leaf yield and 7.6%

Fig.16: Tray seedlings in KLS

Fig.17: KLS crop raised from tray nursery

top grade equivalent (variety Kanchan). The cured leaf yield increased by 127 kg/ha due to use of tray nursery seedlings. The net monetary benefit to the growers worked out to be Rs.4, 640/- per ha with an ICBR of 2.78. However, as the trays lost for minimum three seasons, the additional cost per season works out to Rs.700 only, with an increased ICBR ratio of 10.34 (Table 20).

Evaluation of vermicompost for its efficacy in FCV tobacco production

(M. Mahadevaswamy)

Vermicompost as organic source was evaluated for its efficacy in field crop production during the second crop season of 2005-06. Application of vermicompost @ 4 & 6 t/ha along with recommended NPK increased the cured leaf yield by 5.4 and 6.0%, respectively as compared to recommended practice of FYM + NPK application schedule and by 14.5 and 15.2% compared to recommended NPK schedule alone. Similar trends were noticed in case of Top Grade Equivalent yield also though the yield differences were not significant between the various doses applied. Application of vermicompost @ 4 t/ha was optimum for the variety Kanchan for getting maximum yield of both cured leaf yield and top grade equivalent yield. The root-knot incidence was also significantly lowest in all the vermicompost applied treatments RKI (1.30 – 1.65) compared to NPK alone (2.80). The cured leaf quality was not affected by various treatments.

The results of the bulk trial on vermicompost conducted at Sollepura farm indicated that application of Vermicompost @ 2 t and 4 t/ha increased the cured leaf yield by 8.0 and 12.9%, respectively. Among the different methods of application, spot application of the entire dose at planting time gave maximum cured leaf and Top Grade Equivalent Yields followed by split application at planting + top dressing at 10 days after transplanting. In the on-farm trial conducted also, application at 2 t and 4 t /ha increased the cured leaf production by 16.8 and 20.0%, respectively and plant-hole application at planting time was found to be superior 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

Table 20: Yield and economics of tray nursery seedlings (Bulk evaluation)

(Crop season: 2006)

Treatments	Cured leaf yield (kg/ha)	Top Grade Equivalent (kg/ha)	Additional cost over check (Rs./ha)	Additional Returns (Rs./ha)	Incremental cost :benefit ratio (ICBR)
Conventional nursery seedlings	1718	1113	—	—	—
Tray nursery seedlings	1845	1248	2600* 700** (over 3 years)	7240*** 7240***	2.78 10.34

* Additional cost to be incurred on tray (During the first year of investment) Rs.5, 000–Rs.2, 400 = Rs.2, 600/-
Since the trays lost for minimum of 3 years, the cost of production of tray nursery seedlings for one year Rs.3, 100-

** Therefore, additional cost to be incurred on tray over 3 seasons Rs.3, 100-Rs.2, 400 = Rs.700/-

*** Additional returns @ Rs.57/kg for 127 kg cured leaf Rs.7, 240/-

inorganic fertilizers to find out optimum organic: inorganic ratio during the crop season of 2005-06 on sandy loam soil. Application of vermicompost was comparatively better than FYM or press mud in increasing the productivity. The integrated nutrient management practice involving 25% organic and 75% inorganic was found optimum compared to 50:50 or 75:25 ratios during the first year of the study. The cured leaf yield and Top grade equivalent were increased by about 7% and 10.6% respectively in 25:75 (organic: inorganic) ratio. However, the differences in yield parameters were statistically non-significant.

BTRC, Jeddangi

Studies on plant population densities, topping and nitrogen levels on yield and quality of burley tobacco cv. Swetha

(R. Subba Rao, K. Deo Singh, P. Harishu Kumar and C.V. Narasimha Rao)

Closer row spacings of 0.7 m and 0.8 m while not differing statistically between themselves proved significantly superior to wider row spacing of 0.9 m. Topping the crop at bud initiation stage recorded significantly higher yield, with an increased yield of 7 % over no topping. The yield difference was not significant due to various levels of nitrogen. Data pooled over years (2003-2004 to 2005-2006) showed the statistical variation due to spacings, toppings and nitrogen levels. Closer spacing of 0.7 x 0.5 m recorded significantly higher yields with an increased yield of 4.8 and 11.1 % over 0.8 x 0.5 m and 0.9 x 0.5 spacings, respectively. Topping the crop at bud initiation stage recorded significantly higher leaf yield with an increased yield of 5.6 % over no topping Among the levels of nitrogen, the higher level of 120 and 140 kg N/ha while not differing statistically, found to be better than the lower level of 100 kg N/ha.

Effect of magnesium application on leaf yield and quality of white burley tobacco (var. Banket A1)

(P. Harishu Kumar, R. Subba Rao, S. Kasturi Krishna and V. Krishnamurthy)

Application of magnesium @20 and 30 kg/ha recorded highest cured leaf of 3, 606 and 3, 607 kg/ha. The differences among soil and foliar application were not significant. The harvest index was maximum (0.43) at 20 kg Mg soil application and 2.0% foliar application.

Effect of Zinc application on leaf yield and quality of white burley tobacco (var. Banket A1)

(P. Harishu Kumar, R. Subba Rao, S. Kasturi Krishna and V. Krishnamurthy)

Differential levels of zinc application to soil and foliage did not show any significant effect on cured leaf over control. However, 0.4% $ZnSO_4$ foliar application twice at 35 and 45 DAP recorded maximum cured leaf of 4, 249 kg/ha, the percentage increase being 19.11. Zinc fertilization did not bring any significant changes in leaf nicotine, reducing sugar and chlorides.

Effect of boron application on leaf yield and quality of white burley tobacco (var. Banket A1)

(P. Harishu Kumar, R. Subba Rao, S. Kasturi Krishna and M. Anuradha)

Boron application did not bring any significant change in leaf yields compared to control. However, application of 10 kg boron recorded maximum cured leaf of 2, 968 kg/ha with harvest index of 0.38, the percentage increase being 9.2 over control (Table 21). Boron fertilization did not show any effect on the leaf chemical constituents viz. nicotine, reducing sugars and chlorides and all the parameters were within the acceptable limits.

Table 21: Boron concentration in FCV tobacco crop in Vertisols

Crop condition	Averages	Ranges
Healthy crop	26.00	23.3 – 29.2
Boron deficient crop	19.36	18.9 – 20.2
CMV infected crop	22.35	18.5 - 22.5
Intermediate crop	23.35	20.5 - 25.9

Sufficiency range: 34-96 ppm(Ref: Tandon, H. L. S., 1995. Micronutrient Research and Agricultural Production, FDCO, New Delhi)

Cucumber mosaic virus was seen associated with boron deficient plants in white burley tobacco. Samples were collected from healthy, boron deficient and CMV infected plants and B concentration was estimated. Healthy plants have a B content of 26 ppm, boron deficient plants have 19.31 ppm and diseased plants have 22.35 ppm.

Effect of tobacco stem compost application on leaf yield and quality of white burley tobacco (var. Banket A1)

(P. Harishu Kumar, R. Subba Rao and V. Krishnamurthy)

Five of the composts made out of tobacco stem were at par with FYM application on the burley tobacco cured leaf yield. However, compost A and C recorded maximum cured leaf of 3, 971 kg/ha each, being superior to FYM by 4.17%. Tobacco stem compost could be a good substitute to FYM for soil application. Various composts and FYM did not show any effect on the leaf chemical constituents viz. nicotine, reducing sugars and chlorides.

Carbon and nitrogen metabolism in burley tobacco during development and curing

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

It is inferred from the results of analysis that in Burley tobacco grown in the agency area of East Godavari, nitrate nitrogen decreased during the initial period of curing and increased at the end of curing but the content is less than the amount present at the time of harvest. Increased levels of spacing showed decreased levels of nitrate nitrogen and non-significant increase in starch and polyphenol contents. Increased levels of nitrogen decreased the starch content, whereas topping at bud initiation stage non-significantly increased the starch, polyphenols and nitrate nitrogen contents. Topping the crop at bud initiation stage increased the starch, polyphenols and nitrate nitrogen over no topping.

Salient findings

- Closer spacing showed significantly higher nitrate nitrogen with an increase of 13.95 to 25.38% over wider spacing·
- Topping the crop at bud initiation stage showed 7.26% higher nitrate nitrogen over no topping
- Variations in chlorogenic acid and rutin contents due to spacings and nitrogen levels were non-significant
- Topping the crop at bud initiation stage increased the chlorogenic acid content over no topping at harvest and at 25 days of curing
- Topping the crop also increased the rutin content over no topping
- Different levels of nitrogen showed non significant variation in chlorogenic acid and rutin content
- Topping the crop at bud initiation stage increased the starch content by 9.77% over no topping
- Starch content decreased by 11.78 to 26.62% in higher levels of nitrogen over the lower level

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 (15233.9 kg/ha), cured (2400.8 kg/ha) and first grade (1598.3 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 than the treatments PK, P and 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. FYM at 25 and 50 tonnes/ha alone could not impart beneficial effect unless combined with inorganic fertilizers. Application of phosphorus and potassium alone or in combination with each other gave minimum first grade leaf yield as compared to application of nitrogen alone or in combination of phosphorus and potassium. The highest benefit :cost ratio (1.77) was recorded in 112 kg N + 112 kg P_2O_5 + 112 kg K_2O/ha followed by 112 kg N (1.56), 112 kg N/ha + 112 kg P_2O_5 (1.55) and 112 kg N + 112 kg K_2O/ha (1.39).

Application of phosphorus either in combinations of inorganic fertilizer or alone and FYM significantly increased the P content in the leaves of *Motihari* tobacco as compared to other sources of fertilizers. Significantly higher 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. However, reducing sugar content was less when nitrogen was applied either in combinations or alone with other fertilizers. P, K and nicotine content was minimum, while reducing sugar content was more in control. Incidence of viral diseases (CMV & TMV), *Fusarium* wilt & brown spot has been recorded in varied proportions. CMV, *Fusarium* wilt and brown spot were recorded in all the treatments.

Effect of nitrogen and potassium levels on yield and quality of *Jati* tobacco variety Manasi

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

The influence of different levels of nitrogen and potassium on the newly released *Jati* tobacco variety 'Manasi' was studied. Data on yield, quality, economics, nutrients composition of leaves and available nutrients status in the soil after harvest of the crop were recorded.

Based on the results, it is concluded that application of 150 kg N/ha along with 50 kg K_2O/ha is more profitable, it increased nutrients composition in the leaves and also helped in building up available nutrients status in the soil.

Studies on spacing and topping requirement in *Jati* tobacco variety Manasi

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

In this experiment, data on green, cured and quality leaf yield, economics, nutrients compositions of leaves and available nutrients status in the soil of *Jati* tobacco as influenced by spacing and topping levels have been generated.

It is concluded from the results that narrow spacing i.e. 75 x 75 cm and topping at 12 – 14 leaf produced more cured leaf yield and fetched highest net monetary return of *Jati* tobacco.

Studies on sources, levels and time of nitrogen application of *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,

levels and time of nitrogen application on green, cured and first grade leaf yield, economics, nutrients composition of leaves and nutrient status in the soil of *Jati* tobacco variety Manasi.

It is concluded from the results that basal application of 125 kg N/ha applied in the form of calcium ammonium nitrate is beneficial for producing highest productivity, quality and fetched highest 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 effect of different sources of organic manures and nitrogen levels on green, cured leaf yield, quality, economics, nutrient composition of leaves and status of nutrients in the soil of *Jati* tobacco variety Manasi was studied.

On the basis of the results it is concluded that application of green manuring with dhaincha and FYM @ 10 t/ha along with 100 kg N/ha led to increased productivity and better quality and higher status of nutrients 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, and S. Amarnath)

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 nitrogen requirement for advanced breeding lines of tobacco under Vedasandur conditions

(M. Kumaresan, V. Krishnamurthy and K. Palanichamy)

Two genotypes, HV 94-19 and HV 94-21 with the check Meenakshi and were tested at two spacings (75 x 75 and 90 x 75 cm) and two N levels (75 and 100 kg N/ha) in a split plot design and three replications. Based on the pooled data it is inferred that the leaf length, whole/total leaf yield were significantly influenced by genotypes and spacing. Leaf length was higher with HV94-19 and 75x75 cm spacing. The highest whole leaf yield (2,778 kg/ha) and total leaf yield (3,436 kg/ha) was recorded with the genotype HV94-19 and 75x75 spacing. The leaf width did not vary statistically and nitrogen levels did not influence the yield. However, 75 kg N/ha was sufficient for getting optimum yield. Thus, a spacing of 75 x 75 cm and nitrogen dose of 75 kg/ha are required for producing higher yields of the genotype HV94-19.

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

(M. Kumaresan and K. Palanichamy)

Two genotypes, HV96-3 and HV 96-4 were evaluated with the check VR2 under two spacings (90 x 90 cm and 100 x 100 cm) and two N levels (150 and 200 kg/ha) in a split plot design. Based on the pooled results it is observed that the genotype HV96-3 recorded the highest yield of 2,939 kg/ha followed by HV 96-4. A spacing of

1m x 1m increased the yield (2,879 kg/ha) over 90x90 cm spacing. Nitrogen at 150 kg/ha recorded higher yield over 200 kg N / ha. The genotype x spacing interaction was significant. HV 96-3 at a spacing of 90 x 90 cm increased the yield (3,122 kg/ha). The genotype x spacing x nitrogen interaction was non-significant. However, the genotype HV 96-3 at 90 x 90 cm spacing under 150 kg N /ha recorded a higher yield.

Spacing and Nitrogen requirement for advanced breeding lines chewing tobacco under Vedasandur conditions

(M. Kumaresan and K. Palanichamy)

Two genotypes Viz. HV 98-16 and HV 98-17 were tested against the check variety Abirami under two spacings (75x 75 cm and 90 x 90 cm) and two N levels (75 and 100 kg N/ha) in a split plot design. The whole leaf yield (3,199 kg/ha) was higher with the genotype HV 98-16 under 75 x 75 cm spacing followed by HV 98-17 under 75 x 75 spacing (3,111 kg/ha). The total leaf yield (4,784 kg/ha) was also higher in the genotype HV 98-16 under 75 x 75 cm spacing. The nitrogen levels did not influence the length/width or yield and 75 kg N/ha was found to be optimum for obtaining maximum yields.

Phosphorus management in chewing tobacco under Vedasandur conditions

(M. Kumaresan, P. Harishu Kumar and C. Chandrasekhara Rao)

Different levels of phosphorus ('P') in combination with phosphorous solublizing bacteria (PSB) and No 'P' were tested in chewing tobacco. First year of the results revealed that there were no significant differences between the treatments with respect to leaf length/width and cured leaf yields. However, there was an increase in whole leaf yield at 75% of the recommended 'P' in conjunction with PSB. The yield recorded was 2,850 kg/ha. The total leaf yield was higher with 100% 'P' + PSB recording an yield of 3490 kg/ha. The lowest total leaf yield (2,969 kg/ha) was recorded with No 'P'. Preferable quality was observed in all the treatments. The net returns was higher with 100% 'P' + PSB (Rs.37, 521/ha) followed by 50% 'P' + PSB (Rs. 37,017/ha). The B:C ratio was higher with 50% 'P'+PSB (Table 21).

Table 21: Economics of phosphorus fertilization (2005-06) in Chewing tobacco in Tamil Nadu

Treatments		Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
First year	Second year				
50 % P* + PSB	100% P	34,674	71,691	37,017	2.07
75 % P + PSB	100% P	35,180	70,011	34,326	1.99
100 % P + PSB	100% P	35,685	72,418	36,733	2.03
50 % P + PSB	75% P	34,674	70,218	35,544	2.03
75 % P + PSB	75% P	35,180	70,861	35,681	2.01
100 % P + PSB	75% P	35,685	73,206	37,521	2.05
50 % P + PSB	50% P	34,674	70,383	35,710	2.03
75 % P + PSB	50% P	35,180	64,450	29,270	1.83
100 % P + PSB	50% P	35,685	67,438	31,753	1.89
100 % P	No P	35,435	70,177	34,742	1.98
100 % P	100% P	35,435	69,098	33,663	1.95
No P	100% P	33,410	61,607	28,197	1.84

5. CROPPING SYSTEMS FOR SUSTAINABLE PRODUCTION

CTRI, Rajahmundry

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

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

Among the three systems maize – tobacco recorded significantly higher green and cured leaf yields followed by fallow – tobacco whereas significantly lower tobacco yields were observed in the soybean – tobacco system. Higher bright leaf was recorded in the fallow – tobacco system and grade outturn in the maize – tobacco system.

Two irrigations significantly increased green leaf and cured leaf yields by 13.86 and 10.4%, respectively than one irrigation. Nitrogen application showed significant differences in leaf yields and quality of tobacco leaf. Application of 60 kg N/ha recorded higher yields than 45 and 30 kg N/ha. Interaction between cropping systems, irrigations and nitrogen levels were not significant. However, higher cured leaf, bright leaf and grade outturn was observed in fallow – tobacco with two irrigations and 60 kg N/ha.

Soybean – tobacco recorded higher nicotine than maize – tobacco and fallow – tobacco systems. Two irrigations recorded higher nicotine content than one irrigation. Higher reducing sugars were recorded by fallow – tobacco followed by soybean – tobacco and maize – tobacco system. One irrigation recorded higher sugar content of 15.17% than two irrigations (14.33%). Among the nitrogen levels 45 kg N/ha recorded higher sugar content of 15.11% than other levels.

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 (Fig. 18).

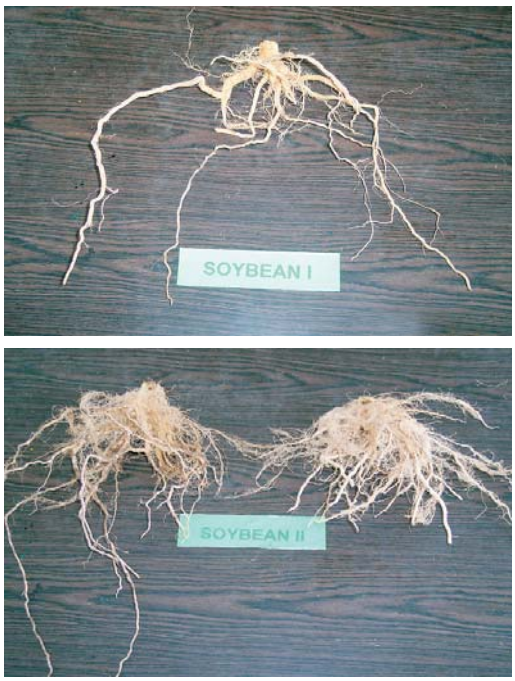

Fig.18: Root system of tobacco in Soybean- tobacco system as influenced by Irrigation

Nutrient management in soybean – mustard sequence as an alternative system to FCV tobacco

(P. Harishu Kumar, S. Kasturi Krishna, C. Chandrasekhara Rao, G. Adinarayana and T. Krishnamurthy)

The experiment was laid out with 12 treatments replicated thrice, in a randomized block design. In *kharif*, soybean was grown with 12 treatments and in *rabi*, mustard was grown in all plots with a common dose of NPK 80:40:20 kg/ha. The yield of soybean and mustard are presented. It is found economical to apply 50 kg N/ha as basal + 10 kg N/ha as top dressing to soybean in *kharif* season followed by 80:40:20 NPK kg/ha to the succeeding mustard crop.

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)

During *kharif* season crop was sown late due to continuous rains and fields were in water logging condition up to September 2nd fortnight. Very low yields were observed i.e. 650-800 kg/ha only. Significant differences were observed in the yields of bengalgram due to residual effect of *kharif* crop nutrition. Though yield of bengalgram was higher in vermicompost applied plots but on par with FYM applied plots. Vermicompost and FYM applied plots recorded significantly higher yields than RDF only. Significant differences were not observed in the yields of bengalgram due to application of fertilizers. Application of RDF gave higher yields than 25% reduction in N &P. Reducing 25% N decreased the yields by 6.1 % than RDF where as 25% reduction in p decreased yields by 2.8% only.

Nitrogen content of the seed was estimated in different samples. Application of *Rhizobium* + PSB to soybean seems to have residual effect and recorded more N content in both FYM and vermicompost applied plots though it was not significant. RDF recorded more N content in seed than other treatment. Application of NP to bengalgram caused significant variation in the N content of the seed. Reducing P by 25% decreased the N content in seed when compared to RDF application. Interactions were also significant showing higher N content in seed in vermicompost with dual inoculation and RDF applied plots. No significant variation in nitrogen content of the straw was observed. However vermicompost applied plots have recorded higher N content.

As the soybean yields were very low due to water logging conditions no returns were recorded. Though gross returns were higher in vermicompost applied plots but net returns were higher in FYM with recommended dose applied plots.

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. Chandrasekhara Rao)

Application of *Rhizobium* and PSB inoculations to blackgram increased the 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 11.26%, cured leaf yield by 9.70%, and grade index by 12.08% 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 (bio-fertilizer 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. Chandrasekhara Rao)

All the *Kharif* crops performed well and the yields were 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 and sunflower-tobacco recorded higher yields followed by fallow-tobacco and soybean-tobacco. Maize-tobacco recorded significantly lower yields.

There was progressive and significant increase in green leaf yield, cured leaf yield and grade index with increased N 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. Chandrasekhara Rao)

Green leaf yield, cured leaf yield and grade index were significantly higher with sunnhemp *in situ* green manuring - tobacco as compared to fallow - tobacco. The yield parameters were significantly higher with 25:75 proportions of organic N: fertilizer N as compared to 0:100 and 50:50 proportions organic N: fertilizer N. Green leaf yield, cured leaf yield and grade index increased with progressive levels of N applied. Application of 150 kg N/ha and 120 kg N/ha both being on par recorded significantly higher green leaf yield, cured leaf yield and grade index as compared to 90 kg N/ha. Interactions were not significant.

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

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

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 (Figs. 19 and 20). Among the intercrops grown palak, amaranthus and radish performed well followed by carrot and onion. The performance of coriander and fenugreek was below average.

Green leaf yield of tobacco in intercrops was significantly higher than in sole tobacco may be due to more no of irrigations to tobacco in intercrops

Fig.19: Intercropping of FCV tobacco + spinach (palak)

Fig.20: Intercropping of FCV tobacco + radish

and earthing up of tobacco was not done. There were no significant differences between cured leaf and grade index between different intercropped treatments and sole tobacco. In respect of rhizosphere activity, alkaline phosphatase (µg p-nitrophenol/g soil/h) and dehydrogenase (Change in OD at 485 nm) activities were found to be higher in fenugreek + tobacco and carrot+ tobacco where as low activities were observed in palak + tobacco.

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. Chandrasekhara Rao, K. Siva Raju and P.Harishu Kumar)

Tobacco was planted with normal spacing. Relay crops were sown when 5-6 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.

CTRI Research Station, Hunsur

Integrated Farming System Model

An Integrated Farming System model comprising of Agri-Horti, Silvipasture, efficient cropping systems along with subsidiary enterprises like animal components, vermicompost production, kitchen gardening with water harvesting structures like farm pond etc., was initiated during June 2005. During the period, Horticulture (mango, sapota, tamarind and pomegranate) and Silvipasture tree components (Eucalyptus, *Casuarina*, Neem and *Acacia*) as well as border tree crops (Silver oak, *Casuriana*, Teak etc.) and vegetative fencing have been successfully established. The cropping system involving hybrid cotton, Ragi, Maize + Cowpea, Red gram + Ground nut, (in kharif) and Field bean and Niger in Rabi season were raised. In the subsidiary components, kitchen gardening with various vegetables/ greens were raised. The animal components (1 cow and 2 goats) were purchased and vermicompost production commenced. A farm pond on 7m x 7m dimension has been constructed for rain water harvesting and its utilization in IFS. The economic evaluation of the different systems/ components indicated maximum net returns in the subsidiary components (Kitchen garden and animal rearing) followed by Agri - Horti and cropping system. The total gross and net returns earned from the entire farming system area of one acre was Rs.15, 000/- and Rs.7, 700/-, respectively with a cost benefit ratio of 2.05.

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 crops, highest grain yield (3724.3 kg/ha) of Aman paddy was recorded when preceding crop of sesame was grown in the system followed by Boro paddy and maize. 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.

It is concluded that Jute – Aman paddy – Tobacco cropping sequence is more profitable cropping sequence in north Bengal region (Table 22). 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 North Bengal region.

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Table 22: Yield and economics of tobacco based relay cropping systems

Treatments	Base crop yield (kg/ha)	Relay-crop yield (kg/ha)	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Sowing on one side of the ridge						
Tobacco + Water melon	1942	17150	75400	141110	65710	1.87
Tobacco +Ridge gourd	1938	1800	72200	113790	41590	1.58
Tobacco +Bottle gourd	1900	25500*	74000	155500	81500	2.10
Tobacco + Cucumber	1948	16568*	73700	140276	66576	1.90
Tobacco + Cluster beans	1940	4687	75400	125448	50048	1.66
Tobacco + Groundnut	1980	1400	76300	125700	49400	1.65
Sowing on both sides of the ridge						
Tobacco + Water melon	1935	19980	77900	146385	68485	1.88
Tobacco +Ridge gourd	1909	2100	75800	113395	37595	1.50
Tobacco +Bottle gourd	1922	27640	75900	160990	85090	2.12
Tobacco + Cucumber	1933	22462	76800	139451	62651	1.82
Tobacco + cluster beans	1878	8358	77400	136722	59322	1.77
Tobacco + Groundnut	1992	2450	78000	138960	60960	1.78
Sole tobacco	2460	30882	68500	135300	83,244	1.78

CLY used for calculating economic returns; sale price/kg of tobacco = Rs 55; sale price/kg of relay crops: groundnut = Rs 12; cluster beans = Rs 4; cucumber = Rs 2; bottle gourd = Rs 2/one fruit; ridge gourd = Rs 4; watermelon = Rs 2/kg

Agricultural Engineering

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

(M. Sannibabu and K. Deo Singh)

Testing the mortar materials

Three materials viz., coarse sand, fine sand carborandum (black sand) were tested for solar heat absorption, which recorded an increase in temperature of about 5-20 °C, 10-25 °C and 15-25 °C, respectively over the atmosphere was observed.

Testing phase changing materials

To absorb more solar heat solid to liquid phase changing materials were procured. These are viz. Sodium carbonate, Polyethylene glycol (Molecular weight: 600), Polyethylene glycol (Molecular weight: 4000), Polyethylene glycol (Molecular weight: 6000), Paraffin wax and Anhydrous Sodium sulphate. The model solar panels designed and modeled for testing the PCM's. The digital thermometers with 10 meter probe were procured for logging the temperature.

Among the chemicals tested for heat absorption, wax was the most efficient in recharging the solar temperature and retaining it till 1.00 PM in the night to equalize with ambient temperature. It is followed by Sodium carbonate, which retained up to 9.00 PM. The PC material panel and the empty panel recorded nearly double the ambient temperature. The ambient temperature recorded at 12.30 PM, the temperatures in the empty panel and the panel with wax were 43.4 °C, 74.3 °C and 70.8 °C, respectively. These were recorded when the air flow in the panel was static. The wax filled panel may transmit/supply the heated air for longer periods than empty panels.

6. BIO- ECOLOGICAL AND PATHOLOGICAL STUDIES ON PESTS AND DISEASES

Plant Pathology

Studies on wilt disease of tobacco

(C.A. Raju, S.V. Krishna Reddy and A.V.S.R. Swamy)

Based on the earlier observations, the disease incidence was not consistent and the disease never appeared in the same field continuously for 2 years and hence chemical control trials did not yield any result so far. The disease incidence was low during the field crop season; however, the disease appeared at high proportion in some pockets at the end of the season in the CTRI RS Farm, Jeelugumilli.

CTRI Research Station, Hunsur

Studies on *Fusarium* wilt disease and its management in FCV tobacco crop

(M.M. Shenoi)

Survey report on wilt disease incidence in tobacco growing areas on KLS

A survey conducted in the tobacco tract of KLS revealed gradual increase in disease severity and its potential threat over the years. Though, the average incidence due to wilt and wilt complex was only 4.9%, in the year 2005, as high as 34.5% fields among 139 fields surveyed showed the presence of wilt disease.

CTRI Research Station, Dinhata

Survey, epidemiology and management of Bacterial wilt in *Motihari* tobacco caused by *Ralstonia solanacearum*

(S. Roy)

Survey

Bacterial wilt incidence (5 to 40%) was recorded in *Jati* tobacco nursery in the third week of November, 2005 in Chama and Podali types. Highest disease incidence (40%) in nursery crop was recorded at Boro Adabari. In the field crop, the disease was recorded in January, 2006 and at the end of crop season (March, 2006). In *Motihari* tobacco bacterial wilt was recorded in the first week of Nov, 2005. In the early crop the disease was recorded at 6 different locations in the varieties, Bitri, Tangua (early maturing) and Hemti (late maturing). During February, 2006 the disease was recorded from Gosanimari in var. Tangua. Severe incidence of the disease was recorded at Balakandi (37.5%).

Epidemiology

Occurrence of the disease in epiphytotic proportions in *Jati* tobacco nursery during November, 2005 is an indicator of manifestation of symptoms as a result of latent infection of the plants initiated in the months of September and October, 2005. Total rainfall recorded during the month of September and October was 86 and 504 mm, respectively. Severe incidence of the disease was recorded both in *Jati* and *Motihari* tobacco at the end of the crop season in Baro Adabari and Balakandi, respectively. At both the locations higher incidence of *Fusarium* wilt was also recorded.

Appearance of bacterial wilt late in the season might be due to the mixed infection of *Fusarium* and bacterial wilt in plants. *Fusarium* wilt was recorded in the beginning of the crop season (January – February, 2006) and bacterial wilt was recorded late in the season (March, 2006). Brief spell of rains in the month of February (13mm) and March (1.3mm) in the year 2005 might have acted as highly favourable predisposing factors for rapid build up and spread of the disease.

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Salient findings

- In *Motihari* tobacco nursery, the infection usually remained latent in the seedlings and the symptoms were expressed in plants at 20-50 days after transplanting (DAT) following favourable predisposing factors like temperature (20-30 °C) and RH (80-90%)·
- Collapse of the plants both under *Jati* and *Motihari* tobacco depended on the rate of bacterial colonization and favourable predisposing factors
- Despite the high rate of colonization by the pathogen, at 60 DAP, the plants remained erect in the field and did not collapse, may be due to adult plant resistance.
- Incidence of bacterial wilt was reduced significantly in nursery and field crop with the incorporation of lime dust @ 560 kg/ha after land preparation and keeping the land fallow for a period of 20-30 days·
- Survival of *R. solanacearum* isolates obtained from tobacco and other solanaceous crops (tomato, potato, brinjal etc.) was observed up to 3-7 months at room temperature·
- The survival of the pathogen in the soil is evident due to extensive cultivation of solanaceous crops like potato, tomato, brinjal and chillies throughout the year, which are potential hosts of the pathogen besides other weed hosts·
- As per the phenotypic/biochemical characterization, the two isolates each from West Bengal and Shimla (Himachal Pradesh) were found to belong to Race 1 biovar 3·
- There was divergence in DNA polymorphism in four isolates of *R. solanacearum* in PCR based RAPD with 12 decamer primers

Nematology

CTRI Research Station, Hunsur

Survey for plant parasitic nematodes associated with tobacco

(S. Ramakrishnan)

Under this long term project, 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. Root and soil samples were drawn randomly from fields and processed for enumeration of nematode population. 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 2.3 and 2.1 to 3.8 in Hunsur and Sollepura farms respectively. The root-knot nematode incidence was more in Sollepura as compared to Hunsur farm.

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)

The relationship between weather parameters and pest incidence under three dates of planning was recorded. During September 30th planting, 80% variability in the incidence of *Spodoptera litura* could be explained by weather parameters. Minimum temperature could significantly and negatively influence the incidence of *S. litura*. Further, 89% variability in the number of white flies/plant could be explained by weather parameters with minimum temperature and sunshine

hours influencing their numbers positively. The changes in the population of the predator *Nesidiocoris tenuis* could be attributed to the weather parameters to an extent of 93.4%. Rainfall contributed positively to their abundance whereas minimum temperature had a significant negative influence. During the second date (October 15th) of planting, the weather parameters could not explain the variability in pest numbers or their damage because of very low incidence of them. During the third date (November 2nd), the changes in the population of adult aphids could be explained by weather parameters to an extent of 98%. Minimum temperature had a significant negative influence on the number of adult aphids and also on the extent of damage by this pest during this date of 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)

Different larval stages of *S. litura*, *S. exigua* and *H. armigera* starting from neonates were confined with known number of adults of *Nesiodiocoris tenuis* for a period of 12h and the mortality of the larval stages was recorded. The neonates of the three pests are the most susceptible stage to predation by the bug. The ability to predate on the larval stages decreased as the larval age advanced. By the sixth day, larvae of all the three pests could not be preyed upon by the bug. This was because the larvae at this stage were observed to wriggle and ward off the bug at every attempt to pierce the body with its proboscis. Mortality of 4 day old larvae of *H. armigera* due to predation by *N. tenuis* was observed to be 43.33% compared to only 16.67% and 6.67% mortality in case of *S. litura* and *S. exigua*. Hence, a higher predation of bud worm by *N. tenuis* could be anticipated in the field compared to other pests under study.

The predatory ability of *N. tenuis* was assessed against neonate larvae of *S. litura* in the background of various tobacco types and other host plants of the prey *viz.*, castor and bottlegourd. It was noted that the predatory ability of the bug was not influenced by the tobacco type. At the same time, it was observed that the bug could indulge in omnivory only on its natural hosts like tobacco and bottle gourd. The efforts to mimic natural host by smearing methanolic extract of tobacco leaf on castor leaves could bring about only a marginal increase in predation. Hence it was understood that natural host of the predator plays an importance role both in its nutrition and predatory behaviour.

Persistent toxicity of selected insecticides to *Nesidiocoris tenuis*

The insecticides acephate, chlorpyriphos, thiamethoxam and imidacloprid were tested for their persistent toxicity to *N. tenuis* when they were used either as spray or through stem application. Highest mean persistent toxicity was recorded in the case of acephate spray followed by imidacloprid and chlorpyriphos sprays. The lowest persistent toxicity was observed with thiamethoxam when applied to the stem at 1:40 dilution followed by stem application of imidacloprid at 1:20 and 1:40 dilutions, respectively.

CTRI Research Station, Guntur

Influence of diversified cropping systems on the incidence, host preference and cross over by major insect pests during *Kharif* and Rabi seasons

(G. Raghupathi Rao)

It is inferred from the results that sucking pest incidence was relatively low on cotton intercropped with blackgram/greengram over cotton. Incidence of lepidopterous pest was high in cotton over cotton+ soybean. In contrast it was low in cotton +redgram over cotton alone. Incidence of aphids was reduced to an extent of 8 to10% on redgram + soybean over redgram alone. Incidence of aphids and jassid was relatively low in cotton + green gram/ black gram over cotton alone. Incidence of aphids and jassids was relatively low, 1.2- 5.6/plant and 0.7- 4.2, respectively in redgram + soybean as against 0.7-6.4 aphids/plants in redgram alone. Stemfly incidence was high (1.8 - 6.4%) on soybean, against 1.7- 4.0% on redgram + soybean. Incidence of aphids was relatively high on redgram over redgram + black gram/greengram. The incidence of thrips was high (0.9-4.5/ plant) on green gram as compared to blackgram (0.5-1.7/plant). Stem borer incidence was relatively high (0.5-3.5%) on maize as compared to maize+ redgram /mustard/soybean.

The incidence of aphids on maize either alone or in combination with other crops showed higher aphid population and harboured more coccinellid populations. Incidence of whiteflies on tobacco was relatively high during the month of December. Incidence of aphids on mustard was high in the range of 1.5-72.8/plant during the season. Incidence of *H. armigera* was high (4.2 larvae/plant) on redgram as against 0.1-2.2/plant in redgram + soybean. *S. litura* infestation was low in redgram and in contrast, *S. exigua* was high on greengram and blackgram as sole crops. *H. armigera* was observed on redgram only. *H. armigera* infestation was high on maize + redgram as compared to maize alone or in combination with soybean crops. *H. armigera* infestation was relatively high on maize + redgram crops as compared to maize alone or in combination with soybean crops.

7. INTEGRATED PEST AND DISEASE MANAGEMENT

Plant Pathology

CTRI, Rajahmundry

Studies on broomrape of tobacco

(C.A. Raju)

Reaction of germplasm accessions, wild types and *Nicotiana* species to *Orobanche*

During the year, 58 new germplasm accessions and 28 selected accessions which showed lower incidence during previous years were planted and observations on per cent plants infested, number and green weight of *Orobanche* spikes per plant in each accession were recorded at 70 and 100 days after planting. The accessions showing lowest rating of these parameters are further screened in the subsequent years for confirmation.

Analysis of the data of the 58 germplasm accessions indicated that overall incidence of *Orobanche* in general was low (2.1% as against 19.0% average of last year), as compared to normal incidence of 70 – 80% in the same sick field during earlier years. Twenty eight accessions which showed higher infestation of *Orobanche* were eliminated and the remaining will be further assessed during next year. Among the 28 selected accessions, 10 lines which showed higher *Orobanche* incidence were eliminated and the remaining ones will be further screened during next year.

Thirty two selections/crosses were screened under irrigated conditions and one selection, 93-1-19-13-12, was observed to be completely free from *Orobanche* which will be further assessed along with other selections. Forty three wild types and *Nicotiana* species were also screened in a sick field (under irrigation) and 23 entries were found to be completely free from *Orobanche* while the remaining 13 entries showed low incidence of less than 20% incidence. This is the first year of the experiment and needs to be repeated during next year for confirmation of the results.

Effect of Nijmegen-I on *Orobanche* incidence

Nijmegen-I, a synthetic *Orobanche* seed germination stimulant obtained from Germany, was tested at 0.1, 0.2 and 0.4% concentrations on the emergence of *Orobanche* under field conditions in bulk plots in a sick field. It is inferred from the data that maximum emergence of *Orobanche* occurred up to 70 days after planting and the emergence after that was negligible. There was slight reduction in *Orobanche* emergence as the concentration of the chemical was increased form 0.1 to 0.4% and similarly, number of spikes per plant also reduced at 0.4% concentration but the differences between 0.2 and 0.1% were negligible. Lower germination could be due to production of germination inhibitors and/or production of less stable stimulants which however could induce germination of parasite seeds located very close to the roots. The experiment will be repeated during next year for confirmation of the results.

Studies on wilt disease of tobacco

(C.A. Raju, S.V. Krishna Reddy and A.V.S.R. Swamy)

So far, 8 isolates of the pathogen were made from different locations. Biological control of the pathogen *in vitro* with *Pseudomonas* isolates yielded promising results. Trials on the biological control of the pathogen using

Trichoderma and *Pseudomonas* showed that all the ten isolates of *Pseudomonas* showed promise, while very few *Trichoderma* isolates are effective. Surprisingly, some of the *Fusarium* isolates are antagonistic to *Trichoderma* isolates.

Screening crosses for their reaction to black shank disease under artificial inoculation conditions in field (In collaboration with Division of Crop Improvement)

A total of 91 plants belonging to different crosses developed in the Division of crop Improvement were artificially inoculated under field conditions and 31 plants were observed resistant while the remaining showed susceptible reaction.

Screening different crosses/ varieties/ germplasm accessions for their reaction to tobacco mosaic virus under artificial inoculation conditions

More than 2,500 tobacco plants belonging to different varieties / crosses / germplasm accessions under various experiments in collaboration with the Division of Crop Improvement were screened under artificial inoculation conditions. A total of 800 were observed resistant to TMV and the same were identified for further studies.

Screening/Selection of *Trichoderma* and *Pseudomonas* isolates for their antagonistic activity against different plant pathogens (In collaboration with Division of Crop Chemistry and Soil Science)

More than 30 *Trichoderma* isolates and 20 *Pseudomonas* isolates obtained from various rhizosphere soils of different crops were tested for their efficacy against *Sclerotium rolfsii, Rhizoctonia solani, Fusarium oxysporum* and *Phytophthora parasitica* var. *nicotianae.* None of the *Trichoderma* and *Pseudomonas* isolates were found effective against *Sclerotium rolfsii.* Some of the *Trichoderma* and *Pseudomonas* isolates showed very good inhibition of *Rhizoctonia solani and F. oxysporum* but surprisingly, some of the *Fusarium* isolates showed antagonistic activity against *Trichdoerma* isolates. Many *Pseudomonas* isolates showed very good antagonistic activity against *Phytophthora parasitica* var. *nicotianae.* These isolates will be tested against the disease during the coming season for their efficacy.

CTRI Research Station, Kandukur

Control of Anthracnose disease in FCV tobacco nursery under SLS conditions

(V. Venkateswarlu)

Results of the experiments indicated non-significant differences among the treatment combinations for seed germination confirming that there was no adverse effect of chemicals tested. Regarding the incidence of Anthracnose and Frog eye spot diseases in nurseries, lowest incidence was noticed in the treatment combination, BM @ 0.4% up to 20 DAG + Ridomil 0.2% at 20 and 30 DAG + Difenoconazole 25 EC @ 0.1% 40, 50 and 60 DAG. The highest number of healthy transplantable seedlings were obtained in beds treated with COC @ 0.2% or BM@ 0.4% as and when required up to 20DAG + Ridomil @ 0.2% at 20 and 30 DAG + Bavistin @ 0.05% at 30, 40 and 50DAG recorded lowest incidence of anthracnose and frog eye spot diseases.

Management of Brown spot disease of FCV tobacco under SLS condition

(V. Venkateswarlu)

The brown spot incidence was relatively higher this year due to continuous rains. The brown spot rating among the varieties ranged from 2.7 to 5.0. The variety Rathna showed relatively more brown spot rating followed by N-98, Hema and CY-79. The

brown spot rating was more in low grades followed by medium and bright grades. The brown spot was more prominent on bottom leaves followed by middle and top position when plant position of the leaf is considered. The brown spot incidence was least when the plants were treated with Score @ 0.1% at 50, 60 and 70 days after planting, followed by Tilt @ 0.1% and Bavistin @ 0.05 %. In general, the incidence of brown spot was less in the treated plots compared to control.

CTRI Research Station, Hunsur

Studies on *Fusarium* wilt disease and its management in FCV tobacco crop

(M.M. Shenoi)

Chemical control studies on wilt disease

Three years' replicated trial on chemical control of wilt has conclusively confirmed better efficacy of copper hydroxide 77% (Kocide 101) over recommended carbendazim schedule (Fig.21). A bulk demonstration trial with Kocide 101 was conducted to validate the results under high disease pressure in sick field and also to work out the cost economics. The efficacy was rated against hitherto recommended schedule involving carbendazim (Bavistin) @ 0.2% at plant hole followed by drench around the plant at 30 & 45 DAT. The results suggested the good performance of Kocide compared to Bavistin in controlling the wilt under high disease pressure. The disease control ranged from 66.0 to 72.0% and 31.1 to 57.5% in Kocide and Bavistin treatments, respectively. The effective control resulted in better yield of total cured leaf and bright grade compared to Bavistin and check. The two fungicides can be proposed as recommendation for wilt control along with other management practices.

Plants treated with copper hydroxide @ 77%

Fig.21: Control plot

Studies on crop rotation for the management of *Fusarium* wilt

A block trial conducted during 2000-05 with non-host crops, Maize and ragi on different cycles as rotation during kharif and leaving rabi fallow was concluded. The study was conducted with varieties Bhavya and Rathna. Wilt incidence in plots with tobacco crop was recorded at regular intervals and root-knot incidence was recorded at the end of crop season. Studies on crop rotation with Maize and Ragi have indicated the positive role of non-host crops in reducing the wilt incidence in tobacco. The disease control with Maize as rotation crop ranged from 54.8 -98.4% over one to three year rotation cycle. The rotation with Maize-Ragi on a two year rotation resulted in 92.0% control of wilt disease. The study indicated that a minimum of three years' rotation is necessary to eliminate the wilt pathogen completely. The root-knot incidence was also reduced from 4.1 to 1.8.

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Integrated schedule recommended for the management of wilt

- Two to three years' rotation with Maize or Maize and Ragi crops during *Kharif*. Sorghum is also preferred
- Growing green manure crops or leaving land fallow during *Rabi*
- Strictly planting root-knot free seedlings preferably raised in trays with soil free organic medium
- Application of enriched organic manures like FYM, Pressmud or Vermicompost at plant hole
- Avoiding root-knot and wilt susceptible crops such as cotton, sweet potato, watermelon, pulses like *Dolichos* and other *solanaceous* crops for rotation
- Avoiding water logging situation
- Careful intercultural operations to avoid root damage and spread of inoculum to other fields
- Chemical control with recommended fungicides like carbendazim and copper hydroxide

Testing the bio-efficacy of Kocide 101 (copper hydroxide 77%) against fungal diseases in FCV tobacco nursery

(M.M. Shenoi)

Kocide 101 (copper hydroxide 77%) was evaluated against damping off, blight and black shank, anthracnose and frog eye diseases in FCV tobacco nurseries for the second year in a replicated trial. Results indicated the positive efficacy of Kocide either alone or in combination with Ridomil MZ for overall management of major fungal diseases in the nursery. The study indicated the possible scope of reducing continuous usage of Ridomil MZ and limiting the number of fungicides in nursery. Application of the chemical resulted in 82.7 to 94.4% control of damping off, 81.8 to 92.0% control of blight and 58.7 to 92.0% control of black shank, 62.5 to 93.9% control of anthracnose (leaf), 68.2 to 76.5% control of anthracnose (stem) and 91.3 to 96.0% control of frog-eye spot diseases.

Demonstration trial on bio-intensive management of fungal diseases in FCV tobacco nursery

The schedule comprising a commercial bio-pesticide, "Kalisena" containing *Aspergillus niger* (strain AN 27 of IARI) was evaluated in a bulk nursery plot. The schedule comprising soil-solarization for 4 weeks to the neem cake amended nursery and application of "Kalisena" enriched FYM @ 200g/m^2 was validated. The biointensive module resulted in 84.4 to 100 % control of damping off, 94.0% control of blight and 91.5% control of black shank diseases and the results are on par with recommended Ridomil MZ 72 WP schedule. This effective bio-intensive module reflected on the better yield of healthy transplants (739/m^2) as against 340/m^2 in check.

CTRI Research Station, Kandukur

Integrated management strategies to control damping off, black shank and leaf blight in Nurseries of FCV tobacco under SLS conditions

(V. Venkateswarlu)

The germination count revealed significant differences among the eight treatments indicating that there was effect of the treatments tested on the germination of seeds. The least incidence of damping off, anthracnose, frog-eye spot, black shank and leaf blight diseases was noticed in the treatment combinations, Rabbing + Copper oxy chloride (COC) @ 0.2% or Bordeaux Mixture (BM) @ 0.4% as and when required up to 20 Days after germination (DAG) + Ridomil @ 0.2% at 20 and 30 DAG. In the rabbed beds fast uniform growth and more number of transplantable seedlings were recorded

when compared to other treatments. Less weed population was also noticed in this treatment and maximum number of healthy transplantable seedlings was recorded.

CTRI Research Station, Dinhata

Influence of planting dates, irrigation methods and chemical application on hollow stalk disease in *Motihari* tobacco

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

Influence of planting dates, irrigation methods and chemical application on hollow stalk disease in *Motihari* tobacco was studied during the crop seasons 2004-05 and 2005-06. It is concluded that latent infection of hollow stalk was higher in late planted crop compared to early and normal planting. Though, latent infection of hollow stalk was recorded under channel and traditional practice, the difference was non-significant. Prophylactic application of Bordeaux mixture and Blitox paste at the topped stem end and desuckered points of leaf were at par in reducing the latent infection of hollow stalk. Cured leaf yield and first grade equivalent yield were significantly higher under early and normal date of planting, channel method of irrigation and prophylactic application of Bordeaux mixture paste.

Nematology

CTRI Research Station, Hunsur

Screening of tobacco germplasm against root-knot nematodes

(S. Ramakrishnan, K.N. Subramanya and M.M. Shenoi)

A total of 29 tobacco germplasm materials were subjected to screening for resistance against root-knot nematode under sick field conditions along with the variety Bhavya as resistant check and the varieties Rathna and Kanchan as susceptible checks. Experimental results revealed that the following materials viz., 147Mx1-21, V-4212, FCH 201, FCH 187, FCH 194, KST 29, RK 9, RK 11 and RK 1 recorded Root-Knot Index (RKI) <1.5 and were most promising. These materials will be further subjected to intensive screening under artificial inoculated conditions for further confirmations.

AT&JL series

Intensive screening of 12 promising AT & JL series materials against *Meloidogyne* spp. singly under micro plots conditions revealed that none of the lines were resistant to all the three species of root-knot nematodes. Three lines were found resistant to *Meloidogyne incognita* alone, four lines to *M. javanica* and six lines to *M. arenaria* alone. Whereas, under sick field conditions against mixed root-knot nematode populations, the following six materials viz., AT&JL V5#2, AT&JL V23#1, AT&JL V24#1, AT&JL V6#2, AT&JL V8#1 and AT&JL V16#3 were found promising with mean RKI ranging from 1.2 to 1.6 under 0-5 scale.

Studies on root-knot nematode – *Fusarium* wilt disease complex in FCV tobacco (In collaboration with Plant Pathology)

(S. Ramakrishnan and M.M. Shenoi)

Management studies with bio-control agents as singly and in rational combinations were attempted against *Fusarium* wilt disease complex involving root-knot nematodes in disease sick field. Results revealed that, application of nematode antagonistic bacterium, *Pseudomonas fluorescens* @ 1g / plant hole in combination with *Aspergillus niger* enriched FYM @ 100 g/plant at time of planting caused 74.5% reduction in *Fusarium* wilt incidence and recorded the least RKI of 1.85, which is 49% reduction over untreated check with 1267 kg/ha total cured leaf yield and 839 kg/ha bright grade yield.

Increase in total cured leaf and Bright grade leaf yield was 26 and 54.5 %, respectively over untreated check (Fig.22).

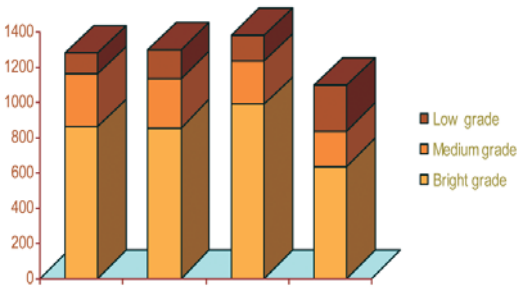

Fig.22: Effect of bio-agents on root-knot - wilt complex and resultant yield of FCV tobacco

Plant growth promoting rhizobacterium (PGPR) *Pseudomonas fluorescens* mediated suppression of root-knot nematode in FCV tobacco nursery
(S. Ramakrishnan and M.M. Shenoi)

Nematode antagonistic bacterium, *Pseudomonas fluorescens* in lignite based formulation (pf1 strain) obtained from PASIC, Pondicherry was evaluated in different dosage levels against root-knot nematodes in FCV tobacco nursery, along with untreated check and carbofuran @ 10g/m^2 as standard chemical check. Second year trial results revealed that, application of *Pseudomonas fluorescens* @ 5g/m^2 reduced RKI to 1.8 compared to 3.6 in untreated check and 2.45 in standard chemical check, carbofuran @ 10g/m^2 (Fig.23). Reduction in root-knot disease ranged from 16.6 to 50 percent in *Pseudomonas fluorescens* treated plots. Reduction in nematode soil population due to the treatment and resultant increase in healthy transplants yield was 55.5 and 56.5%, respectively over untreated check.

Fig.23: Effect Of *P. fluorescens* on root knot disease

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 insecticides to tobacco aphid, *M. nicotianae* on tobacco

An experiment was conducted to understand the effect of rain on insecticide deposits and efficacy against tobacco aphid, *Myzus nicotianae* on FCV tobacco. Tobacco plants (50 days old) were sprayed with insecticides. After insecticidal application simulated rain of different levels (0, 5, 10, 25, 50 mm) at various intervals (0, 2, 6, 12, 24, 48, and 72 h) was done on the plants with the help of a knapsack sprayer at a normal pressure of 2.5-3.0 kg/cm^2, having an adjustable nozzle. *M. nicotianae adults* were used for the experiment. Leaves from different treatments were used to record mortality data. Natural mortality of the aphids, if any was adjusted by Abbots formula. From corrected mortality, the persistent toxicity index was calculated.
It is concluded from the results that there is a negative correlation between rain levels and persistent toxicity. The effect of rain on persistent toxicity of imidacloprid was less as the interval between spray and rain increased (Table 23). Rain occurring up to 6 hrs after spray (HAS) brought about much reduction in toxicity as compared to the rain occurring after 12 HAS and beyond. Rains of 5 and 10 mm occurring 24 h after the spray did not reduce the toxicity of acephate considerably (Table 24).

Table 23: Persistent toxicity of imidacloprid to tobacco aphid *M. nicotianae* as influenced by quantum of rainfall at different time intervals

Rain interval after spray (h)	Quantum of rainfall (mm)					
	0	5	10	25	50	Mean
0	930.0	269.80	154.00	50.00	12.60	283.28
2	930.0	361.00	276.00	108.60	16.00	338.32
6	930.0	483.00	396.00	176.30	29.60	403.14
12	930.0	642.00	577.80	325.40	110.40	517.20
24	930.0	732.40	642.60	448.00	140.60	578.72
48	930.0	886.80	775.20	500.60	200.00	658.52
72	930.0	899.60	732.40	483.80	224.00	653.96
Mean	930.0	610.83	504.86	298.96	104.74	

Table 24: Persistent toxicity of acephate to tobacco aphid, *M. nicotianae* as influenced by quantum of rainfall at different time intervals

Rain interval after spray (h)	Quantum of rainfall (mm)					
	0	5	10	25	50	Mean
0	805.0	186.80	87.5	26.60	8.00	222.78
2	805.0	224.00	136.80	86.60	30.00	256.36
6	805.0	414.60	400.80	125.00	42.60	357.60
12	805.0	599.60	448.00	180.60	87.50	424.14
24	805.0	732.40	642.60	278.00	136.80	518.96
48	805.0	792.40	724.00	482.50	176.40	596.06
72	805.0	790.00	732.40	448.00	142.00	583.48
Mean	805.0	534.26	453.16	232.38	89.04	

A field trial was laid out to study the residue dissipation of acephate and chlorpyrifos in FCV tobacco. Chlorpyrifos and acephate at recommended dose were sprayed periodically after planting. Cured leaf samples were collected pick wise from all the treatments along with untreated tobacco samples. Altogether sixty samples were collected for residue analysis.

Evaluation of trap crops against bud worm in FCV tobacco

(U. Sreedhar and S. Sitaramaiah)

Budworm infestation in tobacco

At 40 days after planting (DAP) the infestation was least (9.35) on tobacco with *Tagetes*-Single Whorl-Border (SW-B) as well as *rustica*-Border (B) as trap crops and it was found to be at par with tobacco plots with *rustica* tobacco-East-West (EW), North-South (NS) and tagetes-Single Whorl-East-West (SW-EW) as trap crops. The infestation was lowest (10.39) on tobacco with tagetes-SW-EW which was on par with tagetes-SW-B, *rustica* -EW and B. At 60 DAP the infestation of the pest was least (10.40) in plots with tagetes –SW-EW and *rustica*-B which were on par with tagetes-SW-B and rustica –EW planting pattern (Fig.24).

Population of budworm on trap crops

Rustica tobacco recorded significantly higher number of eggs irrespective of planting pattern in all the

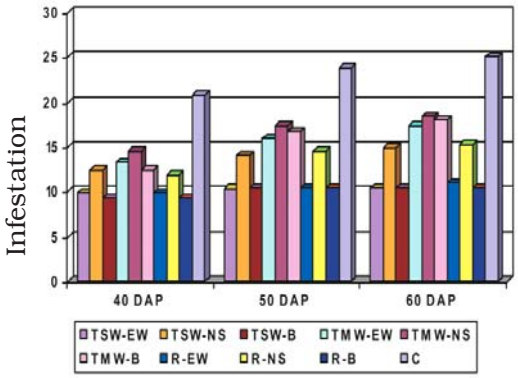

Fig.24: Evaluation of trap crops against H. *armigera* in FCV tobacco

observations. At 40 DAP maximum number of eggs (10.20) were laid on rustica tobacco-B followed by EW planting. At 50 DAP maximum eggs (12.23) were recorded on rustica tobacco-B which was on par with rustica tobacco-EW (12.00). At 60 DAP the number of eggs laid on rustica tobacco-B and EW planting pattern was on par with each other and significantly higher than all other treatments. As regards larval population rustica tobacco-EW and B recorded significantly higher larvae at 40 DAP as compared to all other treatments. At 50 DAP the larval population was highest (6.00) in rustica tobacco-B which was at a par with its EW and NS planting pattern as well as tagetes-SW- B and EW planting pattern. At 60 DAP maximum larvae (6.87) were observed on *Rustica* tobacco – EW. However, the treatment was found to be on par with its other two planting patterns and tagetes-SW-B & EW planting pattern.

Natural enemy activity

Tagetes-MW irrespective of planting pattern supported maximum natural enemy activity as compared to other treatments and it was least in rustica tobacco. Tobacco supported *Nesidiocoris sp*. coccinellids and syrphids of which *Nesidiocoris* sp. was predominant. Among the trap crops rustica tobacco supported maximum *Nesidiocoris* population whereas on others its population was negligible. More coccinellids (1.4-1.8) were recorded on tagetes – MW. Their activity was found to be more on tobacco (1.0 – 1.4) with tagetes – MW as trap crop. Syrphid population was more on tagetes – MW. Their activity was more (0.4 – 0.6) in tobacco with rustica as trap crop though their activity was least (0.0 – 0.2) on rustica trap crop itself. More spiders were recorded (4.4– 5.2) on tagetes – MW followed by tagetes - SW (1.8 – 2.4). Population of other predators was more on tagetes – MW (3.8 – 4.4) followed by tagetes – SW (2.2 - 3.2). Similarly parasitoids were more on tagetes – MW (2.6 – 3.2) and tagetes – SW (1.2 - 1.8). No parasitoids were recorded on rustica tobacco, tobacco with rustica as trap crop and tobacco without trap crop.

Yield

All the tobacco plots with tagetes-SW irrespective of planting pattern and tobacco with rustica tobacco–EW and B recorded significantly higher green leaf yields as compared to control (tobacco without trap crop). Highest cured leaf yield was recorded in tobacco with rustica tobacco-B which was at a par with its other two planting patterns as well as tagetes-SW in all the planting patterns. As regards bright leaf, maximum yield was recorded in rustica-B. Significantly higher bright leaf yields were recorded in rustica B & EW and Tagetes-SW-B and EW planting pattern as compared to control (tobacco without trap crop). The grade index was highest in rustica-B which was on par with its two planting patterns and all the three planting patterns of tagetes-SW and tagetes MW-EW planting pattern.

Development, validation and refinement of IPM module for burley tobacco

(U. Sreedhar and R. Subba Rao)

The following IPM module was tested in burley tobacco at BTRC, Jeddangi in comparison with chemical control.

IPM Module

- Sorghum as border crop
- Application of Imidacloprid @ 50 g a.i./ha at 30 DAP
- Application of Sl NPV and Ha NPV for management of *S. litura* and *H. armigera*
- Need based application of chlorpyrifos 0.05% and acephate 0.075 %

Chemical control

- Scheduled application of insecticides at 30,40,50 and 60 days after planting

The results showed that the infestation of tobacco caterpillar was more followed by stem borer. The infestation of *S. litura* in IPM plot ranged from 1.40- 14.20 whereas it was 0.80 - 12.80 in chemical control plot. Stem borer infestation was more (6.20-10.80) in IPM as compared to chemical control plot (6.46-8.46). Leaf curl incidence was 1.00- 6.20 in IPM plot as against 0.80 - 8.60 in chemical control plot. Budworm infestation ranged from 0.40 -10.80 in IPM and 0.60 – 14.26 in chemical control. On sorghum border crop, more coccinellids 3.20 -6.80 were recorded as compared to other predators during the season. Among others, syrphids were predominant (1.20 -3.86) followed by wasps (0.40- 1.46). Other predators recorded were damselflies, *Harpactor sp.*, chrysopids, spiders and mantids. Green leaf and cured leaf yields in IPM plot was 10465, 1605 kg/ha as against 10250 and 1575 in chemical control plot, respectively.

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 during the season. Imidacloprid 200 SL and thiamethoxam 25 WG were applied to the stem and were compared with foliar spray (FS) of imidacloprid and thiamethoxam @ 50 g a.i./ha in a replicated filed experiment. Stem application of imidacloprid @ 1:30, 1:40 and Thiamethoxam @1:20 were found effective against tobacco aphid. Stem application of insecticides supported more natural enemy activity as compared to foliar spray. Occurrence of leaf curl incidence was also less as compared to control.

Highest green leaf yield was recorded in imidacloprid (FS) followed by thiamethoxam (FS), which were found to be on par with each other as well as with stem application of imidacloprid at all the doses and thiamethoxam 1:20. As regards to bright leaf, highest yield was recorded in imidacloprid (FS) followed by thiamethoxam (FS) which were on par with imidacloprid stem application @ 1:20, 1:30 and thiamethoxam 1:20. Maximum grade index was recorded in imidacloprid (FS) followed by thiamethoxam (FS) which were on par with stem application of imidacloprid 1:20. The grade index of imidacloprid 1:30 was found to be on par with its higher dose (1:20) as well as its lower dose (1:40).

Studies on the bio-activity of medicinal and weed plants against *S. litura* and *H. armigera*

(J.V. Prasad, R. Sreenivasulu and C.V. Narasimha Rao)

The influence of solvent extracts of *Clerodendron inerme* and the medicinal plant *Andrographis paniculata* on the growth and development of *Spodoptera exigua* was studied by incorporating the extracts in the artificial diet of the insect.

The hexane extract of *C. inerme* was found to be causing 100% mortality of the neonate larvae followed by the dichloromethane and methanol extracts. Larval period was the longest in dichloromethane extract at 1% followed by ethyl acetate extract at

0.05% concentration. The lowest per cent pupation was recorded in dichloromethane extract at 0.1% concentration. The lowest adult emergence was observed in the methanol extract at 0.05% concentration. All the extracts (except hexane extract) had very weak antifeedant effect and they supported good growth of the larvae. These extracts had little effect on development of pupae also. The dichloromethane and methanol extracts at 0.1% concentration supported low pupation as evidenced by pupation index lower than 0.3. It can be inferred from the growth indices that the dichloromethane extract of *C. inerme* has a moderate inhibitory effect on the growth and development of *S. exigua larvae* at 0.1% concentration (Table 25).

The highest mortality of larvae was recorded in ethyl acetate extract of *A. paniculata* at 0.2% concentration followed by hexane extract at the same concentration. The larval period was maximum in dichroloromethane extract at 0.2% concentration. Pupation was severely inhibited by hexane extracts at both the concentrations tested. Adult emergence was totally affected in these two treatments. The comparison of growth indices suggests that the extracts of *A. paniculata* had very weak antifeedant effect on the larvae. The ethyl acetate extract had moderate effect on the pupation at 0.2% concentration. The lowest growth indices were recorded in the hexane extracts at 0.1 and 0.2% concentrations followed by ethyl acetate extract at 0.2% concentration (Table 26).

Table 25: Growth indices of *S. exigua* reared on diet incorporated with solvent extracts of *Clerodendron inerme*

Treatments	Growth indices					
	LPI	PPI	PI	SUI	SI	GI
CI (D) 0.05%	0.81	0.84	0.25	0.95	0.71	3.82
CI(D) 0.10%	0.72	0.68	0.24	0.76	0.60	2.68
CI(E) 0.05%	0.80	0.76	0.38	0.94	0.72	3.67
CI(E) 0.10%	0.82	0.65	0.40	0.96	0.70	3.69
CI(M) 0.05%	0.84	0.83	0.37	0.88	0.73	3.68
CI(M) 0.10 %	0.84	0.83	0.25	0.95	0.72	3.95

Table 26: Growth indices of *S. exigua* reared on diet incorporated with solvent extracts of *Andrographis paniculata*

Treatments	Growth indices					
	LPI	PPI	PI	SUI	SI	GI
AP(H) 0.1%	0.94	0	0.03	0	0.24	0
AP (H) 0.2%	0.87	0	0.07	0	0.24	0
AP(D) 0.1%	0.97	0.83	0.64	0.80	0.81	3.67
AP(D) 0.2%	0.82	0.96	0.57	0.90	0.81	3.86
AP(E) 0.1%	0.93	1.06	0.54	0.98	0.88	4.67
AP(E) 0.2 %	0.86	0.78	0.44	0.48	0.64	1.99
AP(M) 0.1 %	0.84	0.90	0.54	0.90	0.80	3.83
AP(M) 0.2 %	0.87	0.78	0.64	0.88	0.79	3.70

LPI-Larval Period Index , PPI- Pupal Period Index, PI-Pupal Index, SUI-Survival Index,
SI- Success Index GI- Growth Index, H: Hexane, D: Dichloromethane, E: Ethyl acetate, M: Methanol

The results of the study clearly prove the growth inhibitory property of the hexane extracts of *C. inerme* and *A. paniculata* against *S. exigua,* and the same could be utilized for developing an effective botanical against this pest by further sub-fractionation and identifying the principle inhibiting the growth.

Studies on the field persistence and efficacy of nuclear polyhedrosis viruses of *Spodoptera litura* and *Helicoverpa armigera* on FCV tobacco

(J.V. Prasad and S. Gunneswara Rao)

A field experiment was conducted using UV protectants along with a sticking agent APSA (Amway) to impart protection to NPV of *Spodoptera litura* (Sl NPV) from degradation by sunlight. It was observed that Mango leaf polyphenols (MLP) @ 5000 ppm could impart maximum resistance to Sl NPV on exposure to sunlight followed by MLP @ 1000 ppm, robin blue and casein. About 23.33% original activity of the virus could be retained even on the third day of exposure to sunlight in case of MLP at 5000 ppm concentration. The possibility of using MLP in NPV formulations needs to be explored.

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

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

Screening of different exotic and indigenous germplasm lines of FCV tobacco against stem borer, *Scrobipalpa heliopa* under artificial infestation

Out of the 80 lines (72 exotic and 8 indigenous) tested, 5 lines from exotic type viz., CSIRO, Coker-128, Delcrest (WF), Early Bright and Faucettes special and 2 lines of indigenous type viz., Rajkhand-3 and TI-70 showed less than 25% infestation by stem borer. After further screening and after confirming their resistance during next season, these seven resistance lines will be utilised in the breeding programme.

Assessment of stem borer infestation in different types of tobacco grown in different localities

Observations in five different localities revealed that the infestation was very high (39.8%) in Hema planted in the first week of December, 2005 at CTRI Farm, Katheru. Delayed plantings, use of aged seedlings and prevalence of dry spell immediately after planting are favourable factors for stem borer incidence.

Efficacy of botanicals against insect pests of tobacco and groundnut under field conditions

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

Effect of botanicals against tobacco caterpillar, *Spodoptera litura* in *Rabi* groundnut

Six dry leaf extracts viz., tobacco, neem, *Pongamia*, *Ipomoea*, *Datura* and *Calotropis* at two different concentrations i.e. 2 and 4% were evaluated against *S. litura* in *Rabi* groundnut. The results indicated that all treatments were significantly superior to control. Chlorpyriphos 0.05% was significantly more effective than the botanicals wherein, the infestation by *S. litura* was less (2.33 plants/m^2). In control plot, the infestation recorded was more (29.66 plants/m^2). All leaf extracts tested at 4% were more effective than at 2%. Among the botanicals tested, *Calotropis* 4% (5.00 plants/m^2), neem 4% (6.00 plants/m^2) and *Pongamia* 4% (6.33 plants/m^2) were more effective. Botanicals reduced infestation by 53.94 to 83.14% over untreated control. Similarly, yields recorded were more (45.66 q/ha) in chlorpyriphos 0.05% treatment followed by *Calotropis* 4% & *Datura* 4% (45.00 q), *Calotropis* 2% (43.33 q) and *Pongamia* 4% (42.00 q).

Effect of botanicals against tobacco caterpillar, *Spodoptera litura* in tobacco nursery

Experiment conducted on tobacco nursery against *Spodoptera* indicated that all the treatments were significantly superior over control in reducing the seedling infestation after 7 days of spraying. Chlorpyriphos 0.05% was most effective with less infested seedlings (4.66 / m^2). However, it was on par with neem 4% (19.33 seedlings) and *Calotropis* 4% (24.66 seedlings/m^2).

Effect of botanicals against insect pests of tobacco in planted crop

A field experiment was also conducted in planted crop of Burley tobacco (Var. Banket A1) with the same leaf extracts. The results revealed that leaf extracts reduced tobacco leaf curl virus approximately by 40%. After 3 weeks of second spray, all the extracts were significantly superior in reducing the leaf curl virus over untreated control and also on par with chlorpyriphos 0.05%. Leaf curl incidence was low (11.33%) in *Pongamia* 4% treated plot followed by neem 4% and *Calotropis* 4% (11.66%). There was no significant difference among all treatments in respect of both green and cured leaf. However, maximum cured leaf (1,718 kg/ha) was recorded in chlorpyriphos 0.05% treated plot followed by *Calotropis* 4% (1,688 kg/ha). Whereas, lowest yield (1,650 kg/ha) was recorded in *Ipomoea* 2% treatment followed by control plot (1,652 kg/ha).

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 and J.V. Prasad)

Methanol extract (2%) of 12 botanicals (dry leaves) viz., neem, *Pongamia*, tobacco, *Ipomoea*, *Datura*, *Occimum*, *Bougainvillea*, Custard, *Neerium*, papaya, *Lantana* and *Calotropis* were evaluated against growth and development of tobacco caterpillar, *Spodoptera litura* Fab.

The results revealed that cent per cent larval mortality was recorded in *Lantana* and *Calotropis* treatments followed by neem (82.6%), *Pongamia* (77.3%), *Neerium* (76.0%) and papaya (75.3%). In control plot, the larval mortality was 46.6% and in the remaining treatments, it varied from 50.6 to 68.0%. Larval length and weight were less and larval period was more in all the treatments compared to control. Regarding pupal mortality, there were no significant differences among all treatments and control. However, pupal length and weight were less and pupal period was more in all the treatments than in control. Adult emergence (12.0%) and egg masses laid (1.33) were less in neem, papaya (14.66% and 0.66), *Pongamia* (16.0% and 2.33) and *Neerium* (18.6% and 1.00). 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 neem, *Pongamia*, *Neerium* and papaya. Highest egg hatching (71.3%) was recorded in untreated control and in the remaining treatments, hatchability ranged from 17.6 (tobacco) to 49.6% (*Occimum*).

Studies on the efficacy of vegetable oils against *Callosobruchus chinensis* and *Sytophilus oryzae* with special reference to tobacco seed oil as grain protectant

(S. Gunneswara Rao and P. Venkateswarlu and J.V. Prasad)

In redgram, egg infestation of *C. chinensis* among tobacco seed oil treatments did not differ significantly and treatments involving neem, *Pongamia* and mahua oils were at par. *Pongamia* oil 0.25% v/w was significantly superior to tobacco seed oil 0.25%v/w. Seed damage was nil in all the vegetable oil treatments despite

egg infestation. All the tobacco seed oil treatments and treatments involving neem oil, pongamia oil and mahua oil were at par and recorded significantly lower egg infestation and gave 100% seed protection in greengram. Egg infestation of *C. chinensis* among tobacco seed oil treatments did not differ significantly and treatments involving neem, pongamia, and mahua oils were at par and the seed damage caused by *C. chinensis* in bengalgram was nil in all the oil treatments.

Tobacco seed oil @ 0.25, 0.50, 0.75 and 1% v/w, neem oil and pongamia oil @ 0.25% v/w effectively reduced egg infestation of *S. oryzae* in wheat and were at par. Tobacco seed oil at higher concentrations and neem oil and pongamia oil at 0.25% v/w were significantly superior to tobacco seed oil @ 0.25%v/w and mahua oil 0.25% v/w which were at par in reducing egg infestation and the seed damage was nil in all the oil treatments. In maize, all the tobacco seed oil treatments, neem oil, pongamia oil and mahua oil recorded lowest egg infestation and were at par. Groundnut oil and palm oil recorded significantly lower egg infestation and were superior to soybean, mustard and sunflower oil. There was no seed damage by *S. oryzae* in all the vegetable oils treatments.

It is concluded that all the vegetable oil treatments could protect greengram, redgram and bengalgram against *C. chinensis.* The protection was cent per cent up to 3 months. Similar protection was also obtained in case of wheat and maize against *Sitophilus oryzae.*

AICRP on Biological Control

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

(S.Gunneswara Rao and P. Venkateswarlu)

Biopesticides, N. *rileyi*, *B. bassiana* and *B.t kurstaki* were equally effective in containing leaf damage caused by *S. exigua. N. rileyi* and NSKS 2% were at par with chlorpyrifos. Per cent seedlings damaged by *S. exigua* was lowest in chlorpyrifos 0.25% treatment which was at par with *N. rileyi* 10^{13} spores/ha and NSKS 2% and significantly superior to the rest. There were no significant differences among *N. rileyi*, NSKS 2%, *B. bassiana* and *B.t.*k. EPN was significantly inferior to the rest of the treatments except control (Table 27). All the insecticide treatments were however superior to control (without spray).

Table 27: Mean per cent seedlings damaged by *Spodoptera exigua* in tobacco nursery 7 days after treatment

Treatments	Seedlings damaged
Nomuraea rileyi 10^{13} spores/ha	9.4ab
NSKS 2 %	9.7ab
Baeuvaria bassiana 10^{13} spores/ha	10.2b
*B.t. kurstak*i 2.0kg/ha	12.5b
EPN (*Steinernema carpocapsae)* 2 lakh IJ/ha	18.7c
Chlorpyrifos 0.25%	6.2a
Control	32.5d
C.D(P = 0.05)	3.6
CV (%)	9.5
SEm ±	2.0

Validation of trap crop and border crops for the management of lepidopteron pests in tobacco

(S. Gunneswara Rao and P. Venkateswarlu)

Validation of *Tagetes* as trap crop

Tobacco with *Tagetes* as trap crop had significantly less number of tobacco plants damaged by *H.armigera* compared to tobacco raised as sole crop

wherein there was progressive increase of damage caused by *H. armigera* from 30 DAT to 60 DAT. Per cent larval parasitization of *H. armigera* infesting tobacco was significantly higher when associated with *Tagetes* as trap crop than in tobacco grown alone. In both the treatments, parasitization by diptera was more than parasitization by Hymenoptera. Parasitization by Hymenoptera progressively decreased whereas that of Diptera progressively increased from 30 DAT to 60 DAT.

Validation of castor as trap crop

Tobacco plants damaged by *S. litura* with trap crop castor were significantly lower than their counterparts grown without the trap crop. There was progressive increase in damage caused by *S. litura* in both the treatments from 50 DAT to 70 DAT but the per cent increase was much less with trap crop than without trap crop. Larval parasitization of *S. litura* in tobacco associated with castor trap crop was significantly higher than parasitization in tobacco without trap crop. In both the treatments parasitization by Hymenoptera was high at 30 DAT and progressively decreased at 60 and 70 DAT. Parasitization by Diptera progressively increased.

It is concluded that parasitization of *H. armigera* and *S. litura* in tobacco with trap crops was 1.13 and 1.30 times more, respectively than parasitization of the pests in tobacco sole crop. Significantly more reduction in damage by the pests was also observed if tobacco was grown with trap crops than without.

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

(S. Gunneswara Rao and P. Venkateswarlu)

At three days after spraying, *Sl* NPV alone was as good as NPV with surf and teepol and NPV with tannic acid plus adjuvants. Significantly higher number of larvae was present when Sl NPV was sprayed with jaggery and starch. At 7 days after spraying NPV alone was at par with all treatments with adjuvants and better than NPV with jaggery and starch. Significantly higher number of larvae was noticed on plants sprayed with jaggery as one of the adjuvants. All the treatments were equally effective in containing leaf damage by *S. litura* over control. Among the NPV treatments highest leaf damage was noticed when jaggery and starch were both added to NPV. Significantly higher number of larvae and damage was noticed in control. Sl NPV alone and all the Sl NPV plus adjuvants treatments without jaggery recorded highest green and cured leaf yield with no significant differences (Fig.25). Sl NPV treatments with jaggery as one of the adjuvants and control recorded significantly lower green and cured leaf yield and all the three treatments remained on par.

Fig. 25: Efficacy of adjuvants in Sl NPV persistence

It is concluded that in tobacco field crop Sl NPV alone was as effective as Sl NPV with adjuvants. Jaggery and starch both should not be added to NPV. Adjuvants did not affect tobacco quality.

Evaluation of BIPM package in soybean

(S. Gunneswara Rao and P. Venkateswarlu)

It is inferred from the results that there was significant reduction in damage caused by *S. litura* in BIPM compared to chemical control, whereas,

the reduction in damage by leaf webber was on par with chemical control. However, the yield was increased by 15% in BIPM plot compared to chemical control plot (Fig.26).

BIPM package

1. Release of *Telenomus remus* for *Spodoptera litura,* depending on the incidence of the pest @ 1, 00,000 parasitoids per ha (Released as soon as the egg masses of *S. litura* were observed)
2. Spray of *Sl* NPV one time @1.5x10^{12} PIB/ha along with 0.5% crude sugar as adjuvant

Chemical control

One spray of monocrotophos and one spray of chlorpyrifos to control leaf webber and *Spodoptera litura* @1.5 and 2.5 ml per liter, respectively.

Fig.26: Biointensive IPM of *S. litura* in Soybean

CTRI Research Station, Guntur

Evaluation of imidacloprid application method for the control of sucking pests of FCV tobacco
(G. Raghupathi Rao)

Imidacloprid 200 SL @ 50g /ha applied through different methods was evaluated in the field against tobacco aphids, *M. nicotianae* on FCV tobacco along with acephate 75 sp@750 g ai/ha. Two days after treatment, aphid population was low in Imidacloprid - foliar application (2.1 /plants) and was on par with foliar application of acephate (750g a.i./ha). Similar trend was observed at 4, 6 and 8 days after treatment. Whitefly incidence was very low. Among the treatments, foliar application of imidacloprid followed by acephate showed lowest whitefly population. Foliar application of imidacloprid followed by acephate showed lowest natural enemy population. Highest activity of natural enemy was observed in untreated control. The activity of coccinellids was more in stem application followed by transplantation. Similarly, more syrphids were recorded in stem application followed by transplantation.

Evaluation of high pressure sprayer for the management of insect pests of FCV tobacco
(G. Raghupathi Rao)

The incidence of whitefly was negligible in the range of 0.5-1/plant and the treatment differences were found to be non-significant. Incidence of aphids was observed 2, 4, 6 and 8 days after spraying. Two days after spray, the aphid population ranged between 8 and 19 aphids/plant and did not vary significantly among the different treatments. Based on mean data, lowest population of 5.87 aphids was recorded in the treatment, spray through high pressure sprayer @ 2 lit/min at every row with 40 cm swath width and it was found superior in minimizing the aphids on tobacco. After the second spray, incidence of *Heliothis armigera* varied significantly from 1.93 to 4.67 larvae/plant in different treatments. The larval population was significantly low (1.93 larvae/plant with 1.53% of infested plants) in plots receiving the treatment. In respect of yield parameters, the treatment differences were non-significant. Taking into consideration the data on incidence of aphid, *H. armigera* and yield

parameters, the above treatment was superior in minimizing the pest incidence with higher yields.

CTRI Research Station, Kandukur

Management of insect pests of tobacco by plant extracts

(K.C. Chenchaiah)

In the laboratory experiment, thirty four plant extracts (5 concentrations) were tried for the control of *H. armigera.* It is inferred from the results that extracts of *Leucas* sp. (95%), *Terminalia arjun* (95%) and *Tagetes erecta* Var. African (90%) gave good control of the larvae of *S. litura* at 10 ml concentration. Similarly, the extracts of *Calotropis* sp. (90%), *Vinca rosea* Var. *Alba* (75%) and *Terminalia arjun* (75%) gave good control of the larvae of *H. armigera* at 10 ml concentration. These extracts will be tested in a replicated field trial to confirm their efficacy against these insect pests.

Management of cigarette beetles of tobacco by plant extracts and inorganic salts

(K.C. Chenchaiah)

The experiment was initiated to evaluate some plant extracts and inorganic salts for the control of cigarette beetle, *Lasioderma serricorne* that damages the tobacco seed and cured leaf. The extracts of *Leucas* sp. and *Piper* sp. inhibited the development of the grub and caused highest mortality of the grubs at 10 µl concentration followed by the extracts of *Nictanthus* sp., *Adiantum* sp. *Myconia* sp. and *Datura stramonium.* The extracts of *Lantena camera* and *Dendrobium* sp. gave lowest control of the grub at all the concentrations.

Evaluation of some IPM modules for the control of insect pests of FCV tobacco under SLS condition

(K.C. Chenchaiah)

This experiment was initiated during 2004-05 cropping season to evaluate six-IPM Modules for the control of the insect Pests of FCV Tobacco under SLS conditions. The IPM Module-5, with need based biological and chemical control gave highest green leaf (3,971 kg/ha), cured leaf (712 kg/ha), bright grade (562 kg/ha), middle grade (82 kg/ha) and low grade (58 kg/ha) yields. While the IPM Module–1, with early planting and chemical schedule gave lowest leaf yield and other yield parameters. The early-planted crop initially suffered largely due to moisture stress but later put up some growth and escaped the attack of insect pests. The two years data were subjected to combined analysis and a similar trend for the yield among the IPM Modules was observed over the two years.

8. SOIL FERTILITY, WATER QUALITY AND NUTRIENT MANAGEMENT

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

(V. Krishnamurthy, M. Mahadeva-swamy and C. Chandrasekhara Rao)

Soil fertility assessment of Hassan district of Karnataka was undertaken during 2005-06. A total number of 812 soil samples were collected from surface (0 – 22.5 cm) and sub-surface (22.5 – 45.0 cm) layers of two taluks viz., Arakalgud and Holenarsipura. These soil samples were processed and analysed for soil pH, electrical conductivity, chlorides, organic carbon, available P and K. Based on soil test values, soil test summaries and nutrient indices values were worked out (Fig. 27).

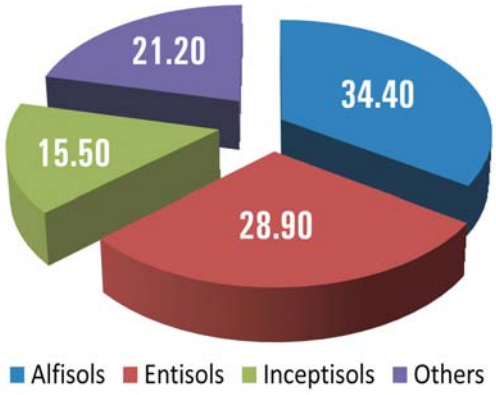

Fig.27: Soils of Hasan district

Nutrient index (NI) values for organic carbon (OC) are low in both the taluks. Holenarsipura taluk showed higher NI values for OC compared to Arakalgud. Nutrient index values for available 'P' were high in both the taluks in surface soils. Hence, phosphorus dose can be reduced to 40 kg P_2O_5/ha in these taluks. Nutrient index values for potassium were medium in both the taluks. Potassium fertilizers have to be applied to soils in both the taluks.

Salient findings

Major soil orders	:	Alfisols, Inceptisols and Entisols
Sub-orders	:	Ustalf, Tropepts, Orthents and Fluvents
Important crops	:	Rice, Finger millet, Sorghum, Coconut, Tobacco, Cotton, Groundnut, Pulses and Chillies·

- Soils are acidic in reaction
- Soluble salts and chlorides are low in both the taluks and hence they are highly suitable for tobacco cultivation
- Soil organic carbon content is low in both the taluks in surface and sub-surface soils
- Available phosphorus is high and hence, phosphorus dose can be reduced to 40 kg P_2O_5/ha
- Available potassium is medium necessitating application of potassium fertilisers as per the recommended dose

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

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

Among the twenty eight samples, 9 samples are from SBS area and 19 samples are from SLS area. Quantity and intensity parameters of soil potassium were measured in all the twenty eight soil samples (Table 28).

Results of the study revealed that variation existed in different Q/I parameters among SLS and SBS soils. AR^K_o values were high in SLS which shows that they have more readily available potassium compared to SBS. PBC^K values were more in SBS compared to SLS which show that they

Table 28: Quantity – Intensity relationship of potassium in SLS and SBS

Region		K_L (cmol (p^+)/kg)	K_0(cmol (p^+)/kg)	K_x(cmol (p^+)/kg)	AR $^K{}_0$	PBC ^{K} (cmol (p^+)/kg)
SBS	Range	0.4 - 1.21	0.257-0.60	0.143 – 0.61	0.002 – 0.0032	80.3 -200
	Average	0.665	0.384	0.281	0.0025	154.1
SLS	Range	0.227-0.646	0.12 – 0.50	0.05 – 0.277	0.0016 – 0.0323	7.3 – 126.4
	Average	0.390	0.250	0.140	0.0094	53.2

have more replenishing capacity compared to SLS. The labile form potassium (K_L), Potassium on specific sites (K_X) and potassium on non specific sites (K_O) were high in SBS soils compared to SLS soils which is a measure of quantity parameter.

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

(P.R.S. Reddy and C.Chandrasekhara Rao)

General soil properties of these soils in four layers of 22.5 cm each in the profile showed that surface soil texture, in general, varied from sand to sandy loam in NLS. Lower layers beyond 45 cm are sandy clays to clays in most of the locations in NLS. Vadalakunta is light textured throughout the profile up to a depth of 90 cm. Soils in general are acidic in reaction with pH ranging from 4.70 to 7.00. Electrical conductivity and chlorides of these soils are low in all the locations and ideal for FCV tobacco cultivation. Organic carbon is low in all layers of soils of all locations. Available P status of soil varied from medium to high in surface layer. Lower layers in general contained low amounts of available P. Available K status of surface soil ranged from low to high. Available K content, in general, was high in lower layers.

In general, surface layers contained higher amounts of available zinc. Available zinc was more than the deficient level of 0.5 mg/kg in surface layers at all locations except at Devarapalli, Dippakayalapadu and Taduvai. East Godavari light soils had relatively higher available zinc content. Available Zn content in surface layers ranged from 0.168 to 2.208 mg/kg with majority of them around 0.9 mg/kg. Available Fe, available Cu and available Mn concentrations were higher than the deficient level of 2.5, 0.2 and 5 mg/kg, respectively in soils of all locations by several folds.

Surface soil samples from four different locations belonging to textural classes, sand and loamy sand with relatively low and high amounts of available zinc in each textural class (Vadalakunta, Chinnayagudem, Taduvai and Jeelugumilli) were selected for studies on fixation of added zinc. In general, fixation of zinc by soil was around 25 to 30% of added zinc at higher levels of added Zn. In general, zinc fixation was less in Jeelugumilli soil. Zinc fixation was relatively higher in Taduvai soil at lower amounts of added zinc. Pot experiment will be taken up with two soils to deplete available zinc to deficient levels by raising exhaust crops for two or three seasons before taking up test crop trial.

Soil Testing Laboratory

One thousand four hundred and sixteen soil samples received from tobacco farmers, tobacco R&D companies and others were analysed during the period. Suitability of soils for FCV tobacco cultivation and fertilizer recommendations were provided to the concerned based on the soil analysis report.

A total of sixty five water samples were analysed during the period. Recommendations on suitability of water for irrigation to FCV tobacco crop were provided to the concerned.

9. ALTERNATIVE USES OF TOBACCO AND REDUCTION OF HARMFUL SUBSTANCES

CTRI Research Station, Jeelugumilli

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

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

Replicated trial (3rd year)

Yield potential of 4 low tar lines (JS 62, JS 115, JS 119 and JS 125) and 5 high yielding lines (JS 96, JS 116, JS 117, JS 128 and JS 129) were tested in an RBD for three consecutive seasons. JS 62 recorded an average of 23-26% increase in cured leaf yield over Kanchan. JS 117 recorded significantly higher cured leaf yield (24-27%) over Kanchan in the last two seasons (Fig.28).

Fig.28: Field crop of JS 117

Based on the over all performance of lines during individual years and on the basis of pooled analysis, the lines JS 62 and JS 117 were promoted for testing under AINRP (T) trials.

Smoke analysis

Eight lines viz. JS 62, JS 73, JS 74, JS 77, JS 78, JS 115, JS 119 and JS 125 were assessed for their tar levels during 2004-05 season. In general tar levels are low. JS 62 and JS 125 recorded lower tar values (around 15 mg/cig).

Burley Tobacco Research Centre, 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)

Seven entries viz. VAM, By Spartan, BY CR 101, By 37, Banket 102, By 49-6 and Banket 127 were identified as nicotine non-converters (Table 29). Nornicotine content was high in ruling cultivars and Va 510, a low TSNA line.

Table 29: Nicotine conversion and total TSNA content in burley germplasm lines

Entry	Nicotine conversion (%)	Total TSNA (ppm)
APIA	12.28	1.5
BY-64	7.10	1.08
BY C 22-1	11.70	0.92
BY-SOTA 51	5.18	1.56
BRIARVET	7.81	1.91
BANKET A.10	6.27	0.83
BURLEY RESISTANT	4.12	0.94
GOLD-2	0.00	1.19
HARROW VELVET	9.86	0.75
KY-10	10.60	1.12
N-503	16.51	1.81
SOTA - 6506	3.99	0.68
THESUES	4.42	0.62
VA 510 (C)	5.01	0.96

Low TSNA and low nicotine conversion are confirmed in lines Gold 2, By. Resistant, Banket A 10, By.64 and Harrow Velvet. Lines, Apia, By. C 22-1, Ky 10 and N 503 recorded low TSNA but slightly higher nicotine conversion. Except lines By. Sota 51

and Briarvet, all the other 12 low TSNA lines were more or less consistent in TSNA content.

Studies on the influence of various agro-techniques on tobacco nitrosamines (TSNAs), yield and quality of burley tobacco

(R. Subba Rao, P. Harishu Kumar, K. Deo Singh and C.V. Narasimha Rao)

Harvested Burley tobacco leaf was cured in air-curing barns with midrib and without midrib (removal of mid rib before curing) grown under various manure and fertilizer schedule for estimating the TSNAs in burley tobacco. The cured leaf yield exhibited statistical variation among the treatments. Tobacco cured with mid rib recorded significantly higher leaf yield over tobacco cured without midrib. Tobacco leaf with midrib has been dried in 21 to 24 days whereas the leaf without midrib has dried in 10 – 12 days.

Among the treatments involving removal of midrib before air-curing, application of *Azotobacter* along with 75% of recommended dose of N/ha and application of 25% organic + 75% inorganic N/ha resulted in 29.1 and 18.4 % reduction in total TSNA, respectively. Application of 120 kg N/ha + 1 kg ammonium molybdate and curing with midrib resulted in 29.1 % reduction in total TSNA (Table 30).

CTRI Research Station, Vedasandur

Breeding for high seed and oil yield in tobacco

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

One hundred and forty five germplasm accessions of chewing,

Table 30: Influence of agro-techniques on leaf yield and TSNA content in burley tobacco

(2005-06)

Treatments	Cured leaf yield (kg/ha)	Total TSNA (ppm)	Reduction in TSNA (%)
Priming and curing with midrib -N: 120 kg /ha	2354	9.31	-
Priming and curing without midrib -N: 120 kg /ha	1656	8.12	12.8
Priming and curing with midrib – Azo + 75% N/ha	2202	9.20	1.2
Priming and curing without midrib - Azo + 75% N/ha	1525	6.60	29.1
Priming and curing with midrib – 25% Organic + 75% inorganic N/ha	2305	9.00	3.3
Priming and curing without midrib - 25% Organic + 75% inorganic N/ha	1595	7.60	18.4
Priming and curing with midrib - 120 kg N/ha + 1 kg ammonium molybdate	2267	6.60	29.1
Priming and curing without midrib 120 kg N/ha + 1 kg ammonium molybdate	1570	8.40	9.8
SE.m ±	105		
CD (P=0.05)	320		

cheroot and cigar filler types, and 15 of other types of tobacco were evaluated along with standards (Bhagyalakshmi, Meenakshi and Abirami) in an augmented block design.

Wide variability found for seed yield as well as component attributes in these accessions. In 39 of the 163 lines the seed yield was more than 1,300 kg/ha. The highest seed yield of 2,239 kg/ha was recorded in the line NP 19 collected from Bihar under no priming. Three other lines viz., Regional Connecticut, A145, and strain 705 recorded seed yields of 2,097, 2,080, and 2,027 kg/ha, under priming. Differential effect of priming on varieties in respect of seed yield was evident. The seed yield of Bhagyalakshmi was 1,424 kg/ha when primed and 1,077 kg/ha under no priming, the trend was just the reverse in Abirami wherein the seed yield was maximum (1,383 kg/ha) under no priming compared to 957 kg/ha under priming. Similarly, the relative contribution of suckers as compared to the main inflorescence to seed yield also deferred between the varieties. It was more or less equal under both priming and non priming in Bhagyalakshmi. In case Abirami, the contribution of sucker: main inflorescence to seed yield was in the ratio of approximately 2:1 under priming and just the reverse (1:2) under no priming.

CTRI, Rajahmundry

Production technology for higher biomass and seed yield

(K. Deo Singh, P. Harishu Kumar, R. Subba Rao, S. Kasturi Krishna and C.V. Narasimha Rao)

The varieties tested for biomass production differed in leaf yield production under rain fed condition while with one irrigation; the leaf yield in general increased but did not differ significantly. The mean data indicated that maximum biomass was recorded in HDBRG (20.322 t/ha) followed by GT-7 (19.751 t/ha), Abirami (18.822 t/ha) and T1-163 (18.410 t/ha) under rain fed conditions. Whereas, under irrigated conditions, maximum biomass was recorded by A145 (32.940 t/ha) followed by HDBRG (29.202 t/ha), GT-7 (26.968 t/ha) and Abirami (25.717 t/ha).

It is inferred from the analysis of nicotine, solanesol and protein in the green leaf samples at different harvests that percentage increased from bottom of the plant (pick I) to top (pick III) in both the cases. Nicotine (2.02 to 4.05 %), solanesol (0.64 to 1.46 %) and protein (2.79 to 4.46 %) increased from bottom level of harvest to top level under rain fed conditions.

However, the percentage increase was more under irrigated conditions compared to rain fed conditions. Pooled data indicated that HDBRG tobacco recorded higher solanesol recovery under rain fed (26.12 kg/ha) and irrigated conditions (26.80 kg/ha). It is closely followed by T1-163 under rain fed conditions and A145 under irrigated conditions with a recovery of 21.58 kg and 22.22 kg/ha, respectively. Nicotine recovery was maximum in A145 under rainfed conditions (69.13 kg/ha) and under irrigated conditions (69.53 kg/ha). Similarly, T1-163 has very closely followed HDBRG tobacco. Under rain fed conditions the recovery was 67.85 kg/ha and under irrigated conditions it was 68.82 kg/ha. Protein recovery (rain fed: 356 kg/ha and irrigated: 470 kg/ha) was higher in HDBRG under both the conditions compared to other varieties. In general, protein recovery was more under irrigated conditions compared to rain fed conditions, followed by GT-7 both in rain fed (329 kg/ha) and irrigated (459 kg/ha) conditions.

It is concluded that HDBRG ranked first for solanesol and protein recovery under rain fed and irrigated conditions while for nicotine, A145 and T1-163

recorded first and second ranks under both conditions. It is clear that HDBRG is stable yielder under both the conditions for protein and solanesol while A145 and T1-163 for nicotine.

Studies on varietal variation in seed production

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

Eight varieties of tobacco were evaluated for their seed yield. The results indicated that the yield differences are highly significant. Maximum seed yield of 958 kg/ha was realized in HDBRG variety and was on par with A145 (785 kg/ha). Maximum oil content (27.16%) was recorded in HDBRG tobacco seed followed by A – 145 (20.60%), VT – 1158 (20.17%) and SC – 58 (20.01%). Maximum oil recovery of 260.19 kg/ha was recorded in HDBRG tobacco followed by A–145 (161.71 kg/ha), SC – 58 (135.47 kg/ha) and Prabhat (122.24 kg/ha). Maximum seed density was recorded in VT-1158 and was at par with SC- 58, Prabhat, Kanakaprabha, HDBRG and GT-7.

Production technology for increasing seed yield of HDBRG tobacco: N, P, K, S requirement under conserved soil moisture and irrigated conditions

(K. Deo Singh, P. Harishu Kumar, R. Subba Rao, S. Kasturi Krishna and K. Siva Raju)

HDBRG tobacco recorded slightly higher seed yield under rain fed conditions compared to irrigated conditions in Vertisols. Under irrigated conditions, the fertilizer treatments did not show any significant difference. However, under rainfed conditions, the treatments were significantly differed. Maximum seed yield of 919 kg/ha was recorded under the schedules of 100-50-150-50 kg NPKS/ha. Except the treatment where NPK @ 100-50-150 kg/ha was applied, all the fertilizer schedules are at par.

A fertilizer dose of 150-50-225 kg NPK/ha recorded the highest oil recovery of 235.99 kg/ha followed by 150-50-225-50 NPKS kg/ha with 234.53 kg/ha under irrigated conditions while under rain fed conditions, the fertilizer schedule 150-50-225-50 NPKS recorded maximum oil recovery of 258.92 kg/ha followed by 100-50-150-50 NPKS kg/ha with 258.33 kg/ha.

Influence of leaf removal on seed yield of HDBRG tobacco in Vertisols

(K. Deo Singh, P. Harishu Kumar, S. V. Krishna Reddy, M. Anuradha and K. Siva Raju)

The experiment was laid out in a randomized block design with four treatments replicated five times. The treatments consisted of different levels of primings and their effect on leaf yield and seed production. Harvesting all leaves had detrimental effect to a tune of 54% on seed yield compared to no leaf harvest in HDBRG tobacco and the seed density also reduced accordingly

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

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

The experiment was laid out with 16 types replicated thrice in a randomized block design. The results indicated that the differences in seed yield by different types did not come to the level of statistical significance. The mean yield was 413.29 kg/ha. Maximum seed yield of 481 kg/ha was recorded in type VR-20 and the minimum 319 kg seed/ha was recorded in type SK-10.

Development of seed production technology in tobacco- Performance of varieties and their hybrids

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

The experiment was laid out in a randomized block design with two varieties and two hybrids at three levels of N with an objective of evaluating them for their seed production potentials and also to see the oil recovery. The hybrid GT 7 x A145 at 150 kg N level under 80 x 40 cm. spacing recorded significantly highest seed yield of 1794 kg/ha representing 33.38 percent increase over A145 and 96.71% over GT 7. This hybrid has resulted in yielding 452 kg oil per ha and significantly superior to other hybrid and parents.

ICAR ad-hoc Project

Synthesis and biological evaluation of solanesol derivatives as novel bioactive substances

{C.V. Narasimha Rao and Kanwal Raj (CDRI)}

Work was carried out under the project in the following areas: raw-material screening, evaluation of solanesol content at different stages of flue-curing, recovery of pure solanesol and solanesol derivatives.

Salient findings

- A total number of 247 samples were analysed
- Higher solanesol content was recorded in the samples from NLS as compared to samples from SLS and KLS
- Maximum solanesol content (3.75%) was recorded in HDBRG tobacco samples
- In some of the *Nicotiana* species samples solanesol ranged from 2.55 to 4.70%
- Pikka tobacco from Orissa was found to be medium in solanesol content
- Solanesol content is low in Cigar filler and Cigar wrapper tobacco from Dinhata; Chewing and Hookah tobacco from Bihar
- Pure solanesol (155 g) was extracted and supplied to CDRI for preparation of derivatives
- Three major impurities with retention times (Rt) 9.067, 10.403 and 11.537 were identified during the HPLC analysis of pure solanesol and the accompanying fractions. The compound with Rt: 10.403 has since been identified as solanesyl ester and characterization of the other two compounds is being attempted
- As the coumarin nucleus appended to solanesol had shown anti-diabetic activity, *in vitro*, its further modification/variation was carried out and the compounds were prepared
- SDB ethylenediamine [N-Solanesyl-N,N-bis (3,4 di methoxybenzyl) ethylene-di-amine] was prepared and its biological evaluation for anti-cancer activity is under progress.

Evaluation of smoke constituents in materials from some Plant Breeding experiments

(C. V. Narasimha Rao)

During the period under report, 10 FCV tobacco leaf samples from different regions and 4 HD Burley tobacco samples were analysed for tar, nicotine, carbon monoxide (Table 31), blend nicotine, reducing sugars and chlorides.

Table 31: Smoke constituents in tobacco
(2006-07)

Tobacco type	Tar (mg/cig)	Nicotine (mg/cig)	CO (mg/cig)
FCV (NLS)	21.08	2.35	10.90
FCV (KLS)	20.52	2.13	10.89
FCV (SLS)	20.95	2.70	11.80
FCV (TBS)	21.72	1.98	12.54
BURLEY	18.13	1.80	8.88

भाकृअनुप
ICAR

Studies on tobacco specific nitrosamines (TSNA) in Indian tobacco and tobacco products

(C.V. Narasimha Rao)

During the period under report, 85 samples were analysed for TSNA including 22 samples of breeding trials and 8 samples of agronomy trials. Mean values of nicotine, nornicotine and TSNA were higher in FCV tobacco samples from NLS when compared to SLS and KLS. Nitrate content was more in KLS and SLS samples as compared to NLS samples (Table 32). In HDBRG tobacco, nicotine and nitrate were higher when compared to FCV tobacco.

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 33).

Table 32: Levels of nitrate, nicotine, nornicotine and TSNA in tobacco

Sample	Nitrate (mg/g)	Nicotine (mg/g)	Nornicotine (mg/g)	Total TSNA (ppm)
FCV (NLS) (11)	1.10 (0.98 -1.20)	29.30 (17.40 –40.10)	0.50 (ND – 1.73)	0.75 (0.43 – 1.14)
FCV (KLS) (24)	1.25 (0.95 – 1.59)	11.80 (5.90 – 22.60)	0.33 (ND- 1.10)	0.35 (ND – 0.93)
FCV (SLS) (20)	1.54 (1.13 – 1.92)	17.47 (5.88 – 29.66)	0.38 (ND- 0.69)	0.38 (0.06 – 1.19)
HDBRG	1.91 (1.24 – 3.26)	30.19 (11.90 – 65.70)	0.38 (ND – 2.17)	10.02 (1.31 - 20.26)

Table 33: Organochlorine pesticide residues (ppm) in FCV tobacco

Area	Total BHC	v- BHC	Chlorp-yriphos	Dieldrin	Total Endosulfan	Total DDT
NLS(20)	0.04 (0.05-0.14)	0.02 (ND-0.05)	0.10 (ND-0.35)	0.04 (ND-0.10)	0.39 (0.04-1.10)	0.09 (0.01-0.70)
KLS(24)	0.08 (ND-0.18)	0.05 (ND-0.20)	0.03 (ND-0.17)	0.04 (ND-0.11)	0.19 (0.09-0.72)	0.03 (ND-0.15)
SLS/SBS/	0.03	0.01	0.03	0.04	0.21	0.04
CBS (30)	(ND-0.16)	(ND-0.05)	(ND-0.12)	(0.01-0.12)	(ND-1.10)	(ND-0.58)
GRL	0.50	0.50	0.50	0.10	1.00	0.40

10. AGRICULTURAL EXTENSION AND INFORMATION TECHNOLOGY

Agricultural Extension

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

(M. Sanni Babu, S. Kasturi Krishna and P.Venkateswarlu)

The location for the demonstration of Farming System was selected at CTRI, Katheru black soil farm for various inter dependable entrepreneurs, recycling of resources for better living by using the modern technologies blended with low cost indigenous technologies. The water harvested in the small pond will be utilized for irrigation for one-acre cultivable land and also pisci-culture. Thus the output of one system will be an input to the other system. Recycling these combinations in the given land can suffice the prime needs of the farmer and attain sustainability.

During 2005-06, the land was leveled, weeds and bushes were cleared. Horticultural plants viz., annual moringa, papaya and banana were planted along the boundary of the field (on the bund). Plantings of vegetable crops bhendi and tomato, vegetable creepers like bottle gourd and ridge gourd and other crops like gingelly and coriander were taken up in the field. The watershed tank bund was also leveled cleared from weeds and bushes. Planting horticultural crops like banana, guava, amla and mangoes, coconut trees and social forestry viz., subabul, *Casuarinas, Eucalyptus* and *Acacia* saplings (energy plantations) were taken up all along the tank bunds.

Multi-dimensional study on burley tobacco in the tribal areas of East Godavari District of Andhra Pradesh

(Y. Subbaiah, R. Subba Rao and S.K. Naidu)

The adoption status was found to be low in Addateegala, medium in Sankavaram and K.D.Peta and high in Rajavommangi divisions. Technology component-wise adoption behaviour clearly indicated that the average adoption rate is ~ 65%, particularly in the technologies: variety, healthy and quality seedlings, planting time, timely gap filling with quality seedlings, plant population, fertilizer application, use of recommended chemicals for pest and disease management on judicious basis, spray of malathion in curing sheds, ridge planting, intercultures, ripe leaf harvest, use of twine for stringing and grading. The technologies viz., application of recommended potash fertilizers, IPM components and timely weeding recorded the lowest adoption rate which needs immediate attention from all the concerned apart from avoidance of plastics and NTRM. Further, it is suggested to arrange community based tractors for undertaking recommended deep summer ploughing. Efforts are to be initiated for arranging healthy and quality seedlings and other critical inputs which encourages the timely application of critical inputs.

The following problems were identified in the area, for productivity (small holdings (0.5 to 1.0 acres); poor financial status of tribal farmers to adopt cost-intensive technological inputs at appropriate time and low knowledge and low to medium adoption status of tribal farmers due to their illiteracy, lethargy and non- availability) and for exports (presence of plastics in

tobacco bales, presence of NTRM in tobacco bales and undesirable flavour due to the exposure of leaf to cattle dung and smoke during air-curing).

Strategies for boosting productivity and exports

- Organizing training programmes for the maintenance of product integrity through adoption of Good Agricultural Practices
- Conducting awareness and knowledge building campaigns through farmer meetings, youth education, slide shows in theatres and cable TV, arranging information corners and distribution of literature
- Supply of natural fibres like Bengal twine and Gogu fibre for stringing
- Popularization of the use of date palm or palmyrah mats for bulking and grading to avoid sand and dust
- Discouraging wetting of cured tobacco by sprinkling water
- Implementation of stringent measures like proper cleaning of curing sheds and avoidance of old storage rooms to avoid DDT residues

Evaluation of Tobacco Portal System

(Y. Subbaiah and S. K. Naidu)

Structured Interview schedule is prepared and pretested in outside the study area to ascertain information on Tobacco Farmer's Portal in terms of its reach and image i.e., Farmer's access to information, Improvement in Farmer's knowledge, Attitudinal change and Adoption rate. Further, schedule will be administered to elicit suggestions for its effective utilization.

The data shows that, though the total number of questions received from NLS area is more as compared to other areas, the average number of questions received from each kiosk per year is highest in the case of CBS followed by SLS, SBS and NLS. It is interesting to note from the data, the average number of questions received from each kiosk is reduced in 3rd year, i.e., 2005 as compared to first two and half years i.e., May, 2002 to December, 2004 in all the tobacco growing areas. However, the questions received are increasing in 4th year, i.e., 2006 which clearly indicates, the technological needs of the farmers is a dynamic and continuous process. Rank-wise utilization pattern indicated that the item, market information received highest number of hits i.e., 56%, while the rest of all Good Agricultural Practices obtained 44% hits.

Analysis of the personality traits of tobacco scientists

(K. Suman Kalyani, S.K. Naidu and P. Harishu Kumar)

With a view to study the personality tests of scientists, three tests viz., Personality Traits, Success Quotient and Basic Needs were conducted for tobacco scientists in the present project. For assessing the personality of the scientists, a culture free and standard test, i.e. Myers Briggs Personality test was conducted for CTRI scientists. For assessing the other aspects of Basic needs and the Success Quotient, two tests were developed. For establishing reliability and validity of the tests, a pilot study was conducted on a sample of 30 scientists of State Departments. After standardizing the tests, the schedules were distributed to a sample of 45 scientists and 25 scientists have returned their schedules after completing them. It is concluded from the data that in respect of personality traits, 48% come under the category "ESTJ (Extrovert, Sensing, Thinking, Judger)", in the case of success quotient, 36% are grouped as "Good" and 48% as "Fair" and as regards basic needs, 68% are under the group "Self Actualization".

Changing Scenario of the Cropping Pattern (SLS, SBS & CBS Regions) of Andhra Pradesh

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

It is concluded from the study that there is no replacement and

substitution for tobacco crop in any of the regions. Even though, there is a change in the cultivable area of tobacco crop after the year of crop holiday, there is a slight increase in the area under tobacco during the year, 2004-05 among the three districts. A negative relationship is observed between the crops of tobacco and chillies in Guntur district (CBS). The area under energy plantations like *Eucalyptus, Casuarina* and subabul is increasing steadily in the three districts (specially grown in barren lands). The increasing trend was noticed from the year 2001-02 in Prakasam and Nellore districts whereas in Guntur district, the increased area was observed during 2004-05.

In Guntur district, an increasing trend is seen in the area under other commercial crops like cotton and chillies. In Prakasam, Nellore and Guntur districts, the area under pulses like chickpea and blackgram is increasing. A declining trend was noticed in all the three districts with respect to the area under millets.

Information Technology

Creation of web pages for CTRI

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

CTRI website domain name was changed to www.ctri.org.in and hosted the same in Internet. New pages viz., Right to Information Act, Annual Report 2004-05, etc. were inserted in the website and new hyperlinks were provided and updated the site regularly.

Information system for FCV tobacco production and marketing trends in India

(H. Ravi Sankar and C. Chandrasekhara Rao)

Software development, Testing and Debugging has been completed. Data entry for tobacco production and marketing for the past 10 years was also completed.

Expert system on pests and diseases of major crops in Andhra Pradesh

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

Developing the software for storing and online retrieval of the information on different pests and diseases of major crops has been completed. Testing, Debugging and data entry into the database is in progress.

Decision support system for FCV leaf quality evaluation

(H. Ravi Sankar and V. Krishnamurthy)

Selection of various parameters for designing the database has been completed. The data-sheet was designed and database was prepared with four major parameters viz., Leaf Chemical quality parameters, Smoke Quality Parameters, Manufacturing Quality parameters and Physical Quality parameters. Software development using Visual Basic.NET, testing and debugging was completed. Data entry is in progress.

Designing algorithms for data classification

(H. Ravi Sankar)

Classification is one of the functionality of data mining. Various algorithms have been designed to classify the data by various researchers. 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. Coding was Debugged in some of the modules and tested with the data. Created the setup program again and tested its compatibility. Datasheets for insect pests of rice, maize and sugarcane prepared. Data entry is in progress.

TECHNOLOGY ASSESSED AND TRANSFERRED

Three improved FCV varieties viz., Kanthi (Cy 79), Hemadri (II 1624), Siri (Cy 135) and one Natu tobacco variety, Bhairavi (NG 73) were released by the AP State Variety Release Committee for commercial cultivation. Two chewing tobacco varieties Abirami and Kaviri were released for commercial cultivation by Tobacco Variety Release Committee for Tamil Nadu.

Closer spacing of 0.7 x 0.5 m and application of 45 kg N/ha were found to be optimum for the FCV advanced breeding lines Cy 135 and Cy 139 for higher cured leaf production at Rajahmundry. In Vertisols, soil application of vermicompost @ 2.5 t/ increased the cured leaf, bright leaf and grade index over control.

In NLS the N:K ratio of 1:1.5 (100 kg N/ha: 150 kg K_2O/ha) recorded maximum cured leaf of 2972 kg/ha and two foliar sprays 0.5% $ZnSO_4$ + 0.5% $MgSO_4$ at 35 and 45 days after planting and topping at 24 or 28 leaves recorded higher GLY, CLY and GI.

Application of prilled potassium nitrate was found on par with SOP in terms of yield and quality of flue-cured tobacco in NLS and KLS.

In SLS, one life saving irrigation utilizing water harvested from farm ponds improved yields by 23.5% in cured leaf and 20.2% in bright leaf. This translated into the increase in the net income by Rs. 9,000/ha.

The bulk trial conducted at Hunsur to evaluate the field performance of tray nursery seedlings indicated an increase of 6.2% in cured leaf yield and about 7.5% increase in top grade equivalent in variety Kanchan. The technology was also found economically feasible and viable. In KLS, application of vermicompost @ 4 /ha + recommended NPK dose was found promising in increasing productivity as well as reducing the root-knot incidence as compared to recommended practice of FYM application @ 8 t/ha + NPK. The bulk trial revealed that application of vermicompost @ 2 t/ha and 4 t/ha increased the yield by 8.0% and 12.9%, respectively, and the plant hole application at the time of planting was found more effective.

For the burley tobacco variety Swetha, closer spacing of 0.7 x 0.5 m recorded significantly higher yield of 4.8 and 11.1%, respectively, over 0.8 x 0.5 and 0.9 x 0.5 m spacing. Nitrogen level at 120 kg/ha was found to be optimum. In West Bengal, for the newly released *Jati* tobacco variety, Manasi, a fertilizer level of 150 kg N/ha + 50 kg K_2O/ha was found to be beneficial in terms of higher nutrient composition in leaves and increase in the available nutrient status of the soil. Basal application of 125 kg N/ha in the form of calcium ammonium nitrate was found beneficial in terms of quantitative and qualitative production besides fetching higher monetary returns in *Jati* tobacco.

Turbofan fixing at the top of the barn and operating during curing saves 400-500 kg fuel and 20 hours curing time per charge in NLS and KLS.

Maize – tobacco cropping system gave significantly higher green and cured leaf yields followed by fallow – tobacco in Vertisols. In the north Bengal region, Jute – Aman paddy – Tobacco cropping sequence was found to be a more profitable cropping sequence.

Clothianidin 50 WDG @ 22.5 g a.i./ ha effectively checked aphids on FCV tobacco. Stem application of imidacloprid @ 1: 40 or thiamethoxam @ 1: 20 was able to check aphid infestation on FCV tobacco and

supported higher natural enemy activity as compared to foliar spray of the insecticides.

In KLS, an integrated wilt management module comprising seven tips including chemical control with carbendazim or copper hydroxide which gave a CBR of 1: 1.2 and 1:1.39, respectively is recommended. Kocide 101 (copper hydroxide 77%) confirmed to be an effective fungicide for the control of several soil-borne fungal diseases in nursery which include damping-off, blight, black shank, anthracnose and frog eye-spot. The bio-intensive module for nursery diseases management with soil-solarization, neem cake amendment and application of *Aspergillus niger* enriched FYM gave a CBR of 1:8.2. Application of *Pseudomonas fluorescens* (pf1 strain) @ 1g/plant hole in combination with *Aspergillus niger* enriched FYM @ 100 g/plant at planting caused 74.5 and 49% reduction in *Fusarium* wilt and root-knot index, respectively. Resultant increase in total cured leaf and bright grade leaf yield was 26 and 54.5%, respectively, over untreated check.

In West Bengal, bacterial wilt disease in *Jati* and *Motihari* tobacco nurseries and field crop can effectively be controlled by the application of powdered lime @ 560 kg/ha after land preparation and keeping the land fallow for a period of 20-30 days.

Green manuring with sunnhemp was found effective in increasing the productivity of bidi tobacco at Anand.

Hybrid bidi tobacco, GTH 1 can be planted during 16th August - 15th September with 45 days old seedlings to obtain high yields under Anand conditions.

Integration of pressmud and *Trichoderma viride* in the integrated management of Black shank disease of FCV tobacco gave significantly higher cured leaf yield (1,213 kg/ha) and TGE (808 kg/ha) at Shimoga when compared to other treatments and untreated check. Reduced incidence of black shank disease was recorded up to 71% by integrating pressmud (spreading) and *Trichoderma viride* application.

Highest cured leaf yield of 1,064 kg/ha was recorded at Shimoga in KLS with 75% recommended N through fertilizer + 2.5 kg/ha *Azotobacter* + 5 t/ha of FYM Indicating the possibility of reducing fertilizer N to the extent of 25% in FCV tobacco cultivation.

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EDUCATION AND TRAINING

The Central Tobacco Research Institute has undertaken the extension activities like training the farmers, 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 coupled with quality, during 2006-07.

Training programme on 'Soil and Water Analysis' was conducted for the officials of Tobacco Board, Ongole and Periyapatna from 3rd to 17th July 2006 at this Institute.

A tobacco farmers training programme on 'Nursery Management' was conducted at CTRI Research Station, Dinhata on 16th September, 2006. A good number of farmers representing different areas of the district were imparted training. On this occasion, a pamphlet in Bengali language entitled "Raising of ideal tobacco nursery in North Bengal" was brought out for the benefit of tobacco farmers of North Bengal region.

A 'Rythu Sadassu' on 'Tobacco Nursery Management' was organized on 11th October, 2006 at commercial tobacco nursery in Dommeru village, wherein 35 farmers have actively participated in the meeting. On this occasion, a 'Question and Answer Session' was conducted for the benefit of farmers. Field visit was undertaken by the Scientists in an area of 20 acres.

CTRI Research Station, Hunsur organized a two days farmers' training programme on 'Organic Farming' from 12 to 13th October, 2006 at CTRI Research Station, Hunsur, in collaboration with Regional Centre of Organic Farming, Bangalore.

Kisan Mela was conducted at CTRI Research Station, Kandukur on 6th January, 2007. About 500 farmers visited the experimental plots and an exhibition on "Tobacco and its management" and acquainted themselves with the new technology on tobacco. Kisan Mela was conducted at CTRI Research Station, Guntur on 18th January, 2007

Krishi Vigyan Kendra of Central Tobacco Research Institute, Rajahmundry organized 'Farmers Day' on 27th January, 2007 at Kalavacherla. An exhibition was arranged and Question-Answer Sessions were organised in the Farmers' Day.

A total number of 425 questions pertaining to all aspects of tobacco production received from the growers of Andhra Pradesh were answered with updated information through Farmers' Portal established at CTRI, Rajahmundry.

Particulars of Programmes Attended

Sl. No.	Participant (s)	Programme attended	Date and place
1.	Sri R. Subba Rao	Impart training to field staff on burley tobacco cultivation	May 23-25, 2006; Viziayanagaram & Parvathipuram
2.	Dr. M. M. Shenoi SriK.N.Subrahmanya	Meeting of Core Team with farmers called by Director (Auctions), Tobacco Board	July 10, 2006; Hunsur.
3.	Dr. A R Panda Sri R. Sreenivasulu	Training programme for ITC trainees on "Production technology of SLS (Tobacco)"	July 17,2006; Kandukur

Sl. No.	Participant (s)	Programme attended	Date and place
4.	Dr. M. M. Shenoi	Farmers' training on "Judicious use of pesticides and social responsibility"	July 21,2006; Hunsur
5.	Dr. M. M. Shenoi	Farmers' training on "Post-harvest product management"	July 21,2006; Melur, Periyapatna
6.	Dr. M. M. Shenoi	Farmers' training on "Post-harvest product management"	August 9, 2006; Bannikuppe & Mardur
7.	Dr. M. M. Shenoi	Farmers' training on "Post-harvest product management"	August 10, 2006; Chapparadahally & Ambalare
8.	Dr. M. Mahadevaswamy Dr. S. Ramakrishnan	Farmers' training on "Post-harvest product management"	August 11, 2006; Ankanahally & Suragally
9.	Sri K. N. Subrahmanya	Farmers' training on "Post-harvest product management"	August 14, 2006; Agrahara & Kirsodlu
10.	Dr. M. M. Shenoi	Farmers' training on "Post-harvest product management"	August 14, 2006; Harinahally & Bekya
11.	Sri K. N. Subrahmanya	Farmers' training on "Post-harvest product management"	August 17, 2006; Kothegala
12.	Dr. M. M. Shenoi	Farmers' training on "Post-harvest product management"	August 19, 2006; Hirekyathanahalli & Seeranahally
13.	Sri K. N. Subrahmanya	Farmers' training on "Post-harvest product management"	August 19, 2006; Badaga & Dadadahally
14.	Dr. A.R. Panda Sri R. Sreenivasulu Sri V. Venkateswarlu Dr. K.C. Chenchaiah	Training programme to the staff of Tobacco Board, field staff of Tobacco companies on "Tobacco nursery management"	August 21, 2006; CTRI RS, Kandukur
15.	Sri K. N. Subrahmanya	Farmers' training on "Post-harvest product management"	August 23, 2006; Kaulanahally
16.	Dr. M. M. Shenoi Sri K.N.Subrahmanya	Farmers' training on "Post-harvest product management"	August 23, 2006; Melur & Kothavally koppalu
17.	Dr. M. M. Shenoi	Farmers' training on "Post-harvest product management"	August 23,2006; Guddenahally & Badekyathanahally

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Sl. No.	Participant (s)	Programme attended	Date and place
18.	Sri M. Sanni Babu	Training programme on “Seed bed preparation, nursery management, pest and disease control in seed beds"	August 25, 2006; Kota Nagavaram
19.	Dr. M. Mahadevaswamy	Farmers’ training on "Post-harvest product management"	August 29,2006; Karpuravally
20.	Sri K. N. Subrahmanya	Farmers’ training on "Post-harvest product management"	August 30,2006; Hadya & Nadappanahally
21.	Sri M. Sanni Babu Dr.J.V.Prasad	Training programme to the farmers and Tobacco Board staff on “Nursery management"	August 30, 2006; Jeelugumilli
22.	Dr. M. M. Shenoi	Farmers’ training on "Post-harvest product management"	September 1, 2006; Basavarajapura & Melur
23.	Sri M. Sanni Babu Dr. P. Venkateswarlu	Training programme on “Seed bed preparation, nursery management, pest and disease control in seed beds"	September 6, 2006; Sangaigudem & Gandhinagaram
24.	Dr. J.V. Prasad	Training programme on “Nursery management, pest and disease control in seed beds“	September 6, 2006; Kannapuram
25.	Sri. K. N. Subrahmanya	Farmers’ training on "Post-harvest product management"	September 14, 2006; Hunsekuppe
26.	Sri K. N. Subrahmanya	Farmers’ training on "Post-harvest product management"	September 14, 2006; Gagenahally
27.	Dr. M. M. Shenoi	Farmers’ training on "Post-harvest product management"	September 14, 2006; Bhuvanahally
28.	Dr. M. M. Shenoi	Farmers’ training on "Post-harvest product management"	September 15, 2006; Halaganahally
29.	Sri M. Sanni Babu Dr. J.V. Prasad	Training programme on “Main field preparation, fertilizer application, ridge formation, plantings, inter-cultivations, IPM and irrigations"	September 20, 2006; Makkinavarigudem
30.	Dr. A R Panda Sri R. Sreenivasulu	Farmers training programme on "Raising tobacco nurseries"	September 21, 2006; Maddiralapadu

Sl. No.	Participant (s)	Programme attended	Date and place
31.	Sri M. Sanni Babu Sri S. Gunneswara Rao	Training programme on “Main field preparation, fertilizer application, ridge formation, plantings, inter-cultivations, IPM and irrigations"	September 21, 2006; Borrampalem
32.	Dr. K. Palanichamy	Meeting of Tamil Nadu Chewing tobacco farmers, manufacturers, dealers and workers association	September 24, 2006; Bhavani Tamilnadu
33.	Dr.C.Chandrasekhara Rao Dr. U. Sreedhar Dr. S. Kasturi Krishna	Training programme on “Seed bed preparation, nursery management, pest and disease control in seed beds"	September 27, 2006; Thorredu
34.	Sri R. Sreenivasulu	Farmers training programme on "Tobacco nurseries"	September 27, 2006; Ongole I
35.	Dr. A. R. Panda Sri R. Sreenivasulu Sri V. Venkateswarlu Dr. K.C. Chenchaiah	Training programme to the staff of Tobacco Board, field staff of Tobacco companies on "Field crop management (Tobacco)"	September 28, 2006; CTRI, RS, Kandukur.
36.	Dr. A. R. Panda	Farmers meeting	October 1, 2006; Kaligiri
37.	Dr.A.R.Panda Sri R. Sreenivasulu	Awareness programme on "Tobacco production"	October 10, 2006; Ongole II
38.	Dr. K. Nageswara Rao Dr. S. Kasturi Krishna	Training programme on “Main field preparation, fertilizer application, ridge formation, plantings, inter-cultivations, IPM and irrigations"	October 12, 2006; Devarapalli
39.	All Scientists and Technical Officers of CTRI RS, Hunsur	Farmers’ training programme on "Organic farming"	October 12 -13 2006 CTRI RS, Hunsur
40.	Dr. S.V. Krishna Reddy Sri. S.Gunneswara Rao	Training programme on “Main field preparation, fertilizer application, ridge formation, plantings, inter-cultivations, IPM and irrigations"	October 13, 2006; Pothineedipalem
41.	Dr.C.Chandrasekhara Rao	Delivered invited lecture in the Seminar on "The role of sulphur nutrition in maize crop"	October 29, 2006; Ravulapalem
42.	Dr. M. M. Shenoi Sri K.N. Subrahmanya Dr. M. Mahadevaswamy	Farmers’ training under “Rabi crop cultivation management–2006”	October 31, 2006; Hunsur
43.	Dr. J.V. Prasad Sri M. Sannibabu	Training programme to growers on "Practices from land preparation to post-harvest management aspects"	November 2, 2006; Vankavarigudem

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Sl. No.	Participant (s)	Programme attended	Date and place
44.	Dr. A. R. Panda Sri R. Sreenivasulu	Inter-agency team visit to SLS area	November 8-10, 2006; Podili, Kaligiri & Ongole
45.	Dr. P. Venkateswarlu	Training programme on “Good agricultural practices”	November 20, 2006; Pothavaram
46.	Shri R. Sreenivasulu	Farmers training programme on "Cultivation of FCV tobacco"	November 22, 2006; Pydipadu
47.	Sri S. Nageswara Rao Sri T.Krishnamurthy	Training programme on "Intercultural operations“	November 27, 2006; Gopalapuram
48.	Dr.A.R.Panda Sri R. Sreenivasulu	Farmers meeting on "Production of FCV tobacco"	November 29, 2006; Cumbham
49.	Sri R Sreenivasulu	Training programme on "FCV tobacco production"	November 30, 2006; Yerrareddypalem
50.	Sri M. Nageswara Rao Sri I.J. Chandra	Training programme on “Main field operations, fertilizer applications, plantations, inter-cultivation & IPM"	November 30, 2006; Rapaka & Sithanagaram
51.	Dr.A.R.Panda Sri V. Venkateswarlu Dr. K.C. Chenchaiah	Training programme to the staff of Tobacco Board, field staff of Tobacco companies on "Tobacco harvesting, curing, PHPM"	December 7, 2006; CTRI RS, Kandukur
52.	Dr. V. Krishnamurthy Dr. P. Harishu Kumar Dr. C.A. Raju Dr. K. Sarala	Training programme on “Main field operations, fertilizer applications, plantations, inter-cultural, irrigations and IPM”	December 9-10, 2006; Badrachalam
53.	Dr.P.Harishu Kumar Dr. R.V.S. Rao Dr. C.V.N. Rao Dr. U. Sreedhar Sri. M. Sannibabu Dr. C.C.S. Rao Dr. Kasturi Krishna Dr. S.V. Krishna Reddy	Study tour programme of FCV tobacco growers of Podili-I and II	December 16, 2006; CTRI Rajahmundry
54.	Dr.A.V.S.R. Swamy	Training programme to growers and curers on "Harvesting, curing, and post-harvest product management"	December 21-23, 2006; Podili, D.C.Palli, Kandukur
55.	Dr.K.Nageswara Rao	Training programme on “Toping and desukering, harvesting and curing, grading and post-harvest product management“	December 28, 2006; Challavarigudem

Sl. No.	Participant (s)	Programme attended	Date and place
56.	Dr. K.C. Chenchaiah	Farmers training on "Harvesting, grading and NRM strategies"	January 2 , 2007; K Uppalapadu
57.	Dr. K. Nageswara Rao	Training programme on “Harvesting, curing, PHPM and NTRMs”	January 17 -20, 2007; Ongole
58.	Dr.A.R.Panda Sri R Sreenivasulu	Farmers meeting on "Harvesting, curing and grading of FCV tobacco"	January 24, 2007; Juvvi gunta
59.	Sri Shaik Ameer Ali	Training programme on “Curing techniques to curers and graders“	February 1, 2007; Mallavaram
60.	Sri K. Sesha Sai Smt. K.Sathi Nandivelu	Training Programme on “Toping and desukering, harvesting and curing, grading and post-harvest product management“	February 1, 2007; Gopalapuram
61.	Dr.P. Harishu Kumar Sri M.Sanni Babu Dr.P.Venkateswarulu Dr.K.Nageswara Rao	Orientation Programme on “Tray nurseries, organic fertilizer use, IPM methods, drip irrigation system, ripe leaf harvest, fuel saving techniques, PHPM and removal of NTRMs”	February 2, 2007; CTRI RS, Jeelugumilli
62.	Sri R. Sreenivasulu	Farmers training programme on "Curing and grading of FCV tobacco"	February 5, 2007; Kandukur
63.	Sri T. Krishna Murthy Sri I.V.Subba Rao	Training programme on ‘Harvesting and curing, grading and post-harvest product management and NTRM”	February 6, 2007; Thorredu
64.	Sri S.S. Prasad Sri G. Adinarayana Sri M. Nageswara Rao	Training programme on “Toping and desukering, harvesting and curing, grading and post-harvest product management “	February 7, 2007; koyyalagudem
65.	Sri M. Nageswara Rao Sri I.J. Chandra Sri T.Krishna Murthy	Training programme on “Toping and desukering, harvesting and curing, grading and post-harvest product management“	February 8,2007; Badrachalam
66.	Dr. S.Roy	Visit to disease affected farmers fields of different locations in Dinhata division to suggest farmers how to mitigate the problem and control measures of different disease of tobacco	February 11, 2007; Dinhata
67.	Sri V. Madhava Rao	Curers training programme	March 5, 2007; Vadisileru

Sl. No.	Participant (s)	Programme attended	Date and place
Field Days/ *Rythu Sadassulu*			
1.	Sri M. Sanni Babu	Rythu Sadasu	May 5, 2006; Jangareddigudem
2.	Sri M. Nageswararao Sri K.Sesha Sai	Field Day on "Integrated Pest Management"	January 12, 2007; Ankalagudem
3.	Dr. K.C. Chenchaiah	Field Day and Farmers Training	January 23, 2007; Vennuru
4.	Sri .R. Sreenivasulu	Field Day and Farmers meeting	February 3, 2007; Cherkurapadu
5.	Dr. K.C. Chenchaiah	Field Day and Farmers Training on Insect Pest Management	February 7,2007; Ankabhupalapuram
6.	Sri R. Sreenivasulu	Field Day and Farmers meeting	February 13, 2007; R R Palem
7.	Sri M.Sanni Babu Sri M.Nageswara Rao Sri I.Jagadeesh Chandra	Field day Result Demonstration Programme	February 20, 2007; Aswaraopet
8.	Sri T.Krishna Murthy Sri S.Nageswara Rao	Field Day	February 28, 2007, Thorredu
9.	Sri I.Jagadeesh Chandra Sri M.Nageswara Rao	Field day on "Harvesting, Curing, Bulking and elimination of NTRMS"	March 14,2007; Mysannagudem
10.	Dr .V.Krishna Murthy Dr. C.A.Raju Dr. R V S Rao Dr. C.V.N.Rao	Field Day on 'Farm trial plots'	March 15, 2007; Rudramkota & Velurupadu
FIELD VISTS			
1.	Sri K.N. Subramanya Dr.S.S.Sreenivas	Visit to farmers' fields and attended Farmers' Group Meeting on "*Fusarium* wilt disease management" Area under Auction Platform No.7	June 9, 2006; Ramanathapura
2.	Dr. M. M. Shenoi Sri K.N. Subramanya	Visit to farmers' fields and attended Farmers' Group Meeting on "*Fusarium* wilt disease management" Area under AuctionPlatform No.4	June 13, 2006 Periyapatna
3.	Dr. M. M. Shenoi Sri K.N. Subramanya	Visit to farmers' fields and attended Farmers' Group Meeting on "*Fusarium* wilt disease management" Area under Auction Platform No.2	June 23, 2006; Hunsur

Sl. No.	Participant (s)	Programme attended	Date and place
4.	Sri K.N. Subramanya Dr.S.S.Sreenivas	Visit to farmers' fields and attended Farmers' Group Meeting on "*Fusarium* wilt disease management" Area under Auction Platform No.6.1 and 6.2	June 29, 2006; Kampalapura
5.	Dr.S.Ramakrishnan Dr.S.S.Sreenivas	Visit to farmers' fields and attended Farmers' Group Meeting on "*Fusarium* wilt disease management" Area underAuction Platform No.3	June 30, 2006; Hunsur
6.	Dr. M. Mahadevaswamy Dr. S. S. Sreenivas	Visit to farmers' fields and attended Farmers' Group Meeting on "*Fusarium* wilt disease management" Area under Auction Platform No.6	July 1, 2006; Periyapatna
7.	Dr. M. M. Shenoi Sri K. N. Subrahmanya	Visit to farmers' fields and attended Farmers' Group Meeting on "*Fusarium* wilt disease management" Area under Auction Platform No.5	July 3, 2006; Periyapatna
8.	Sri K. N. Subrahmanya	Visit to farmers' fields and attended Farmers' Group Meeting on "*Fusarium* wilt disease management" Area under Auction Platform No.1	July 4, 2006; H.D. Kote
9.	Sri K. N. Subrahmanya	Visit to farmers' fields and attended Farmers' Group Meeting on "*Fusarium* wilt disease management" Area under Auction Platform No.4	July 7,2006; Periyapatna
10.	Dr. M. Mahadevaswamy Dr. S. S. Sreenivas	Visit to farmers' fields and attended Farmers' Group Meeting on "*Fusarium* wilt disease management" Area under Auction Platform No.2	July 8, 2006; Hunsur
11.	Dr. M. Mahadevaswamy Dr. S. Ramakrishnan	Visit to farmers' fields and attended Farmers' Group Meeting on "*Fusarium* wilt disease management" Area under Auction Platform No.7	July 11, 2006; Ramanathapura
12.	Dr. A.R. Panda	Nursery visit and Farmers meeting	September 11, 2006;Podili, Markapur
13.	Dr. A. R. Panda	Field visit and Farmers meeting	September 13, 2006; DC Palli
14.	Dr. A. R. Panda	Field visit and Farmers meeting	September 22, 2006; Ongole
15.	Dr. A.R.Panda	Field visit and Farmers Meeting	October 3, 2006; Mogilicherla

Sl. No.	Participant (s)	Programme attended	Date and place
16.	Dr.A.R.Panda	Field visit and Farmers Meeting.	October 11, 2006; Ongole
17.	Dr.A.R.Panda	Field visit and Farmers Meeting	October 14, 2006; Dornala
18.	Dr. A.R.Panda	Field visit and Farmers Meeting	October 15, 2006;DC Palli
19.	Dr.A.R.Panda Dr. K.C. Chenchaiah	Field visit and Farmers Meeting	October 20, 2006; Maddiralapadu
20.	Dr.A.R.Panda	Field visit and Farmers Meeting	October 24, 2006; PC Palli
21.	Dr.A.R.Panda	Field visit and Farmers meeting	October 31, 2006; K Aagraharam
22.	Dr.A.R.Panda Dr. K.C. Chenchaiah	Field visit and farmers meet	November 30, 2006; Ankabhupalapuram
23.	Sri R. Sreenivasulu	Field visit and farmers training.	November 7, 2006;Podili
Kisan Melas			
1.	Dr. M.M..M.Shenoi Dr. M..Mahadevaswamy Sri S. Ramesh Sri T. Venkatesh Sri Ramachandre Gowda	Krishimela-2007 of JSS KVK, Suttur	January 18, 2007, Suttur
2.	Dr.K. Nageswara Rao Dr.J.V.Prasad	Kisan Mela	March 8, 2007; Maruteru

Sl. No.	Participant (s)	Programme attended	Date and place
Guest Lectures/ Orientation Programmes Attended			
1.	Dr. Y. Subbaiah	State level seminar on "Coir industry in Andhra Pradesh"	August 24- 25, 2006; Rajahmundry
2.	Sri S. Gunneswara Rao Sri R. Sudhakar	As resource persons in the "Orientation programmes for science teachers"	August 28 - 31, 1-2 September, 2006; Rajahmundry, Ramachandrapuram, Kakinada & Rampachodavaram
3.	Sri. R. Subba Rao Smt. N. Aruna Kumari	Training programme on "Entrepreneurship development programme for farmers of Yanam region"	September 13, 2006; Yanam
4.	Dr. V. Krishnamurthy	ICAR sponsored Winter School on "New dimensions in integrated nutrient management of major field crops for sustainable crop production"	October 23, 2006; DOR, Hyderabad
5.	Dr. A. R. Panda Sri R Sreenivasulu	District level coordination committee (DLCC) meeting held at District agricultural technology transfer centre	October 19, 2006; Ongole
6.	Dr. K. Siva Raju Dr. M. Anuradha Sri Gunneswara Rao Dr. K. Suman Kalyani	Evaluate the projects presented at the District level children's science congress – 2006	November 4, 2006; Rajahmundry
7.	Dr. U. Sreedhar	Guest lecture on "Pesticides - pollution" at S.K.R. College for Women	November 21, 2006; Rajahmundry
8.	Dr.K.Siva Raju	"V Bio-fest-Enzyme Kaleidoscope"	December 20, 2006;Kakinada
9.	Dr. C.A. Raju	"Science day" at Aryabhatta science and technology society	February 28, 2007; Rajahmundry

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Radio Talks

Sl. No.	Name	Topic, Station & Date of broadcast
1.	Dr. V.Krishnamurthy	Suitable soils for FCV tobacco cultivation and importance of soil testing (AIR, Visakhapatnam, 13.4.2006)
2.	Dr. Y. Subbaiah,	Proper usage of investments in agriculture (AIR, Visakhapatnam 28.4.2006)
3.	Dr. P Harishu Kumar	Importance of summer ploughings and green manuring crops in FCV tobacco production (AIR,, Visakhapatnam, 29.4.2006)
4.	Dr. K. Sarala,	Role of bio-technology in developing new varieties (AIR, Vijayawada, 9.5.2006)
5.	Dr. J. V. Prasad,	IPM in FCV tobacco using pest monitoring methods (AIR, Visakhapatnam 21.5.2006)
6.	Smt. V.V.Lakshmi Kumari	Fruit juices in summer (AIR, Visakhapatnam, 18.5.2006)
7.	Dr. B. John Babu,	Rearing of different breeds of backyard poultry (AIR, Visakhapatnam, 30.5.2006)
8.	Sri I.V. Subba Rao,	Management practices for burley tobacco nursery in agency area of AP. (AIR, Visakhapatnam, 11.6.2006)
9.	Sri R. Sudhakar,	Women empowerment programme of KVK (AIR, Visakhapatnam, 24.6.2006)
10.	Dr. R.V.S. Rao	High yielding varieties of FCV tobacco (AIR, Visakhapatnam, 9.7.2006)
11.	Smt. N. Aruna Kumari	Role of supplementary nutrition - Hints to mother (AIR, Visakhapatnam, 20.7.2006)
12.	Dr.V. Krishnamurthy,	Fertilizer management in burley tobacco cultivation (AIR, Visakhapatnam, 24.8.2006)
13.	Smt.J.V.R. Satyavani	Kitchen garden raising (AIR, Visakhapatnam, 24.8.2006)
14.	Dr. S.V. Krishna Reddy	Management of tobacco nurseries (AIR, Visakhapatnam, 30.8.2006)
15.	Dr. C.A. Raju	Control of pests and diseases in tobacco nurseries (AIR, Visakhapatnam,13.9.2006)
16.	Dr. P.V.V.S. Siva Rao	Prevention of rabies in cattle (AIR, Visakhapatnam, 14.9.2006)
17.	Dr. B. John Babu,	Role of mixed farming and dairy in National Agricultural Policy (AIR, Viskhapatnam, 19.9.2006)

Sl. No.	Name	Topic, Station & Date of broadcast
18.	Smt.V.V.Lakshmi Kumari	Food beliefs and taboos in health and nutrition (AIR, Vijayawada, 12.10.2006)
19.	Sri S. Jitendranath	Modern methods in paddy sowing - Advantages (AIR, Viskhapatnam, 20.10.2006)
20.	Dr. P.R.S. Reddy	Fertilizer management in FCV tobacco cultivation (AIR, Visakhapatnam 8.11.2006)
21.	Sri E. Vijaya Prasad	Integrated fertilizers management in orchids (AIR, Viskhapatnam 9.11.2006)
22.	Sri R. Sudhakar	Coir yarn making activity as a self employment programme for rural women (AIR, Vijayawada, 13.11.2006)
23.	Sri R. Sreenivasulu	Improved package of practices for FCV tobacco production in Southern Light Soils (SLS) area (AIR, Vijayawada, 19.11.2006)
24.	Smt. J.V.R. Satyavani	Balanced fertilizer management in orchids (AIR, Viskhapatnam 29.11.2006)
25.	Dr. S. Kasturi Krishna,	Tips for FCV tobacco production (AIR, Visakhapatnam, 30.11.2006)
26.	Dr. Y. Subbaiah,	Oil seeds and pulses development programmes (AIR, Visakhapatnam, 17.12.2006)
27.	Smt. N. Aruna Kumari	Tips to improve the nutritional values in our daily diet (AIR, Vijayawada, 18.12.2006)
28.	Dr. P.Venkateswarulu	Management of pests and diseases in tobacco field crop (AIR, Visakhapatnam, 21.12.2006)
29.	Sri S.Gunneswara Rao	Plant protection through bio-control methods in tobacco (AIR, Visakhapatnam, 31.12.2006)
30.	Sri V. Venkateswarlu,	Diseases in tobacco field crop - Control measures." (AIR, Vijayawada, 11.01.2007)
31.	Sri R. Sreenivasulu	Tips in leaf harvesting and curing operations in tobacco (AIR, Vijayawada,16.1.2007)
32.	Dr. U. Sreedhar	Rational use of pesticides in tobacco cultivation (AIR, Visakhaptnam,18.1.2007)
33.	Smt.V.V.Lakshmi Kumari	Diet during old age (AIR, Vijayawada, 22.1.2007)
34.	Sri S. Jitendranath,	Modern agricultural implements (AIR, Vijayawada, 30.1.2007)

Sl. No.	Name	Topic, Station & Date of broadcast
35.	Dr. Y. Subbaiah	Tips for scientific grain storage methods (AIR, Visakhaptnam, 7.2.2007)
36.	Dr. P.V.V.S. Siva Rao	Rearing of different breeds in backyard poultry (AIR, Vijayawada,11.2.2007)
37.	Smt. N. Aruna Kumari	Nutritional importance in prevention of anemia (AIR, Visakhaptnam, 22.2.2007)
38.	Sri R. Subba Rao	Tips in leaf harvesting and curing operations in tobacco (AIR, Visakhaptnam 24.2.2007)
39.	Sri R. Sudhakar	Training to rural youth on handicrafts in leisure time (AIR, Vijayawada,11.3.2007)
40.	Smt. J.V.R. Satyavani	Tips for chillies cultivation (AIR, Vijayawada, 13.3.2007)
41.	Dr. C.C.S. Rao	Post-harvest technologies for tobacco cultivation (AIR, Visakhaptnam, 18.3.2007)
42.	Smt. N. Aruna Kumari	Importance of soybean in protection of health (AIR, Vijayawada 18.3.2007)
43.	Dr. A.V.S.R. Swamy	Importance of FCV tobacco grading system (AIR, Vijayawada,21.3.2007)
44.	Sri E. Vijaya Prasad	Package of practices for vegetable cultivation (AIR, Vijayawada,28.3.2007)

Exhibitions Organised

- CTRI has Organized an Exhibition in connection with Pride of India – Science Expo Organized on the occasion of 93rd Indian Science Congress at Acharya N.G. Ranga Agricultural University (ANGRAU), Rajendranagar, Hyderabad from 3-7, January, 2006.

T.V. SHOWS

Sl. No.	Name	Topic and Channel	Date of telecast
1.	Dr. V. Krishnamurthy	Pogakulo seethaphalam, CMV tegullu - vaati nivaarana	10th February, 2007; (ETV-Annadata)
2.	Dr. M. M. Shenoi Sri K.N. Subramanya	Video module on "Post harvest product management"	12th August, 2006; Local T.V. Network at Hunsur

Press Meets

A Press Meet was arranged on 02-06-2006 in connection with Dr. V. Krishnamurthy assuming the charge of the office of the Director, CTRI, Rajahmundry.

A press meet was arranged on 27-06-2006 in connection with the release of three FCV tobacco varieties viz., Kanthi, Siri, Hemadri and a Natu tobacco variety, Bhairavi.

Books/ Technical Bulletins Published

- Back-yard Poultry (In Telugu)
- Entrepreneurship in Banana Fibre
- Siri - High yielding Virginia tobacco variety for black soils of Andhra Pradesh
- Indian Flue-cured tobacco varieties
- Tobacco Scientists - A profile

In Kannada

- Raising seedlings in plastic trays using 'Tray nursery' technology (Revised)
- Use of 'Wellgro soil' for healthy seedling production
- Integrated management practices for the control of wilt disease in FCV tobacco crop
- Need to topping & desuckering in tobacco crop under the prevailing situation

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KRISHI VIGYAN KENDRA, KALAVACHERLA

The Krishi Vigyan Kendra of CTRI is acting as a light house for the farming community and emerged as pioneering organization in the field of transfer of technology assessment, refinement and demonstration. In its saga of achievements, KVK has facilitated thousands of farmers towards adoption of viable technologies in agriculture and allied areas.

A total of 174 training programmes were conducted covering 3,089 farmers and 2,475 farm women from all sections of KVK.

Under APERP-AIP, a total of 765 farm women were trained in different agricultural technologies viz. INM, IPM in field crops and drudgery reducing agricultural implements.

Four months duration "Gardener Training Programme" was conducted for 20 rural youth, sponsored by the State Department of Horticulture, government of AP.

Gardener training programme


Rural youth in Gardener training programme

A total of 1,467 chicks, 7,713 eggs of improved poultry breeds viz. Gramapriya, Kadaknath and Turkey were supplied to farming community.

An amount of Rs.42,000/- was received from AP State Agro-Industries Development Corporation Ltd., Hyderabad towards royalty for Banana Fibre Extractor (BFE).

Target for establishment of 1,000 satellite fodder farms (Co-3) through out the State have been taken up and the target was achieved benefiting thousands of farmers and livestock throughout the state.

Added emphasis was given to sponsored vocational training activity and two long-duration training programmes entitled, (1) Integrated Animal Health Management and (2) Extraction of banana fibre from pseudo-stems were organized in collaboration with World Vision-Vizianagaram.

FLD programme of oilseeds (Sesamum & Groundnut) and pulses (Blackgram) was successfully implemented in selected villages in 20 ha area and 10 ha area, respectively during *Rabi*-summer.

Seed village concept has been developed in three different villages of Mukkamala, Ravulapalem and Yanam on oilseeds, pulses and cereals.

System of Rice Intensification (SRI) cultivation was introduced and popularized in Rajanagaram mandal, Rangampeta and Konaseema areas.

Paddy row seeder demonstrations were successfully conducted in 25 ha. area covering five villages.

Paddy row seder demonstration

Six motorized coir 2-ply yarn making units were established by six women groups of KVK at Irusumanda, Gannavaram, Kakinada, Vedurupaka, Kalavacherla, Sitanagaram areas with an investment of Rs 75,000 each working with 10-15 women at each unit earning Rs.1,200 per month.

Forty five self help groups were motivated to start income generation units viz. garment making, quilt bag making, coir yarn making, coir door-mat making, banana fibre decoratives, fabric painting and hand embroidery.

Training in garment making

A total of 47 field level demonstrations on banana fibre extraction were conducted in Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Gujarat and New Delhi.

Twenty beneficiaries of the KVK 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.

Scientists - farmers interface was organized at KVK farm in collaboration with the Doordarshan Kendra - Hyderabad on 13-03-2007

An amount of Rs 5,15,875/- was realized through KVK farm receipts during the period.

Impact of KVK Activities

Diversification of agriculture

Farming System Model was developed and implemented in the up land irrigated system in one hectare. Several agricultural components viz. Field crops, Horticultural crops, Dairy, Sheep, and Poultry were included in the model. An amount of Rs.45,000/- was obtained from Integrated farming systems as against mono crop returns of Rs.34,000/-.

Vermi-culture units were started along with dairy to increase the over all income. Previously, the dairy farmers used to sell the FYM @ Rs.300/- per one tractor load. After starting of vermi-culture units, they are getting an additional amount of Rs.1,800/-.

Livelihood security of the farmers

Technologies were popularized for generating minimum returns for the investments made by the farmers in respect of raising field crops by following cropping systems viz, rice-rice- pulses - 32%: increase in yield with 85% adoption. Rice-pulses 43%: increase in yield with 50% adoption. Dry paddy-groundnut/sesamum : 52% :increase in yield with 70% adoption.

KVK introduced backyard poultry breeds viz., Vanaraja, Gramapriya, Nicobari and Kadaknath. As the result, the egg production raised to 140 eggs as against 65 eggs per year per bird. These chicks were being supplied to the farmers by maintaining electrical incubator cum hatcher of 1,000 No. capacity at KVK. This programme is ensuring regular income apart from supplementing protein food to the rural families.

School drop-outs and rural women those who are not going for agricultural wage works were trained in various skill development training

programmes with locally available cheaper raw materials so as to initiate homestead occupation at their doorsteps and earning Rs.1,000-2,000 per month depending upon the activity undertaken by them.

Creation of job opportunities

Technologies viz. tobacco curing technology, raising of tobacco nursery, management of plant protection equipment (sprayers and dusters) fabrication of improved storage bins were imparted to rural artisans, unemployed rural youth for creation of self employment and job opportunities. These trainees are earning Rs.1,500-2,500/- per month.

KVK trained rural youth on animal first-aid and artificial insemination for a period of two months. Trainees were selected from remote villages where there are no veterinary hospitals. These trainees are now practicing animal first aid and earning Rs.2,000 – 2,500/- per month.

The selected trainees were given skill upgradation training and these trainees are acting as Master Trainers and earning monthly income for their livelihood. The master trainer concept has helped extending the technology transfer even to the remote areas and covered the un-reached core of people.

Skill development of the farmers

For enhancing the knowledge and skills of farming community, and to utilize their fullest potential, some of the location specific, need based and low cost drudgery reducing technologies were imparted to the farmers and farm women. Different drudgery reducing equipment viz., Paddy drum seeder, Seed cum fertilizer drills, Naveen sickles, Groundnut decorticators, Maize cob shellers and row crop weeders have been popularized.

In horticulture, grafting techniques, nursery management and skilled training programmes were conducted. The skilled persons are earning Rs.200 – 300 per day.

Turkey rearing is not popular in the district and KVK took lead in maintaining the breeding stock. The eggs and chicks were supplied to the farmers. As the chick mortality is very high in the first month, the farmers were trained on skills to rear day old turkey chicks. As a result, the farmers are earning Rs.1,200/- by sale of eggs and Rs.5,000/- through sale of chicks

Entrepreneurship development

The person trained at KVK started his own nursery taking 2 acres of land on lease basis and maintaining seedlings/ graftings of all flower plants, fruit crops and plantation crops.

As per the requirement of the skilled persons in rural industries, the rural youth were provided with skill training especially in curled coir units, automatic coir yarn production units, saree printing units etc. After completion of full-fledged training, the trained personnel are being absorbed by the entrepreneurs on monthly wage basis. A total of 40 rural women were provided with employment.

Where there is no demand for milk, farmers were suggested to procure early pregnant animals and heifers from nearby towns and maintain till they reach full term pregnancy and advise to dispose the animals for higher price in the towns where there is demand for milk. Nine farmers started this entrepreneurship.

Six training cum production centres of coir 2-ply yarn making units at Vedurupaka, Irusumanda, Gokavarm, Bavajipeta, Seethanagaram and Dharmavaram under the guidance of KVK with an investment of Rs.1.00 to 1.50 lakhs each. A total of 10-15 trainees are working at each centre earning a net income of Rs.15,000 to Rs.20,000/- per month.

AWARDS AND RECOGNITIONS

- Recognized as Lead Centre for Women Empowerment activities and allotted a Workshop to the KVK by the Zonal Co-ordination Unit, Zone –V.

- Young Scientist Award -2007 was conferred on Dr. K. Suman Kalyani, Sr. Scientist for her contribution in the field of Agricultural Extension in the Extension Education Congress held from 9-11th March, 2007 at JNKVV, Jabalpur, Madhya Pradesh.

- Two booklets published by KVK were selected and released in the second National Conference on KVKs, 2006 (Entrepreneurship in banana fibre by the Hon'ble Chief Minister of Andhra Pradesh and Backyard Poultry by the Secretary, DARE & Director-General, ICAR.

- Best Administrative Worker Award for 2006 was given to Sri A. Muthuraman, Assistant Administrative Officer, CTRI, Rajahmundry.

Dr. K. Suman Kalyani receiving the Award


Sri A. Muthuraman receiving the Award

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LINKAGES AND COLLABORATIONS

CTRI has developed strong linkages with various organisations at regional, national and international level. At the regional level, linkage between CTRI and various state government departments and Agril. Universities in Andhra Pradesh, Tamil Nadu, Karnataka, Bihar, Gujarat, West Bengal and Maharashtra 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, NBSS & LUP, Nagpur and PDBC, Bangalore.

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, Guntur	Model Project Area scheme and on-farm trials for improving yield and quality of FCV tobacco in KLS, SLS, SBS, NBS and NLS areas
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.	State Departments of Agriculture	Transfer of technology in non-FCV types and supply of inputs
9.	Indian Meteorology Department, Pune	Maintenance of meteorological observatories at different Stations

Sl. No.	Name of the Collaborating Agency	Project title/Activity
10.	M/s ITC Ltd., ILTD Division, 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, storage tests
11.	NRC on Rapeseed Mustard, Bharatpur, Rajastan	Testing of promising lines of mustard
12.	PDBC, Bangalore	Coordinated trials in Biological control
13.	Uttar Banga Krishi Viswavidyalaya Pundibari, West Bengal	Ph.D. programme on Variability and Management of brown spot disease in *Motihari* tobacco caused by *Alternaria alternata* Keissler
(b)	**International Institutions**	
1.	CORESTA, France	Evaluation of pest and disease resistant varieties
2.	Tobacco Institute of Japan	Asia Collaborative Study on cigarette smoke analysis
3.	Tobacco Board, Mauritius	Amarello air-cured tobacco production

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ALL INDIA NETWORK RESEARCH PROJECT ON TOBACCO

Salient research findings emanated from the experiments conducted at different centres of AINRPT (Rajahmundry, Pusa, Anand, Shimoga, Nipani, Nandyal, Berhampur, Araul, Hunsur, Guntur, Dinhata, Ladol, Kandukur, Jeelugumilli and Vedasandur) during the crop season 2005-06 in different disciplines are summarized below.

CROP IMPROVEMENT

Initial varietal trials (IVT)

Initial varietal trials with 4 entries of FCV tobacco, 7 entries of bidi tobacco, 3 entries of bidi tobacco hybrids, 3 entries of natu tobacco, 3 entries of chewing tobacco and 5 entries of rustica tobacco were conducted separately for each type at different centres of AINRPT during 2005-06 season. The promising entries at different centres were promoted to the AVT in respective centres. Promising FCV tobacco entries were 147M x 1-21 at Guntur, V 4212 at Rajahmundry and 54-30-21 at Jeelugumilli, Rajahmundry and Shimoga. Promising bidi tobacco entries were ABD 103 at Anand, ABD 103 and ABD 104 at Araul and ABD 101, ABD 102 and ABD 103 at Nandyal. Promising bidi tobacco hybrids were BTH 128 and BTH 129 at Araul and Nandyal. Promising natu tobacco entries were 33-90, 45-90 and 58-90 at Jeelugumilli. None of the chewing entries were promoted to AVT. Rustica tobacco entries, AR 85, AR 88 and AR 89 at Anand and all the five entries of IVT were promoted to AVT at Ladol.

Advanced varietal trials (AVT)

The advanced breeding FCV tobacco line, N 98 was the best entry with 12, 13 and 13% improvement in cured leaf, bright leaf and grade index, respectively over the better control, VT 1158 at Rajahmundry during 2004-06 while KST 28 was the best entry with 35, 27 and 20% improvement in cured leaf, bright leaf and grade index, respectively over the better control, Cy 79 at Guntur. Two FCV tobacco entries, KST 28 and KST 27 gave significantly higher cured leaf yield (23% and 18%, respectively) than Kanchan at Jeelugumilli. Entry KST 27 is light cast and hence not suitable for NLS area. KST 28 is a medium cast line. FCV tobacco entries, N 98 and KST 28 gave significantly higher yield over the better check, VT 1158 at Kandukur were promoted to bulk trial. FCV tobacco entries, KST 27 and KST 28 gave higher yields over the checks at Shimoga.

Bidi tobacco entry, ABD 93 showed significant superiority in AVT II over the better check, GTH 1 at Anand. Advanced breeding bidi tobacco lines, NBD 154 and ABD 100 in AVT I and ABD 93 in AVT II recorded significantly higher cured leaf yields over the check, A 119 at Nandyal.

Natu tobacco selections, II-1873, II-1874 and II-1876 showed significantly superior performance at Guntur in AVT conducted for two seasons (2004-06) and the selection II-1873 was promoted to bulk trials. *Pikka* tobacco advanced breeding line, PTB 3 produced significantly higher cured leaf yield over the check, Pyruvithanam in AVT I at Berhampur.

Chewing tobacco advanced breeding line, HV. 98-16 was significantly superior to all the three checks, Bhagyalakshmi, Meenakshi and Abirami at Vedasandur during 2004-06.

Rustica tobacco advanced breeding line, AR 84 showed significant

superiority over better check, GCT 3 at Ladol during 2005-06 in AVT I.

Bulk trials

Advanced breeding FCV tobacco line, Cy 149 recorded 1,698 kg/ha cured leaf, 1,025 kg/ha bright leaf and 1,373 kg/ha grade index with an improvement of 26, 23 and 25%, respectively over the better control, VT 1158 in the bulk trial at Rajahmundry. On-farm trials are proposed for 2006-07 season.

Advanced breeding FCV tobacco line, N 98 recorded highest green leaf, cured leaf and bright leaf yields over the checks in bulk trial at Kandukur.

Advanced breeding bidi tobacco line, ABD 90 recorded highest yield in bulk trial at Nandyal.

Salient findings

Seed yield was low (55 to 95 kg/ha) in the fourteen FCV tobacco entries screened for seed yield at Shimoga.

Bidi tobacco line, Line 340-13-49 proved superiority for early maturity over GT 5 in the breeding programme for early maturity at Anand. Many lines bred for normal planting conditions recorded significantly higher yield over the check, GT 5. Bidi tobacco line, Line100-13-85, bred for drought tolerance showed significant superiority over the other lines and the better check, GT 7. The hybrid, ms (und) TMVR GT 5 x BC_2 {$(GT\ 7)^2$ x oriental} gave significantly higher yield than the better check, GTH 1 among the six bidi tobacco hybrids evaluated at Anand

Selected plants of four F_3s (A 119 x GT 4, A 119 x GT 7, GT 4 x GT 7 and GT 4 x Bhavyashree) among the five F_3s were advanced as cross bulks in the hybridization programme at Nandyal.

Among the *Jati* tobacco genotypes evaluated at Berhampur, Manasi ranked first for preparation of tobacco products (*kharamasala*, snuff and tobacco paste). Among the chewing tobacco genotypes, Abirami gave highest leaf yield (1,173 kg/ha). Trade ranked Bhagyalakshmi and Meenakshi as superior genotypes for *kharamasala* and Meenakshi as superior genotype for snuff preparation.

Rustica tobacco lines, AR 44, VR 5, VR 35 and SK 413 and tester, ST 1 proved to be good general combiners at Araul.

CROP PRODUCTION

Use of Alachlor @ 0.75 kg ai/ha two weeks before sowing as pre--emergence spray + one hand weeding at 25 days after sowing recorded significantly lower weed count and weed dry weight and higher number of transplantable seedlings. This technology with highest weed control efficiency is under farm trial stage for weed management in FCV tobacco nursery in Shimoga area.

Among the alternative cropping systems studied in KLS at Shimoga, higher net returns (Rs.12,751/ha) were recorded by paired row of Hybrid cotton + chilli + three rows of groundnut. However, higher tobacco equivalent yield was recorded by sole crop of tobacco itself (710 kg/ha). Productivity levels were low due to excessive rains during crop growth period.

Among the different crops tested during *kharif* and *rabi* in the scarce rainfall zone of Andhra Pradesh at Nandyal, A.P., *kharif* sown redgram (no *rabi* crop) recorded maximum net returns of Rs 62,040/ha with C: B ratio of 1: 11.34 followed by soybean - safflower with net returns of Rs 37,510/ha and C: B ratio of 1:5.16. Fallow - tobacco recorded a net return of Rs 8,928/ha with C: B ratio of 1:2.48. Among the various tobacco based cropping systems, bhendi-tobacco cropping system recorded maximum net returns of Rs 85,558/ha followed by soybean-tobacco cropping system with net returns of Rs 19,472/ha.

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Pikka tobacco + tomato intercropping system in 2:4 rows at Berhampur in Orissa gave net returns of Rs13, 625/ha as against Rs 11,005/ ha by sole crop of *pikka* tobacco and Rs 16,915/ha by sole crop of tomato. *Pikka* tobacco + chilli intercropping system in 2:4 rows gave net returns of Rs 12, 990/ ha as against Rs 11,960/ha by sole crop of *pikka* tobacco and Rs 14,710/ha by sole crop of chilli.

Among the different agro-technologies tried for growing tobacco for dual purpose (cured leaf and seed yield) at Shimoga, FCV tobacco grown as per the recommended spacing and fertilizer but priming stopped after 18th leaf harvest recorded 897 kg/ha cured leaf yield and 535 kg/ha TGE. In addition, the technique resulted in a seed yield of 308.7 kg/ha. Growing tobacco as per recommendation only for cured leaf resulted in highest cured leaf yield (1,403 kg/ha) and TGE (781 kg/ ha). Although highest seed yield of 460 kg/ha was obtained at closer spacing with additional N&K and stoppage of priming after 14th leaf, the cured leaf yield was drastically reduced to 708 kg/ ha.

Green manuring with sunnhemp was found effective in increasing the productivity of bidi tobacco at Anand.

Hybrid bidi tobacco, GTH 1 can be planted during 16th August - 15th September with 45 days old seedlings to obtain high yields under Anand conditions.

Application of 85% RDF (AS + Urea) + *Azotobacter* or *Azospirillum* + FYM @ 12.5 t/ha produced higher cured leaf of bidi tobacco at Anand when compared to the recommended dose along with 12.5 t FYM/ha which indicated the substitution of more than 30 kg N/ha through inclusion of bio-fertilizer.

Bulk plot trial confirmed superiority of poultry manure application @ 5 t/ha to *pikka* tobacco in Orissa in respect of yield and quality with net returns of Rs 7,676/ha as against Rs 6,308/ha by green manuring with *dhaincha*. Bulk plot trial confirmed superiority of zinc sulphate application @ 25 kg/ha for *pikka* tobacco in respect of yield and quality with net returns of Rs 7,626/ ha as against Rs 5,208/ha by non-application of zinc sulphate.

Application of N @ 30 kg/ha from organic source out of the total 120 kg N/ha to *pikka* tobacco in Orissa recorded highest cured leaf yield of 1,388 kg/ha and highest net returns of Rs 11, 020 /ha. Application of bio-fertilizer Azotoplus @ 1.5 kg/ha along with recommended dose of fertilizers (80 kg N + 40 kg P_2O_5 + 40 kg K_2O/ha) also gave significantly higher cured leaf yield of 1,513 kg/ha as against that of 1,250 kg/ha without bio-fertilizer.

Furrow irrigation to *pikka* tobacco once during stress period in Orissa significantly increased cured leaf yield over no irrigation and it is proposed for bulk trial.

Different sources and levels of K tested for *chewing* tobacco at Vedasandur in Tamil Nadu revealed that application of K @ 50 kg/ha in the form of KCI proved superior with whole leaf yield of 2,593 kg/ha, total leaf yield of 3,291 kg/ha, net returns of Rs 34,916/ha and C: B ratio of 1:1.97. Different spacing and nitrogen levels tested for seed yield of chewing tobacco revealed higher seed yield (1,072 kg/ ha) at spacing of 75 x 40 cm with N fertilizer dose of 75 kg/ha.

Application of NPK in combination with bio-fertilizers (*Azotobacter* & PSB) fetched higher net returns and benefit: cost ratios over recommended dose of fertilizers without bio-fertilizers in *Motihari* tobacco in West Bengal by bringing down the rate of inorganic N and K fertilizers application by 25% and FYM by 75%.

CROP PROTECTION

Maize as a border crop prevented aphid infestation in FCV tobacco to an extent of 56.64% over control in the bulk trial at Rajahmundry. Highest percent reduction (98.14) of aphid-infested plants was recorded in chemical control followed by maize border with one spray of imidacloprid (97.52). Natural enemies, *Nesidiocoris* and *Coccinellids* were recorded on tobacco crop, whereas, *Coccinellids*, spiders, wasps, dragonflies, damselflies, preying mantids and predatory bugs were recorded on border crop. Predators were found in high numbers (10.0 and 11.2/plant) in treatments involving only border crop and control (no border and no spray).

Bajra as a border crop prevented aphid infestation in FCV tobacco to an extent of 52.55% over control in the bulk trial at Hunsur. Highest percent reduction (94.63) of aphid-infested plants was recorded in chemical control followed by bajra border with one spray of imidacloprid (90.13). Natural enemies, *Nesidiocoris* and *Coccinellids* were recorded on tobacco crop, whereas, *Coccinellids*, spiders, wasps, dragon flies, damsel flies, preying mantids and predatory bugs were recorded on border crop. Natural enemy population build up was more on bajra border (7.4 to 9.9/plant).

Screening of germplasm and advanced breeding lines of FCV tobacco against root-knot nematode at Shimoga revealed that only CM 12 (KA), Rathna, Kanchan and Thrupthi were found to be resistant among the 21 entries screened as they registered least root-knot index ranging between 0.6 and 2.0. Delcrest (w) x Bhavya, L 621 x Bhavya, KST 27, KST 28 and Cy 146 showed moderate resistance by exhibiting gall indices varying from 2.3 to 3.0.

Integration of pressmud and *Trichoderma viride* in the integrated management of Black shank disease of FCV tobacco gave significantly higher cured leaf yield (1213 kg/ha) and TGE (808 kg/ha) at Shimoga when compared to other treatments and untreated check. Reduced incidence of black shank disease was recorded up to 71% by integrating pressmud (spreading) and *Trichoderma viride* application.

Studies on seasonal abundance of *B. tabaci* (white flies) *on* different host plants at Anand, Gujarat revealed that the population of this pest remained very low through out the year. Comparatively high activity (above 3 flies/leaf) was observed in brinjal during 49th and 4th standard weeks followed by cotton and Indian bean. Similarly, the activity of various natural enemies was also very low or negligible.

Studies on moth catches through pheromone traps at Anand showed that comparatively high trapping of S. *litura* was observed during 39th and 48th standard weeks. In the case of *H. armigera,* the moth catch was not observed throughout the year except during 22nd and 24th std. weeks. The correlation coefficient study revealed that the weather factors viz; rainfall, number of rainy days and relative humidity (morning and afternoon) showed negative correlation whereas, the other factors showed positive correlation for both the pests.

Delay in planting of bidi tobacco from August 1st week to October 1st week at Anand significantly reduced the frog-eye spot, brown spot and root-knot diseases and increased the yield. Significantly highest yield was recorded in October 1st week planting with minimum frog-eye spot, brown spot and root-knot diseases; it was at par with September planting with regard to yield.

Monitoring study on resistance development in *Pythium aphanidermatum* to metalaxyl MZ revealed absence of resistance development in the pathogen to the chemical under Anand conditions and

metalaxyl MZ was found effective in the management of damping-off in bidi tobacco nursery.

Search for resistance source to damping-off and root-knot in bidi tobacco indicated only five cultures/ varieties free from damping-off while four and six cultures out of 24 tested in the nursery and controlled conditions, respectively, showed highly resistant reaction to root-knot disease.

Application of bio-pesticides (Nemastin, Yorker, Monitor WP, Biohit and Tricho – X-P) significantly managed root-knot disease in bidi tobacco nursery till 47 days after sowing but could not help much in the management of damping-off disease under Anand conditions.

Application of schedules consisting formalin either @ 1.5 % or 3 % followed by drenchings of metalaxyl MZ @ 2.16 kg/ha and one carbendazim spray @ 0.025 % with or without plastic mulch or irrigation significantly reduced the number of weeds, frog-eye spot and increased number of transplantable and total surviving seedlings in bidi tobacco nursery compared to control, over a four year period from 2002-2006. . However, these schedules could not help in the management of damping-off and root-knot diseases.

In the trial on management of bidi tobacco root-knot disease at Nipani, Karnataka, the lowest percent disease incidence of 17.2 with minimum severity of 1.42 was observed with poultry manure 1 t/ha + Carbofuran 3 G @ 5 kg/ha.

Carbendazim, propiconazole and hexaconazole were more effective than other fungicides tested in the trial on management of frog-eye spot through chemicals at Nipani.

Survey of Nipani and surrounding areas for occurrence of diseases and pests indicated that frog-eye spot and brown spot appeared early in the season on one month old crop in the month of September. The severity ranged from 10.1 -15.2 %. The incidence of root-knot nematode was low (5.0%) at the time of harvest and damping-off was the major constraint in the nursery.

Studies on light trap and pheromone trap catches at Nandyal revealed that *Helicoverpa* and *Spodoptera* were present throughout the crop growth period. In light trap, peak moth of 47/ week of *Helicoverpa* was recorded during 23rd standard week, i.e. 2nd week of June and moth catch decreased thereafter. However, in pheromone trap, peak moth catch of 115 /week was recorded in 40th standard week i.e. 1st week of October. In light trap, peak *Spodoptera* moth catch of 34/week was recorded during 42nd standard week i.e. 2nd week of November. But, in pheromone trap, peak moth catch (24/ week) was recorded during 25th standard week i.e. 3rd week of June.

Out of the four advance cultures of bidi tobacco screened against *Spodoptera* and aphid at Nandyal, lowest *Spodoptera* incidence of 30.9% was recorded in A 119 x GT 4 cross and highest incidence (44.2%) was recorded in GT 7 x Bhavyasree cross. Aphid score was 1.0 in all the crosses.

Aphid continues to be a major pest on bidi tobacco in Kurnool district, A.P. Incidence of *Helicoverpa* and *Spodoptera* was more than 10%. Moderate incidence of *Orobanche* was observed in some of the fields surveyed.

Studies on the integrated management of aphid, *Myzus nicotianae*, in bidi tobacco at Nandyal revealed that border crop (sorghum or maize or bajra) alone reduced the aphid incidence from 72.3 to 76.8% over control. Border crops and one spray of imidacloprid 18.5 % SL @ 25 g a.i./ha reduced aphid incidence from 81.0 to 89.1% over control. On border crops predators like *Coccinellids*, syrphids,

spiders and Chrysopids were recorded. Highest natural enemy population was recorded on sorghum (2.40/plant) followed by maize and bajra. On tobacco, only *Nesidiocoris* bugs and *Coccinellids* were recorded.

Experiment on IPM for tobacco revealed that, jowar as barrier crop against aphid played a major role in obstructing the movement of aphid in to the main field. As a result, aphid incidence was low in IPM plot (23%) compared to non-IPM plot (93%). Like wise trap crops viz., marigold and castor played an important role in trapping the larvae and eggs/egg masses of *Helicoverpa* and *Spodoptera* resulting in less incidence of these pests in IPM plot. Aphid score recorded in IPM plot is less than one, compared to non-IPM plot where it is more than one.

Incidence of bacterial wilt (9.9 - 22.6%) and *Fusarium* wilt (6.6 - 17.5%) was higher in *Jati* tobacco at the end of the crop season (March, 2006) compared to *Motihari* tobacco in West Bengal.

CROP CHEMISTRY AND SOIL SCIENCE

For the soils deficient in zinc, application of zinc sulphate to nursery @ 2 g/m^2 before sowing helps in improving leaf yield and quality giving additional returns of Rs.13, 500 /ha with ICBR of 1: 6.1. The increase seen in bright grades was up to 362 kg/ha. Technology on use of $ZnSO_4$ for improving leaf yield and quality of FCV tobacco has been recommended to the farming community.

Highest cured leaf yield of 1,064 kg/ha was recorded at Shimoga in KLS with 75% recommended N through fertilizer + 2.5 kg/ha *Azotobacter* + 5 t/ha of FYM Indicating the possibility of reducing fertilizer N to the extent of 25% in FCV tobacco cultivation.

Studies on burn related K in FCV tobacco in TBS at Rajahmundry for two seasons indicated that very high level of K application (180 kg K_2O/ha) is necessary to obtain significant increase in leaf K content over no application of potassium. Since it is difficult to increase the leaf K content in TBS with normal levels of potassium application, it is better to aim for improvement of burn related K in TBS by selecting soils containing low chloride levels for FCV tobacco cultivation. The results in NLS at Jeelugumilli, A.P. over a two year period did not show significant increase in leaf K content and burn related K of FCV tobacco with higher levels of K application (160 and 200 kg K_2O/ha) over recommended level of 120 kg K_2O/ha. The second year trial at Hunsur in KLS revealed that the cured leaf yield and top grade equivalent responded up to 140 kg K_2O/ha in both Rathna and Kanchan varieties.

Pooled results of long term experiment (1998-99 to 2004-05) on the effect of manuring on soil productivity and quality of bidi tobacco at Anand, Gujarat showed significantly lowest leaf nicotine, P and K in organic matter omitted plots than in plots where bulky manures were applied. None of the soil properties studied was altered significantly except soil pH due to application of different bulky manure or manurial combinations tried.

Early transplanting of bidi tobacco (16th August) at Anand resulted in significantly higher nitrogen, nicotine and chloride content of leaf than normal or late transplanting up to 30th September but without significant differences in yield levels. However, nicotine and reducing sugars in leaf were on par with 31st August and 15th September planting. Leaf N only was significantly higher due to use of 30 day old seedlings than the older seedlings (45, 60 and 75 day old seedlings).

Furrow planting (recommended method) gave significantly higher yield of bidi tobacco at Anand and reduced *Orobanche* number and weight as

compared to ridge planting. Application of weedicides, pendimethalin or fluchloralin @ 1 l/ha reduced *Orobanche* infestation to an extent of 13.8 to 18.4% over no application but the differences in number and weight of *Orobanche* were not significant.

Topping bidi tobacco at 24 leaves and sucker control with suckericide (pendimethalin @ 0.45% + 2% urea) gave significantly higher yield at Anand over topping at 21 leaves and no sucker control, respectively during 2002-04. None of the chemical parameters were altered significantly by variety, topping stages, topping levels and suckericide treatments.

Seven different breeding lines/ varieties of bidi and chewing tobacco were raised at Anand with 180 kg N/ha and harvested at 90 days for production potential of protein. Eight more genotypes were also raised with same dose of nitrogen and harvested at proper maturity stage for production potential of tobacco seed oil. Incase of protein study, true protein content was highest in ABD 65 with lowest green leaf yield. Highest protein yield and nicotine content were recorded by line R9 (GT 5) 14-34. Malic and oxalic acid contents were higher in GTH 1 while citric acid content was high in ABD 38. In case of tobacco seed oil study, genotype ABD 28 gave highest seed yield (1,135 kg/ ha) and oil yield (407 kg/ha) with lowest oil content (35.85%) as compared to other genotypes. The highest oil content (38.56%) was found in the variety A 145.

In a study on evaluation of bidi tobacco genotypes for less health risk factors at Anand, the smoke constituents were lowest in NBD 159 and highest in ABD 96 and GTH 1. Among the chemical constituents, nitrogen content was high in ABD 96 while nicotine and reducing sugar content were high in GTH 1. The chloride content was less than two per cent in all the genotypes.

A seed rate of 8 to 10 kg/ha appears to be good for raising the *Rustica* tobacco nursery in Gujarat.

Wider spacing of 60 x 45 cm for *Rustica* tobacco at Ladol resulted in higher leaf nitrogen, nicotine, reducing sugars and chlorides than closer spacing of 60 x 30 cm. High topping (15 leaves) resulted in higher leaf nitrogen, nicotine and chloride than low topping (12 leaves).

WORKSHOP

The IV Group Meeting of All India Network Research Project on Tobacco was held on 30th & 31st July, 2006 at CTRI, Rajahmundry.

IV Group Meeting of All India Network Research Project on Tobacco

WOMEN EMPOWERMENT IN AGRICULTURE

As part of KVK mandate, women specific gender oriented women empowerment training programmes have been designed and implemented by the KVK.

Coir mahila yojana special programme

The Coir Board, Kochin has sponsored 8 special training programmes of two months duration each on coir 2-ply yarn making over motorized ratts, coir 2-ply yarn making over traditional motorized ratts and coir door-mat making. Under this programme, a total of 96 rural girls were trained from eight villages of East Godavari Districts. After successful completion of the training programme Certificates were issued by Coir Board and an amount of Rs.96,000/- was given by the Coir Board.

Micro-enterprises promotion and development agency

In collaboration with MEPDA, NABARD, DRDA, SINDHURA, four long duration programmes were conducted on Banana Fibre Extraction & Its Products and a total of 120 Rural women were trained.

Banana fibre products

In collaboration with World vision organisation (Vizianagaram) & Rayala Seema Seva Samithi (Thirupathi), KVK has organized three long duration training programmes of one month duration each on Banana Fibre Extraction and its products and a total of 90 rural youth were trained. The KVK has given the technical know how and master trainer.

Training in extraction of Banana fibre

Post-harvest technologies of fruits & vegetables

Four training programmes of one week duration have been conducted at ABIRD-Dowleswaram, Deputy Director, Agriculture Office - six villages and a total of 120 rural women were trained in preparation of fruit and vegetable products.

Tailoring & garment making

To empower women towards self sufficiency skill oriented long duration (2 months) vocational training programmes on tailoring and garment making were organized by KVK at N.T.Rajapuram & Elakolanu villages and a total 45 rural girls were trained in Garment making.

Leaf plate making

Three skill-oriented income generation training programmes of leaf-plate making were conducted at Kolar (Karnataka) Gokavaram and Kalavacherla and a total of 55 school drop-outs were trained.

Palmyrah fibre production

In collaboration with West Bengal Khadi Industries Board, two training programmes of 15 days duration on palmyrah fibre production were organized by KVK and a total of 50 rural women were trained at Bankura in West Bengal.

Hand-embroidery & fabric painting

Two training programmes of Three weeks duration on hand embroidery & fabric painting were conducted at KVK and a total of 30 rural girls have participated.


Training in fabric painting

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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* *Dr. T.G.K. Murthy and Dr. R.V.S. Rao*
2.	G.S.1	Germplasm acquisition maintenance, multiplication, evaluation and utilization *Dr. R.V.S. Rao and Dr. T.G.K. Murthy*
3.	Br.6.1.4(a)	Incorporation of disease resistance for tobacco mosaic virus (TMV) *Dr. P.V. Venugopala Rao and Dr. C.A. Raju*
4.	Br.2	Evolving superior varieties of FCV tobacco through hybridization *Dr. P.V. Venugopala Rao*
5.	Cy.7(i)	Tissue culture studies in tobacco (I) Interspecific hybridization *Dr. T.G.K. Murthy and Dr. K. Sarala*
6.	Cy.7(iii)	Tissue culture studies in tobacco (III) Micropropagation of elite lines and other selections *Dr. K. Sarala and Dr. 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* *Dr. T.G.K. Murthy, Dr. R.V.S. Rao, Dr. U. Sreedhar and Dr. K. Siva Raju*
8.	Bio-tech-4	Development of virus tolerant tobacco lines under *in vitro* *Dr. K. Sarala, Dr. C.A. Raju, Dr. P. Venkateswarlu and Dr. K. Siva Raju*
9.	Br.7	Developing hybrid FCV tobacco suitable for traditional black soil area of Andhra Pradesh *Dr. T.G.K. Murthy, Dr. R.V.S. Rao, Dr. P.V. Venugopala Rao and Dr. K. Sarala*
10.	MB-9	Evaluation of advanced breeding lines for yield and quality *Dr. K. Sarala, Dr. R.V.S. Rao, Dr. P.V. Venugopala Rao and Dr. T.G.K. Murthy*
11.	Biotech-5	Maintenance, evaluation and characterization of tobacco transgenics *Dr. K. Sarala, Dr. J.V. Prasad and Dr. K. Siva Raju*
12.	Biotech-6	Molecular Mapping of tobacco traits: Tobacco specific nitrosamines in burley *Dr. K. Sarala, Dr. T.G.K. Murthy, Dr. C.V.N Rao and Dr. P.V. Venugopala Rao*
13.	Biotech-7	Development of tobacco specific microsatellite markers *Dr .K. Siva Raju and Dr. K. Palanichamy*
14.	Biotech-8	Molecular mapping of genes responsible for production of solanesol and nicotine in tobacco *Dr. K. Sarala, Dr. T.G.K Murthy, Dr. K. Siva Raju and Dr. 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 Dr. P. Harishu Kumar*
2.	Ag. Eng.5	Design and development of tobacco leaf stringing machine *M. Sanni Babu and I. Srinivas*
3.	ARISENT-1	Information system on agricultural pests of coastal Andhra Pradesh *Dr. U. Sreedhar and H. Ravi Sankar*
4.	ARIS-2	Creation and maintenance of WEB pages of CTRI *H. Ravi Sankar, Dr. J.A.V. Prasad Rao and Dr. C.V. Narasimha Rao*
5.	A-65	Production of organically grown tobacco *Dr. P. Harishu Kumar, Dr. V. Krishnamurthy, Dr. K. Siva Raju, Dr. M. Anuradha, Dr S. Kasturi Krishna, Dr. P. Venkateswarlu and Dr. G. Raghupathi Rao*
6.	A-66	Effect of foliar nutrition of K under S and Mg fertilization on yield and burn related potassium in FCV tobacco *Dr. P. Harishu Kumar, Dr. S. Kasturi Krishna, Dr. M. Anuradha and Dr. V. Krishnamurthy*
7.	A-67	Effect of Bio- compost on the yield of FCV tobacco under graded levels of N in Vertisols *Dr. P. Harishu Kumar, R. Subba Rao, Dr. S. Kasturi Krishna and Dr. V. Krishnamurthy*
8.	A-70	Integrated rainwater and nutrient management in tobacco based cropping system under rainfed Vertisols *Dr. S. Kasturi Krishna, Dr. S.V. Krishna Reddy, Dr. P. Harishu Kumar and Dr. V. Krishnamurthy*
9.	Ag.Extn-33	Assessment of identified slow moving technologies in NLS tobacco growing zones of Andhra Pradesh *Dr. Y. Subbaiah and S.K. Naidu*
10.	ARIS-9	Expert System for different diseases of major crops in Andhra Pradesh *H. Ravisankar and Dr. C.A. Raju*
11.	A- 72	Evaluation of *Rustica* tobacco types for oil production under conserved soil moisture condition in Vertisols of Andhra Pradesh *Dr. P. Harishu Kumar, R. Subba Rao and Dr. K. Siva Raju*
12.	A -72 (A)	Development of Seed Production Technology in Tobacco *Dr. P. Harishu Kumar, Dr. S.V. Krishna Reddy and Dr. K. Siva Raju*
13.	A -73	Effect of foliar nutrition of boron on quality leaf production in FCV tobacco under Vertisols conditions *Dr. P. Harishu Kumar, Dr. S. Kasturi Krishna and Dr. C.Chandrasekhara Rao*

Sl. No	Institute Code	Title of the project and Investigator(s)
14.	A- 74	Productivity enhancement of soybean-bengalgram through integrated nutrient management in rainfed vertisols of Andhra Pradesh *Dr. S. Kasturi Krishna, Dr. S.V. Krishna Reddy, Dr. P. Harishu Kumar and Dr. V. Krishnamurthy*
15.	CTRI Nursery -1	Efficacy of different micro irrigation nozzles in wetting tobacco nursery with appropriate soil aeration techniques *Sri M. Sannibabu*
16.	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. Sanni Babu, Dr. S. Kasturi Krishna and Dr. P. Venkateswarlu*
17.	Ag.Engg-6	Developing and constructing solar barn at CTRI Farm, Katheru *M. Sannibabu*
18.	Ag.Extn:34	Evaluation of tobacco portal system *Dr. Y. Subbaiah and S.K. Naidu*
19.	Ag.Extn.36	Stress analysis of tobacco farmers and changing scenario of the cropping pattern *Dr. K. Suman Kalyani and S.K. Naidu*
20.	ARIS-10	Decision support system for quality evaluation of flue cured tobacco *H. Ravi Sankar and Dr. V. Krishnamurthy*
21.	A -75	Evaluation of tobacco hybrids for leaf biomass and seed yield *Dr. P. Harishu Kumar, Dr. C.V.N. Rao, Dr. K. Siva Raju and Dr. R.V.S. Rao*
22.	ARIS-11	Designing algorithms for data classification *H. Ravi Sankar*
23.	Ag.Extn 38	FLD on Cy 135 in NBS areas of Andhra Pradesh *S.K. Naidu, Dr. K. Suman Kalyani and Dr. K. Sarala*
24.	Ag.Extn 39	Trend analysis of cost of production and price behaviour of FCV tobacco in SLS area of Andhra Pradesh *Dr. Y. Subbaiah and S.K. Naidu*
25.	Ag.Extn 40	Critical analysis of the Empowerment of farm women in tobacco growing agency area of East Godavari District *Dr. K. Suman Kalyani and S.K. Naidu*
Crop Chemistry & Soil Science		
1.	AC- 1	Permanent manurial experiment *Dr. 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 dist., Karnataka *Dr. V. Krishnamurthy and Dr. C. Chandrasekhara Rao*

Sl. No	Institute Code	Title of the project and Investigator(s)
3.	OC-10	Evaluation of smoke constituents in materials from some plant breeding experiments. *Dr. C.V. Narasimha Rao*
4.	PR-1	Monitoring of pesticide residues in .tobacco samples collected from different areas *Dr. C.V. Narasimha Rao*
5.	OC-21	Studies on tobacco specific nitrosamines (TSNA) in Indian tobaccos and tobacco products *Dr. C.V. Narasimha Rao*
6.	BC-8	Electrophoretic characterization of tobacco cultivers *Dr. K. Siva Raju and Dr. K. Nageswara Rao*
7.	SSMB-7	Plant growth-promoting *Rhizobacteria* (PGPR) in tobacco based cropping systems *Dr. D.V. Subhashini and Dr C. Chandrasekhara Rao*
8.	Phy-68	Response of light intensity in relation to nitrogen fertilization in flue cured virginia tobacco *Dr. M. Anuradha, Dr. K. Nageswara Rao, Dr. K. Siva Raju and Dr. V. Krishnamurthy*
9.	SS-23	Investigations on lead and cadmium contents in Indian tobaccos *Dr. C. Cahndrasekhara Rao and Dr. P.R.S. Reddy*
10.	BC -10	Development of molecular markers for *Fusarium* wilt in tobacco *Dr. K. Siva Raju and K. Subrahmanya*
11.	SS-25	Investigations on phosphorus and potassium characteristics of FCV tobacco growing soils of Prakasam and Nellore districts *Dr. C. Cahndrasekhara Rao, Dr. V. Krishnamurthy and Dr. P.R.S. Reddy*
12.	SSMB- 8	Fluorescent *Pseudomonads* in tobacco disease management *Dr. D.V. Subhashini*
13.	SS -26	Determination of critical level of zinc for FCV tobacco in soils of NLS area *Dr. P.R.S. Reddy and Dr. C. Cahndrasekhara Rao*
14.	BC-11	Biochemical characterization of tobacco seed oil *Dr. K. Siva Raju, Dr. C.V.N. Rao, Dr. R.V.S. Rao and Dr. V. Krishnamurthy*
15.	PHY- 70	Carbohydrate metabolism as influenced by nitrogen and potassium nutrition in flue cured tobacco grown in NLS *Dr. K. Nageswara Rao, Dr. M. Anuradha, Dr. C.V.N. Rao and Dr. V. Krishnamurthy*
16.	PHY-71	Chloride nutrition in flue-cured tobacco *Dr. M. Anuradha, Dr. K. Nageswara Rao, Dr. C. Cahndrasekhara Rao and Dr. V. Krishnamurthy*
17.	PHY-72	Dynamics of potassium absorption, utilisation and re-translocation in FCV tobacco *Dr. K. Nageswara Rao, Dr. M. Anuradha and Dr. V. Krishnamurthy*
18.	PHY-73	Sucker control in flue cured tobacco grown in NLS *Dr. K. Nageswara Rao and Dr. M. Anuradha*

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Sl. No	Institute Code	Title of the project and Investigator(s)
Crop Protection		
1.	P.Orb-1	Studies on broomrape of tobacco *Dr. C.A. Raju*
2.	P.78	Studies on wilt disease of tobacco. *Dr. C.A. Raju*
3.	E53	Integrated pest and disease management CORESTA collaborative study on insect host plant resistance studies *Dr. U. Sreedhar*
4.	EC-58	Studies on persistency and dissipation of insecticides in tobacco *Dr. U. Sreedhar, Dr. C.V.N. Rao and Dr. J.V. Prasad*
5.	E-59	Evaluation of trap crops against budworm, (*H. armigera)* in FCV Tobacco *Dr. U. Sreedhar*
6.	E-61	Screening of different tobacco germplasm against stem borer, *Scrobipalpa heliopa* Low *Dr. P. Venkateswarlu, Dr. R.V.S. Rao, S. Gunneswara Rao and Dr. J.V. Prasad*
7.	E-62	Development and validation of weather based forewarning system for major pests of FCV tobacco *Dr. J.V Prasad, Dr. U. Sreedhar and Dr. K.C. Chenchaiah*
8.	E-63	Assessment of avoidable yield loss due to insect pests in FCV tobacco under northern light soil conditions *Dr. J.V. Prasad and Dr. P. Venkateswarlu*
9.	E-65	Studies on stem application of insecticides for management of tobacco aphid, *Myzus nicotianae* *Dr. U. Sreedhar and Dr. J.V. Prasad*
10.	E-68	Studies on the efficacy of organic solvent leaf extracts against oviposition, feeding and growth and development of tobacco caterpillar, *Spodoptera litura* *Dr. P. Venkateswarlu, Dr. K. Siva Raju and Dr. J.V. Prasad*
11.	E-69	Development, validation and refinement of IPM module for burley tobacco *Dr. U. Sreedhar and R. Subba Rao*
12.	E-70	Studies on the ecological role of *Nesidiocoris tenuis*, an Omnivorous mired bug in tobacco ecosystem *Dr. J.V Prasad, S. Gunneswara Rao, Dr. U. Sreedhar and Dr. K. Siva Raju*
13.	E-71	Life table studies of *Spodoptera exigua* on certain types of tobacco and *Nicotiana* species *S. Gunneswara Rao and Dr. J.V. Prasad*
14.	E.72	Efficacy of various aqueous leaf extracts against tobacco stem borer, *Scrobipalpa heliopa* Lower *Dr. P. Venkateswarlu, Dr. K. Siva Raju and S. Gunneswara Rao*
15.	E-73	Studies on compounds with insecticidal value from wild *Nicotiana* species against the major pests of FCV tobacco *Dr. J.V Prasad and S. Gunneswara Rao*

Sl. No	Institute Code	Title of the project and Investigator(s)
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 *Dr. T.G.K. Murthy*
2.	JLN-1	Maintenance of germplasm of Natu tobacco *Dr. T.G.K. Murthy*
3.	JLN-2	Developing new varieties of irrigated Natu tobacco for A.P. *Dr. T.G.K. Murthy*
4.	JL Br.3	Developing hybrid FCV tobacco suitable for northern light soils (NLS) of Andhra Pradesh *Dr. T.G.K. Murthy, Dr. R.V.S. Rao and Dr. K. Sarala*
5.	JL.Br.4	Evaluation of flavourful exotic lines for their suitability in NLS area of Andhra Pradesh *Dr. T.G.K. Murthy, Dr. R.V.S. Rao and Dr. C.V. Narasimha Rao*
6.	Br C2(4)	Evaluation of advanced breeding lines for yield and tar content under Northern Light Soil condition *Dr. K. Sarala, Dr. C.V. Narasimha Rao, Dr. TGK Murthy and Dr. 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 *Dr. S.V. Krishna Reddy , Dr. S. Kasturi Krishna, Dr. P. Harishu Kumar and Dr. J.A.V. Prasad Rao*
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 NLS-4 in irrigated alfisols of AP. *Dr. S.V. Krishna Reddy, Dr. Kasturi Krishna, Dr. P. Harishu Kumar and Dr. 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 (NLS-4) under irrigated Alfisols *Dr. S.V. Krishna Reddy, Dr. S. Kasturi Krishna and Dr.C.Chandrasekhara Rao*
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 *Dr. S.V. Krishna Reddy, Dr. S. Kasturi Krishna and Dr.C.Chandrasekhara Rao*
14.	JLA-C-1	Quantification of aroma in tobacco in terms carbonyls and other gases by anemometric method *M. Sannibabu and Dr. K. Siva Raju*

Sl. No	Institute Code	Title of the project and Investigator(s)
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 *Dr. S.V. Krishna Reddy, Dr. S. Kasturi Krishna, Dr. C. Chandrasekhara Rao, Dr. K. Siva Raju and Dr. P. Harishu Kumar*
16.	SS-27	Crop growth modeling in FCV tobacco in NLS *Dr. C. Chandrasekhara Rao, Dr. M Anuradha, Dr. K. Siva Raju, Dr. S. Kasturi Krishna and H. Ravisankar*
BTRC, Jeddangi		
1.	By.Br.1	Evaluation of advanced burley breeding lines for productivity and quality *Dr. P.V. Venugopala Rao, Dr. T.G.K. Murthy, Dr. R.V.S. Rao and R. Subba Rao*
2.	By.Br.2	Evaluation of burley tobacco hybrids suitable for burley growing areas of Andhra Pradesh *Dr. P.V .Venugopala Rao, Dr. T.G.K. Murthy, Dr. R.V.S. Rao and R. Subba Rao*
3.	By.Br.3	Developing high yielding burley cultivars with low TSNA levels *Dr. T.G.K. Murthy, Dr. P.V. Venugopala Rao, Dr. R.V.S. Rao, Dr. C.V.N. Rao, R. Subba Rao and Dr. 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 Dr. 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 Dr. P. Harishu Kumar*
6.	AO-2a	Studies on N and K interaction effects on oriental tobacco production and its quality *Dr. P. Harishu Kumar, R. Subba Rao and Dr. C. Chandrasekhara Rao*
7.	AO-2b	Response of oriental tobacco types to N and K fertilization under different agro-climatic conditions *Dr. P. Harishu Kumar and Dr. 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 *Dr. P. Harishu Kumar and Dr. G. Raghupathi Rao*
2.	A-50	Effect of FYM, N, P and K on tobacco leaf yields in permanent manurial trial on Natu tobacco *Dr. P. Harishu Kumar and Dr. G. Raghupathi Rao*
3.	Br.14	Development of FCV tobacco varieties suitable for cultivation in SBS of AP *Dr. A.V.S.R. Swamy*

Sl. No	Institute Code	Title of the project and Investigator(s)
4.	EG-6	Performance of different spray schedules on the incidence of major insect pests on tobacco *Dr. 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 *Dr. G. Raghupathi Rao and S. Gunneswara Rao*
6.	A-83	Influence of plant population on nitrogen on advanced breeding line V-4064 *Dr. P. Harishu Kumar and Dr. G. Raghupathi Rao*
7.	EG-9	Evaluation of imidacloprid application method for the control of sucking pests of FCV tobacco *Dr. G. Raghupathi Rao*
8.	EG10	Evaluation of high pressure sprayer for the management of insect pests of FCV tobacco *Dr. G. Raghupathi Rao*
9.	EG-11	Studies on population dynamics and management of tobacco aphid *Dr. G. Raghupathi Rao*
CTRI Research Station, Kandukur		
1.	PK-18	Screening of Germplasm for important diseases and prevailing in Prakasam District *V. Venkateswarlu*
2.	K.Br 5	Evaluation of new line N-98 for yield and quality under SLS conditions *Dr. P. V. Venugopala Rao, R. Sreenivasulu, V. Venkateswarlu and Dr. J.V. Prasad*
3.	PK-22	Integrated management strategies to control damping off, black shank and leaf blight diseases in nurseries of FCV tobacco under SLS conditions *V. Venkateswarlu*
4.	PK-23	Control of Anthracnose diseases in FCV tobacco nursery under SLS conditions in Prakasam District *V. Venkateswarlu*
5.	EK-11	Management of insect pests of tobacco by plant extracts *Dr. K.C. Chenchaiah*
6.	EK-12	Management of cigarette beetle of tobacco by plant extracts and in organic slats *Dr. K.C. Chenchaiah*
7.	K.Br.6	Breeding FCV tobacco variety for yield and quality under SLS conditions *Dr. A.R. Panda, Dr. C.V. Rao, V. Venkateswarlu, Dr. K.C. Chenchaiah, Dr. P.V. Venugopala Rao, Dr. T.G.K. Murthy, Dr. K.N. Subrahmanya, Dr. A.V.S.R. Swamy and Dr. C.V.N. Rao*
8.	PK-24	Management of brown spot disease of FCV tobacco under SLS conditions *V. Venkateswarlu*
9.	EK-13	Evaluation of IPM modules for insect pests of FCV tobacco under SLS conditions *Dr. K.C. Chenchaiah*

Sl. No	Institute Code	Title of the project and Investigator(s)
CTRI Research Station, Hunsur		
1.	BR.12	Germplasm maintenance of *Nicotiana tabacum* varieties/lines *K.N. Subrahmanya and Dr. 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 Dr. 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 Dr. M.M. Shenoi*
4.	P.3.2	Screening of tobacco germplasm against root knot nematode *Dr. S. Ramakrishnan and K.N. Subrahmanya*
5.	N 1.1	Survey for plant parasitic nematodes infecting tobacco *Dr. S. Ramakrishnan*
6.	N–15	Studies on root-knot – wilt complex in FCV tobacco crop *Dr S. Ramakrishnan and Dr. M.M. Shenoi*
7.	P-18	Testing the bio-efficacy of 'Kocide 101' (Copper hydroxide 77%) against fungal diseases in FCV tobacco nursery *Dr. M.M. Shenoi*
8.	A-35	Evaluation of vermicompost for its efficacy in FCV tobacco production *Dr. M. Mahadevaswamy*
9.	A-36	Integrated Nutrient Management for FCV tobacco in KLS *Dr. M. Mahadevaswamy*
10.	BR-19	Development and evaluation of F1 hybrids of FCV tobacco suitable to Karnataka Light Soil region *K.N. Subrahmanya, Dr. M.M. Shenoi, Dr. M. Mahadevaswamy and Dr. S. Ramakrishnan*
11.	N-16	Plant growth Promoting *Rhizobacterium* (PGPR), *Pseudomonas fluorescens* mediated suppression of root-knot nematode in FCV tobacco nursery *Dr. S. Ramakrishnan and Dr. M.M. Shenoi*
12.	N.17	Bio-intensive management of root-knot nematode and soil-borne fungal diseases in FCV tobacco nursery *Dr. S. Ramakrishnan and Dr. M.M. Shenoi*
13.	P.19	Further studies on *Fusarium* wilt and wilt complex in FCV tobacco crop *Dr. M.M. Shenoi, Dr. S.S. Srinivas and Dr. S. Ramakrishnan*
14.	P.20	Studies on Soreshin disease *(Rhizoctonia)* in FCV tobacco nursery in KLS *Dr. M.M. Shenoi*

Sl. No	Institute Code	Title of the project and Investigator(s)
CTRI Research Station, Vedasandur		
1.	G.S.1	Evaluation and maintenance of germplasm *Dr. K. Palanichamy*
2.	B.38	Breeding for insect resistance against caterpillar (*Spodoptera litura*)attack in chewing tobacco – pre released bulk trial *Dr. K. Palanichamy*
3.	B.48	Studies on heterosis breeding in chewing tobacco (*N. tabacum*) *Dr. K. Palanichamy*
4.	B.49	Synthesis of broad-based gene pool in chewing tobacco (*N. tabacum*) enhancing selection gain *Dr. K. Palanichamy*
5.	BA-48	Spacing and nitrogen requirement for the advanced breeding lines of chewing tobacco under Vedasandur conditions *Dr. M. Kumaresan, Dr. V. Krishnamurthy and Dr. K. Palanichamy*
6.	BA-49	Spacing and potassium requirement for the country cheroot tobacco genotypes under Bhavani conditions *Dr. M. Kumaresan and Dr. K. Palanichamy*
7.	BA-50	Spacing and potassium requirement for the chewing tobacco genotypes under Vedaranyam conditions *Dr. M. Kumaresan and Dr. K. Palanichamy*
8.	A-98	Phosphorus management in chewing tobacco under Vedasandur conditions *Dr. M. Kumaresan, Dr. P. Harishu Kumar and Dr. C.Chandrasekhara Rao*
9.	B.50	Breeding for high seed and oil yield in tobacco *Dr. K. Palanichamy and Dr. C.V.N. Rao*
10.	BA-51	Spacing and nitrogen requirement for the advanced breeding lines of chewing tobacco under Vadasandur conditions *Dr. M. Kumaresan and Dr. K. Palanichamy*
CTRI Research Station, Dinhata		
1.	A-10	Permanent manurial experiment with *Motihari* tobacco *Dr. R.L. Arya and Dr. S. Roy*
2.	A-66	Studies on sources, levels and time of nitrogen application of *Jati* tobacco variety cv. Manasi *Dr. R.L. Arya, Dr. S. Amarnath, Dr. S. Roy and Dr. C.Chandrasekhara Rao*
3.	A-67	Studies on sources of organic manures on nitrogen levels in *Jati* tobacco *Dr. R.L. Arya, Dr. S. Amarnath, Dr. S. Roy and Dr. C.Chandrasekhara Rao*
4.	A-68	Studies on nitrogen requirement of *Jati* tobacco variety Manasi in relation to different sequential cropping systems *Dr. R.L. Arya, Dr. S. Amarnath, Dr. S. Roy and Dr. C.Chandrasekhara Rao*

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Sl. No	Institute Code	Title of the project and Investigator(s)
5.	B-17	Dialliel analysis in *Motihari* tobacco (*N. rustica*) *Dr. S. Amarnath*
6.	A 69	Studies on effect of plant population and fertility levels on seed yield of *Jati* tobacco cv. Manasi *Dr. R.L. Arya, Dr. S. Roy, Dr. S. Amarnath and Dr. C.Chandrasekhara Rao*
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 *Dr. S. Amarnath and Dr. S. Roy*
8.	PP-7	Management of bacterial wilt in *Motihari* tobacco and biochemical and molecular characterization of pathogenic isolates *Dr. S. Roy, Dr. S. Amarnath, Dr. R.L. Arya and Dr. K. Siva Raju*
9.	PP-8	Role of biocides against damping-off of seedlings and growth promotion activity in *Jati* and *Motihari* tobacco nurseries *Dr. S. Roy, Dr. S. Amarnath and Dr. R.L. Arya*

RAC, QRT, MANAGEMENT COMMITTEE & SRC MEETINGS

RESEARCH ADVISORY COMMITTEE

Dr. M. Mahadevappa Former Chairman, ASRB, Samarasa, 1576, I Cross, Chandra Layout, Bangalore – 560 040	Chairman	Dr. V. Krishnamurthy Director, CTRI, Rajahmundry - 533 105	Member
		Dr. K.C. Jain Asst. Director General (CC), Indian Council of Agril. Research, Krishi Bhawan, New Delhi - 110 001.	Member
Dr. R. Lakshminarayana Principal Scientist (Retd.), CTRI, D.No.23-11-12/1, Ramakrishnarao Pet, Rajahmundry – 533 105.	Member		
		Sri T. Ramasiva Gupta Member, IMC of CTRI, Thullur Post & Mandal, Guntur Dist., Andhra Pradesh	Member
Dr. Shrikanth Kulkarni Prof. & Head, Dept. of Pathology, University of Agril. Sciences, Krishi Nagar, Dharwad - 580 005	Member		
		Sri I. Kurma Rao Member, IMC of CTRI, 4-C, Golden towers, Patamata, Vijayawada, Andhra Pradesh	Member
Dr. B. Rosaiah Assoc. Director of Research, Regional Agril. Res. Stn., (ANGRAU), Anakapalle - 531 001,	Member	Dr. C.V. Narasimha Rao Principal Scientist, CTRI, Rajahmundry - 533 105.	Member-Secretary
Dr. B.K. Patel Head, BTRS (Retd.), Anand Agril. University, Anand Campus, Anand -388 110. Gujarat	Member		

The RAC meeting was held on 15th November, 2006 at CTRI, Rajahmundry. Dr. M. Mahadevappa, Chairman and Dr. V. Krishnamurthy, Director, CTRI, Dr. R. Lakshminarayana, Dr. S. Kulkarni, Dr. B.K. Patel, Sri I. Kurma Rao and Sri T. Ramasiva Gupta attended the meeting.

QUINQUENNIAL REVIEW TEAM

Dr. S.A. Patil - Chairman
Vice-Chancellor,
University of Agril. Sciences,
Dharwad - 580 005
Karnataka.

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.N. Chowdhary - Member
Ex-ADG (Ag. Extn.), ICAR,
B/41, Kamala Nagar,
Kotra Sultanabad,
Bhopal, Madhya Pradesh.

Dr. B.N. Patel - Member
Research Scientist (PP),
Anand Agril. University,
Anand - 388 110,
Gujarat.

Dr. B.R. Hegde - Member
Director of Research (Retd.),
UAS, Bangalore
347, 7th Cross,
10th Main,
NTI Layout,
Vidyaranyapura,
Bangalore - 560 097.

Dr. J.A.V. Prasad Rao - Secretary
Principal Scientist,
Central Tob. Res. Institute,
Rajahmundry - 533 105.

STAFF RESEARCH COUNCIL (SRC) MEETINGS

The Staff Research Council meetings of CTRI were held at this Institute during 26-29th July, 2006. Eminent scientists, VIPs, Scientists from Research Stations, Tobacco Board Officials, and Officials from Tobacco Trade & Industry attended the meetings. New project proposals and continuing projects were discussed in detail and the technical programme for 2006-07 was finalised.

INSTITUTE MANAGEMENT COMMITTEE

Dr. V. Krishnamurthy
Director & Chairman

Dr. K.C. Jain Asst. Director General (CC), Indian Council of Agril. Research, Krishi Bhawan, New Delhi - 110 001	Member
Dr. M.M. Shenoi Principal Scientist & Head i/c, CTRI Research Station, Hunsur, Karnataka	Member
Sri M. Sannibabu Principal Scientist, Div. of Crop Production, CTRI, Rajahmundry	Member
Dr. T.G. Nageswara Rao Principal Scientist (Pathology), NRC for Sorghum, Hyderabad	Member
Dr. A. Vishnuvardhan Reddy Sr. Scientist (Plant Breeding), Directorate of Oil Seeds Research, Hyderabad	Member
Director of Agriculture Govt. of Andhra Pradesh, Hyderabad	Member
Director of Research (Ag.) ANGRAU, Rajendranagar, Hyderabad	Member
Director of Agriculture Govt. of Karnataka, Bangalore	Member
Sri I. Kurma Rao 4-C, Golden Towers, Patamata, Vijayawada, Krishna Dist., Andhra Pradesh	Member
Sri T. Ramasiva Gupta Thullur Post & Mandal, Guntur Dist., Andhra Pradesh	Member
Sri V.S. Subramanian Fin. & Accounts Officer NAARM, Rajendranagar, Hyderabad	Member
Sri G.G. Harakangi Sr. Administrative Officer CTRI, Rajahmundry	Member-Secretary

The 42nd Meeting of Institute Management Committee Meeting was held on 11.09.2006 at CTRI, Rajahmundry.

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PARTICIPATION OF SCIENTISTS IN CONFERENCES, MEETINGS, WORKSHOPS AND SYMPOSIA

Sl. No.	Participant (s)	Programme attended	Date and place
1.	Dr. V. Krishnamurthy Dr. D.V.Subhashini	The Brainstorming session on "Role of agriculturally important micro-organisms in sustainable food and agricultural production"	April 17 , 2006, NBAIM, Varanasi
2.	Dr. K. Sarala	National seminar on "Gene constructs"	May 17-18,2006; IIHR, Bangalore
3.	Dr. P. Venkateswarlu Sri S. Gunneswara Rao	Annual group meeting of AICRP on 'Biological control' and National symposium on 'Biological control of sucking pests'	May 24-27, 2006 PDBC, Bangalore
4.	Dr. P. Harishu Kumar	Biennial workshop of All India Coordinated Research Programme on "Weed control"	June 1-3,2006; ANGRAU, Hyderabad
5.	Sri C.V.K.Reddy	Training programme on "Information bank "	June 12, 2006; NBPGR, New Delhi
6.	Sri R. Sreenivasulu	Workshop for Southern region on "Future strategies for improving the performance of farming systems"	June 14 - 15, 2006; Hyderabad
7.	Sri M.N.P. Kumar	Workshop on "Maintenance of Personnel Management Information System Network" (PERMIS NET)	July 21 -22, 2006; NASC, New Delhi
8.	Dr. Y. Subbaiah	Training Workshop on "Evaluation of KVK Performance"	August 7, 2006; ZCUnit, Hyderabad
9.	S. Jitendranath	ZREAC Meeting	August 8, 2006 RARS, Anakapalle
10.	J.V.R.Satyavani S.Jitendranath R.Sudhakar N.Arunakumari	Coconut workshop conducted by Dept. of Horticulture, Govt. of A.P.	Sept. 2, 2006; CTRI, Rajahmundry
11.	Dr. Y. Subbaiah	Workshop on 'Process of agriculture knowledge management	Sept., 12-15, 2006; Thiruvanthapuram

Sl. No.	Participant (s)	Programme attended	Date and place
12.	Dr. P. Harishu Kumar Sri R. Sreenivasulu Dr. S.V. Krishna Reddy Dr. S. Kasturi Krishna Dr. R.L. Arya	Golden Jubilee National Symposium on "Conservation agriculture and environment"	Oct.,26-28,2006; BHU, Varanasi
13.	Dr. Y. Subbaiah	Annual Zonal Workshop of KVKs	Nov. 1, 2007 CRIDA, Hyderabad
14.	Dr. V. Krishnamurthy	ICAR Institutes Directors' Conference	Nov. 3-4, 2006 ICAR, New Delhi
15.	Sri Ch. Sri Rama Rao Sri Md. Elias	Training Programme on "Hindi Computer Training"	Nov. 6-10, 2006; Bangalore
16.	Dr. V. Krishnamurthy Dr. P.R.S. Reddy Dr.Chandrasekhara Rao	71st Annual Convention Indian Society of Soil Science (ISSS)	November 10-13, 2006; OUAT, Bhubaneswar
17.	Dr. V. Krishnamurthy	Employment Summit organized by CII	Nov. 13, 2006; New Delhi
18.	Sri R. Sreenivasulu	All India Seminar on 'Phosphatic Fertilizers : Latest Development'	Nov.13-14, 2006; Institute of Engineers, New Delhi
19.	Dr. S. Ramakrishnan	Brainstorming Session on 'Status, prospects and road map for enhancing the uptake of antagonistic organisms in nematode management in India'	Nov.17-18, 2006, PDBC, Bangalore
20.	Dr. B. John Babu	Advanced technologies in Animal Science, Dairy and Fisheries	Nov. 20-21, 2006 KVK, Pune
21.	Dr. P.R.S. Reddy Dr.R.L.Arya	International Symposium on "Balanced fertilization for sustaining crop productivity"	Nov. 22-25, 2006; PAU, Ludhiana
22.	Dr. Y. Subbaiah	National Conference on KVKs	Nov. 26-27, 2006; ANGRAU, Hyderabad
23.	Dr.M.M. Shenoi	Annual Meeting and Symposium of Indian Phytopathological Society (Southern Zone)	Nov. 27-28, 2006; CPCRI, Kasaragod
24.	Dr. (Smt.) M. Anuradha Dr. K. Nageswara Rao	National seminar on "Plant Physiology"	Nov. 28 -30, 2006; KAU, Vellanikkara

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Sl. No.	Participant (s)	Programme attended	Date and place
25.	Dr. Y. Subbaiah	Presentation of KVK report in KVK - QRT workshop	Nov. 22, 2006 Pune
26.	Dr. P.R.S. Reddy Dr. C.C.S. Rao Dr. K. Siva Raju Dr. C. A. Raju Dr. J.V. Prasad Dr. R.V.S. Rao Sri H. Ravishankar	94th Indian Science Congress	January 3 -7, 2007; Annamalai University, Annamalainagar
27.	Dr. Satyajit Roy	National Symposium on "Plant pathogens exploitation and management" 59th Annual meeting of Indian Phytopathological Society	January 16-18, 2007; Ranidurgavathi University, Jabalpur
28.	Dr. V. Krishnamurthy	National seminar on “Changing Global Vegetables Oils Scenario: Issues and Challenges before India”	January 30, 2007 ANGRAU, Hyderabad
29.	Dr. K. Palanichamy	National seminar on ‘Changing Global Vegetable Oils Scenario: Issues and Challenges before India’	January 29-31, 2007; Hyderabad
30.	Sri K.N. Subramanya	Refresher Course on “Computer Based Multimedia Presentation”	February 16 – March 5 2007; NAARM, Hyderabad
31.	Sri K.N. Subramanya	Workshop on “Data Analysis and Data Mining”	February 26, 2007; NAARM, Hyderabad
32.	Dr. R.V.S. Rao	Training programme on “DUS Testing for plant variety protection: Principles and Procedures”	February 19 -24, 2007; New Delhi
33.	Sri N. Syam Prasad	International conference Semantic Web & Digital Libraries	February 21 - 23, 2007, Bangalore
34.	Sri S. Jitendranath	HRD training programme on “Organic Agriculture’	March 8-9, 2007; Ahmednagar
35.	Smt. K. Suman Kalyani	Fourth National Extension Education Congress-2007 on “Livelihood Security Extension System Perspectives “	March 9 -11, 2007; JNKVV, Jabalpur
36.	Dr. U. Sreedhar Dr. J.V. Prasad Dr. M. Mahadevaswamy Dr. S. Ramakrishnan Dr. Satyajit Roy	National Conference on “Organic Waste Utilization and Eco-friendly Technologies for Crop Protection”	March 15-17, 2007; ANGRAU, Hyderabad

Sl. No.	Participant (s)	Programme attended	Date and place
37.	Dr. P.V.V.Siva Rao Smt. J.V.R. Satyavani	One day Sensitization and Orientational workshop	March 28, 2007; ANGRAU, Hyderabad
COMMITTEES			
1.	Dr. V. Krishnamurthy	118th meeting of Tobacco Board	April 3, 2006; Hyderabad
2.	Dr. V. Krishnamurthy	119th meeting of Tobacco Board	July 19, 2006; Hyderabad
3.	Sri K.N. Subramanya	Meeting of Core Team	July 3, 2006; Mysore
4.	Dr. V. Krishnamurthy	Special meeting of Tobacco Board	September 5, 2006; Hyderabad
5.	Dr. V. Krishnamurthy	4th meeting of the Tobacco Products Sectional Committee FAD-4	October 2 , 2006; BIS, Manak Bhavan, New Delhi
6.	Dr. M.M. Shenoi	Selection process for finalizing the beneficiaries of Farmers Awards of Karnataka 2005 -06	October 12 -13, 2006; Mysore
7.	Dr. M.M. Shenoi	24th meeting of RAC of CSR&TI as a Member	November 27-28, 2006; Mysore
8.	Dr.A.R.Panda Sri R Sreenivasulu	Inter-agency team Visit to Podili, DC Palli, Kandukur areas.	December 21-23, 2006; SLS areas
9.	Dr. S.Amarnath	18th meeting of the ICAR Regional Committee-II	December 22-23, 2006; New Delhi1
10.	Dr. M. M. Shenoi Dr.M. Mahadevaswamy	Input Committee Meeting of Tobacco Board	March 12, 2007; Bangalore

WORKSHOPS, SEMINARS AND FARMERS' DAYS ORGANISED

Farmers' Day celebrations were organized at KVK, Kalavacherla on 13th June, 2006

A Farmers' Day at KVK, Kalavacherla

The Official Language Implementation Committee Meeting was held on 11.07.2006 at CTRI, Rajahmundry.

The second meeting of 10th IJSC Meeting was held on 22nd August, 2006 at CTRI Research Station, Dinhata.

IJC meeting at CTRI RS, Dinhata

Hindi fortnight celebrations were held at CTRI, Rajahmundry from 13th to 27th September, 2006.

Hindi fortnight celebrations

A tobacco farmers training programme on 'Nursery Management' was conducted at CTRI Research Station, Dinhata on 16.09.2006. On the occasion, a pamphlet in Bengali language entitled "Raising of ideal tobacco nursery in North Bengal" was brought out for the benefit of tobacco farmers of North Bengal region.

A meeting on NTRM (Non-Tobacco Related Material) in Burley tobacco' was held on 23.09.2006.

A 'Rythu Sadassu' on 'Tobacco Nursery Management' was organized on 11th October 2006 at commercially tobacco nursery in Dommeru village, wherein 35 farmers have actively participated in the meeting. On this occasion, a 'Question and Answer Session' was conducted for the benefit of farmers. Field visit was undertaken by the Scientists in an area of 20 acres.

Training on seedling production

CTRI Research Station, Hunsur organized a two days farmers' training programme on 'Organic Farming' from

Training on Organic Farming

12-13th October, 2006 at CTRI Research Station, Hunsur, in collaboration with Regional Centre of Organic Farming, Bangalore.

KVK of CTRI organized a Training-cum-Workshop on "Food & Nutrition, Drudgery Reduction and Empowerment of Women in Rural Areas" during 16-17th October, 2006 at CTRI, Rajahmundry for Home Science Scientists of A.P. and Maharashtra. Dr. V.M. Myande, Zonal Coordinator, Z.C. Unit, Zone-V, Hyderabad and 30 scientists participated in the workshop.

Training-cum-Workshop

Women in Agricultural Day was celebrated on 04.12.2006 at KVK, Kalavacherla

Kisan Mela was conducted at CTRI Research Station, Kandukur on 6th January, 2007.

Kisan Mela at CTRI RS, Kandukur

Field SRC was conducted at CTRI Research Station, Jeelugumilli to monitor the experiments conducted at Jeelugumilli on 11.01.2007.

Field SRC in Jeelugumilli

Kisan Mela was conducted at CTRI Research Station, Guntur on 18th January, 2007

Farmers' Day was celebrated on 24th February, 2007 at CTRI Research Station, Dinhata.

The XVIIth Scientific Advisory Committee Meeting of Krishi Vigyan Kendra, Kalavacherla was held on 20th February, 2007 at CTRI, Rajahmundry.

SAC Meeting of KVK

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DISTINGUISHED VISITORS

Date	Name	Address
CTRI, Rajahmundry		
25.05.2006	Dr. M.V. Rao	Ex. Director General of ICAR
14.06.2006	Dr. Suresh Babu, IAS Sri Mathur Sri Veera Reddy	Chairman, Tobacco Board Under Secretary, Ministry of Commerce, New Delhi Regional Manager, Tobacco Board, Guntur
07.09.2006	Mr. Brian Fleming	British American Tobacco, U.K
08.09.2006	Dr. K. K. Sharma	Coordinator, Pesticide Residues, IARI , New Delhi
26.09.2006	Dr. R.J. Rabindra	Project Director, PDBC, Bangalore
04.01.2007	Sri B. Lucas	Leaf TC, UK
12.01.2007	Dr. Salej Sood, Dr. H. Bindumadhava Dr. Mahavishnan	Scientists from ITC, R&D Centre, Hyderabad
08.02.2007	Dr. B. Mishra	Project Director, Directorate of Wheat Research, Karnal
14.02.2007	Mr. Taco Tuinstra Ms. Elise Ward Rasmussen	Representatives of the Journal Tobacco Reporter, North Carolina, USA
CTRI RS, Kandukur		
20.01.2007	Sri M. Srinivasulu Reddy Sri M. Maheedhar Reddy	M. P., Ongole M.L.A., Kandukur
06.01.2007	Dr. Divi Sivaram	Ex-MLA, Kandukur
06.01.2007	Sri C. Venkateswara Rao	Member, Tobacco Board, Guntur
CTRI RS, Hunsur		
18.07.2006	Farmer delegates	Srilanka
05.09.2006	Mr. Brian Fleming	Global Leaf Production and Integrity Manager, British American Tobacco, London, UK.
18.09.2006	Mr. S.K. Mehta	JCF, Nepal

Dr. M.V. Rao, Former Spl. DG visits CTRI

Trainees visit to Chemistry Lab

Dr. V. Krishnamurthy, Director explaining the activities to D Tobacco Board Chairman

Mr. Brain Fleming, British American Tobacco, UK in the CTRI Museum

Dr. R.J. Rabindra, Project Director, PDBC, Bangalore visiting the Smoke Research Laboratory

Sri M. Srinivasulu Reddy, Hon'ble MP, Ongole and Sri M. Maheedhar Reddy, Hon'ble MLA, Kandukur visiting CTRI RS, Kandukur

PERSONNEL

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 Chem. & Soil Science	:	Dr. J.A.V. Prasad Rao
CTRI Res. Stn., Guntur	:	Dr. G. Raghupathi Rao
CTRI Res. Stn., Kandukur	:	Sri A.R. Panda
CTRI Res. Stn., Hunsur	:	Dr. M.M. Shenoi
CTRI Res. Stn., Vedasandur	:	Dr. K. Palanichamy
CTRI Res. Stn., Dinhata	:	Dr. S. Amarnath
CTRI Res. Stn., Jeelugumilli	:	Dr. C.Chandra Sekhara Rao
BTRC, Jeddangi	:	Sri R. Subba Rao
RMC Unit	:	Dr. P.R.S. Reddy (up to 13.11.2006) Dr. C.V. Narasimha Rao (from 14.11.2006)
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
Lib. & Documentation Service	:	Sri Y.V. Suryanarayana
Agricultural Extension	:	Sri S.K. Naidu
Engineering Section	:	Sri T. Narasimha Rao
CTRI Farm, Katheru	:	Sri N. Prabhakara Rao
Senior Administrative Officer	:	Sri G.G. Harakangi
Finance & Accounts Officer	:	Sri N. Venkata Rao

PHYTOCHEMICALS FROM TOBACCO

SIRI IN NBS