भाकृअनुप
ICAR

वार्षिक प्रतिवेदन
Annual Report
2012 - 13

केन्द्रीय तम्बाकू अनुसंधान संस्थान
(भारतीय कृषि अनुसंधान परिषद)
राजमन्द्री - 533 105, आन्ध्र प्रदेश

CENTRAL TOBACCO RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
RAJAHMUNDRY - 533 105, ANDHRA PRADESH, INDIA

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Published by

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Preface

Tobacco is an important commercial crop grown in an area of 0.45 M ha (0.27% of net cultivated area) contributing ₹ 21,515 crores to the national exchequer through foreign exchange earnings and internal excise revenue. Concerted and intensified research efforts of the Central Tobacco Research Institute and its regional stations benefited the tobacco farming community and other stakeholders dealing with tobacco in the country. It is a great pleasure to present the CTRI Annual Report: 2012-13 that embodies the important research and institutional activities undertaken and salient achievements made during the reporting period.

I am happy to inform that satisfactory progress has been made in the development of high yielding varieties and hybrids. Promising FCV tobacco advanced breeding lines viz., TBST-2, V-4219 for vertisols; NLSH-1 (low tar hybrid), JS-117 (low tar line) and NLST-2 for alfisols; YB-4 for burley tobacco areas of Andhra Pradesh; chewing tobacco hybrid VDH-3 for Tamil Nadu, DJ-1 for *Jati* tobacco tracts of West Bengal were identified for release to farmers. Also, significant success has been achieved in the other important areas of tobacco research such as improving the input-use-efficiency, adopting IPM strategies and evaluation of new formulations with low active ingredients for efficient plant protection as well as reducing pesticide residues. Apart from the scientific achievements, the Institute has made noteworthy contribution to resource generation. Also, good progress has been made in infrastructure development for research in the frontier areas.

In the context of emerging national and international tobacco scenario and to meet the specific research requirements of different tobacco growing regions of the country, the thematic research areas of the Institute have been reoriented. The Institute will continue to foster the established linkages with national and international organizations in the coming years to promote R & D activities on traditional and non-traditional aspects. The close linkages with line-departments of the State Governments, Tobacco Board (Ministry of Commerce, GOI) and other agencies concerned with tobacco industry and trade are of particular interest to reorient, refine and strengthen our R & D initiatives.

I appreciate the contribution of all the Scientists and staff members in successful execution of different research and developmental programmes of the Institute during the reporting period. I extend special thanks to the Chairman and Members of the Editorial Committee for their meticulous efforts in editing of the report. I offer thanks to the Nodal Officer (PME-Cell) and his team for compilation of information and supervising the whole process of bringing out this publication.

I place on record sincere thanks and gratefulness to the Honourable Secretary, DARE & Director General, ICAR, Dr. S. Ayyappan; the Deputy Director General (Crop Science), Dr. S. K. Datta and the Assistant Director General (Commercial Crops), Dr. N. Gopalakrishnan for extending all needed support, guidance and encouragement from time to time in planning and execution of research, extension and other related activities of the Institute.

(T.G.K. MURTHY)
Director - Acting

Date : 30.06.2013

कार्यकारी सारांश

केन्द्रीय तम्बाकू अनुसंधान संस्थान का अधिदेश है उत्पादकता में वर्षद्धि तथा उत्पाद की गुणवत्ता में सुधार पर विशेष ध्यान देते हुए विभिन्न प्रकार के तम्बाकूओं पर अनुसंधान करना है। इस अवधि के दौरान अनुसंधान कार्य का मुख्य ध्येय तम्बाकू फसल का विकास, सतत तम्बाकू उत्पादन हेतु कषषि प्रौद्योगिकियों का विकास, उत्पादन क्षमता एवं उत्पाद की गुणवत्ता हेतु संसाधनों की कमी का प्रबंधन, जैविक स्ट्रेस तथा वैकल्पिक फसलों की पहचान हेतु समेकित प्रबंधन और तम्बाकू के वैकल्पिक उपयोग ढूंढना रहा है। उल्लेखनीय अनुसंधान उपलब्धियों का विवरण निम्नवत् है।

तम्बाकू फसल विकास

- कुल 59 विदेशी एफसीवी जननद्रव्य वंशक्रमों, 447 नए रसटिका जननद्रव्य तथा 37 वन्य निकोटियना प्रजातियों को जननद्रव्य बैंक में संग्रहित किया गया।
- तम्बाकू जननद्रव्य के व्यापक डीयूएस परीक्षण तथा जारी किए किस्मों के प्रलेखन हेतु 53 रूपात्मक लक्षणों से एक प्रोफार्मा बनाया गया।
- विभिन्न कषषि–जलवायुओं के लिए उपयुक्त अनेक उन्नत वंशक्रमों/संकरों का एफसीवी तम्बाकू वंशक्रम टीबीएसटी–2 तथा वरटीसोल के वी4219; एनएलएसएच–1 (निम्न तारकोल संकर), जेएस–117 (निम्न तारकोल वंशक्रम) तथा अल्फीसोल के लिए एनएलएसटी–2; आन्ध्र प्रदेश के बर्ली तम्बाकू क्षेत्र के लिए वाईबी–4; तमिलनाडु के लिए जुगाली तम्बाकू संकर वीडीएच–3, पश्चिम बंगाल के जाति तम्बाकू क्षेत्र के लिए डीजे–1 सम्मिलित हैं।
- मूल्यांकन हेतु बड़े पैमाने पर किए गए परीक्षणों में एफसीवी वंशक्रम टीबीएसटी–2 (टीएमवी प्रतिरोधी वंशक्रम), टोबियोस–2, ए–13, एनएलएसटी–2, एफसीएच–222, एनएलएसएच–1 (सीएमएस संकर), जुगाली तम्बाकू संकर वीडीएच–3, जाति तम्बाकू डीजे–1 तथा नातू वंशक्रम के सेल–47, सेल–45 तथा 45–90 क्रमशः उनके चेक किस्मों की तुलना में उल्लेखनीय रूप से बेहतर पाए गए।
- लगातार तीन वर्षों तक दोहराये गए खेत परीक्षणों में सोमाक्लोन एनएलसीआर–1–11–10, एनएलसीआर–4–7–15, एनएलसीआर–6–10, एनएलसीआर–8–2–2 तथा प्रजनन वंशक्रम वी–4954, वी–4852, वी–4948, वी–4955, वी–4853, वी–4934, वी–4908, वी–4914, वी–4910, वी–4915 तथा वी–4939 में उपचारित पत्तों की उपज क्रमशः उनके चेक किस्मों की तुलना में अधिक पायी गयी। संकर जातियां टीबीएसएच–75, टीबीएसएच–91, टीबीएसएच–81 तथा सीएमएस संकर एमएसएच–5 में क्रमशः चेक किस्मों सिरी तथा कंचन की तुलना में उपचारित पत्तों की उपज में उच्च मानक भिन्नाश्रय दर्ज की गई।
- बीज उपज के लिए 15 वंशक्रमों में किए गए परीक्षणों से एसवाई–2 में बेहतर चेक किस्म ए–145 (1292 कि.ग्रा/हे.) की तुलना में अधिक बीज उपज (1562 कि.ग्रा./हे.) पायी गयी।
- सीएमएस और उपजाऊ वंशों में अंतर करने वाले दो एएलपी प्राइमरों की पहचान की गई तथा 28 सीएमएस वंशक्रमों एवं उनके उपजाऊ समकक्षों को विधिमान्य बनाया गया।
- केन्द्रीय तम्बाकू अनुसंधान संस्थान के राजमंद्री, जीलुगुमिल्ली, दीनहट्टा एवं हन्सूर प्रादेशिक केन्द्रों के डेम्पिंग आफ रोग से प्रभावित तम्बाकू नर्सरी खेतों से 20 कारकों को पष्थक कर प्राप्त किया गया। आईटीएस क्षेत्र के प्रवर्धित अंशों के अनुक्रमात्मक विश्लेषण से ज्ञात हुआ है कि अधिकांश रोगाणु *पइथियम एपनिडरमाटम* तथा बहुत ही कम *पी. मैरियोटायलम* से संबंधित हैं।
- सात विभिन्न किस्मों के कुल 9666 कि.ग्रा. आधार बीजों का उत्पादन किया गया।

तम्बाकू के सतत उत्पादन हेतु कषि–प्रौद्योगिकियों का विकास तथा प्रौद्योगिकी हस्तांतरण को सुदष्ढ़ बनाना

- परम्परागत काली मष्दा में न्यूनतम अंतर को भरने, तेज विकास एवं अच्छी स्थापना से नर्सरी अंकुरों की तुलना में ट्रे अंकुरों के उपज में उल्लेखनीय सुधार देखी गई।
- अविर्भाव पूर्व एलखलर 1000 तथा 1500 जी ए आई प्रति हे., मेट्रीबुजिन 263 तथा 394 जी ए आई प्रति हे. के उपयोग से खरपतवारों की नियंत्रण हुई एवं अधिकतम अंकुर प्राप्त हुए हैं।
- सिंचित अल्फीसोल में परम्परागत नर्सरी अंकुरों का ड्रिप फर्टिगेशन की तुलना में ट्रे अंकुरों का ड्रिप फर्टिगेशन से 16.8 प्रतिशत अधिक उपज प्राप्त हुई।
- रोपण के 15+75 दिनों के उपरान्त क्विजालोफोप–ईथाइल 60 जी ए आई प्रति हेक्टर की दर से उपयोग करने पर घासदार खरपतवारों का प्रभावी नियंत्रण हुआ और वीड–फ्री चेक की तुलना में अधिक उपज प्राप्त हुई।
- सीएच–1 के संदर्भ में नाईट्रोजन एवं पोटाशियम के सस्य उपयोगी क्षमता, पोटाशियम की उपयोगी क्षमता, नाईट्रोजन की भौतिक क्षमता, पोटाशियम की न्यूट्रियंट हारवेस्ट इन्डेक्स तथा नाईट्रोजन की आन्तरिक क्षमता सीवी कंचन की तुलना में थोड़ा अधिक पाया गया जब कि सीएच–1 की तुलना में सीवी कंचन के संदर्भ में पोटाशियम की शारीरिक उपयोगी क्षमता, नाईट्रोजन की न्यूट्रियंट हारवेस्ट इन्डेक्स तथा पोटाशियम की आन्तरिक क्षमता अधिक पायी गयी।
- जैव–सक्रिय जैविक खाद 30 कि.ग्रा. नाईट्रोजन प्रति हेक्टर के साथ 90 कि.ग्रा. अजैविक नाईट्रोजन के उपयोग से प्राप्त तमबाकू पत्तों की उपज 160 कि.ग्रा. अजैविक नाईट्रोजन उपयोग से प्राप्त उपज से तुलनीय पायी गयी।
- 100% आरडीएन तथा 80% से ड्रिप फर्टिगेशन करने पर 'अ' श्रेणी के पत्तों की उपज (एफजीएलवाई) तथा उपचारित पत्तों की तुलनीय उपज (टीसीएलवाई) प्राप्त हुई। 100% आरडीएन से ड्रिप फर्टिगेशन करने पर उच्च शुद्ध प्रतिफल एव ंबीःसी अनुपात दर्ज की गई।
- केएलएस परिस्थितियों के अंतर्गत लाल रेतीली दोमट मष्दा में आशाजनक शिथिलता प्रतिरोधी किस्म एफसीएच–222 में 20 पत्तों पर टॉपिंग तथा सिफारिश की गई 100 X 50 से.मी. अन्तराल को अपनाने तथा 60 कि.ग्रा./हे. नाईट्रोजन के सामान्य डोज का उपयोग, पत्ती क्षेत्र में वषद्धि तथा उपचारित पत्तों की उत्पादकता के साथ साथ उच्च श्रेणी के पत्तों के उत्पादन के लिए उपयुक्त पाया गया।
- पोटाश अनुपचारित विशेषकर रूट नॉट से प्रभावित मष्दा में आरकेआई अधिक पाया गया जो निम्न सूखे पदार्थ के उत्पादन एवं पत्तों की उत्पादकता से परिलक्षित होता है। रूट नॉट से प्रभावित खेतों में पोटाश की मात्रा बढ़ाने से उत्पादकता के स्तर में वषद्धि हुई। पोटाश स्तर से उपचारित पत्तों की रसायनिक गुणों में कोई प्रभाव नहीं पड़ा है।
- *जाति* तम्बाकू के वर. चामा और पोडाली किस्मों में पोटाश स्त्रोत के रूप में एमओपी 75 कि.ग्रा/हे. की दर से देना पर्याप्त एवं आर्थिक रूप से लाभदायक पाया गया।
- खेतों में एफसीवी तम्बाकू में एबीएल परीक्षण से स्पष्ट होता है कि एबीएल वी–4219 तथा टीबीएसटी–2 नियंत्रित सिरी से भी क्रमशः 10.92 और 11.09% अधिक उपज प्राप्त हुई है और यही गुणवत्ता आन्ध्र प्रदेश के एनबीएस जोन में भी बरखरार रहा है।
- खेत परीक्षण से ज्ञात होता है कि बुर्ले तम्बाकू का आशाजनक एबीएल वाईबी–4 जिसमें वास्तविक रूप से बुर्ले अभिलक्षण हैं, से नियंत्रित बैंकेट–ए1 से 23.67% अधिक उपज हुई।

- वर्ष 2010–2012 के दौरान उर्वरकों के उपयोग के मूल्यांकन अर्थात आन्ध्र पदेश के एनएलएस जोन में पोटशियम को चार भागों में रोपण के 10, 25, 40 एवं 70 दिनों के बाद डालने पर 1.92% अतिरिक्त उपज तथा सिफारिश की गई पद्धति 4.18% उच्च श्रेणी के उत्पाद प्राप्त हुई।

उत्पादन क्षमता एवं उत्पादों की गुणवत्ता हेतु संसाधन अवरोधों का प्रबंधन

- प्रकाशम जिले के टंगूटूर मंडल के 13 गांवों में मष्दा एव ंजल की गुणवत्ता की जांच की गई तथा मंडल स्तर के जलीय गुणवत्ता तथा ग्राम स्तर के मष्दा उर्वरता संबंधी स्थानिक मानचित्रों का विकास किया गया।
- नागापट्टणम, कड्डालोर तथ एरोड जिलों में जुगाली तम्बाकू उगाने वाली मष्दा सामान्य रूप से क्षारीय है। जुगाली तम्बाकू उगाने वाली अधिकांश मष्दाओं में ईसी स्तर सामान्य एवं क्लोराइड मात्रा <100 पीपीएम है। नागापट्टणम की मष्दा में उपलब्ध पोटाशियम मात्रा मध्यम (71%) स्तर का है जब कि कड्डलोर (84%) एवं एरोड (75%) जिलों की मष्दा में उपलब्ध पोटाशियम मात्रा उच्च स्तर का है।
- मष्दा की जैविक कार्बनिक पूल पर लम्बी अवधि तक उर्वरक उपयोग के प्रभाव तथा मोतीहारी तम्बाकू उत्पादन प्रणाली के अंतर्गत सीक्वेसट्रेशन का मूल्यांकन किया गया। एनपीके उर्वरकों का संतुलित उपयोग से अन्य असंतुलित उर्वरकों (एन, पी, के, एनपी, एनके तथा पीके) के उपयोग की तुलना में कार्बन खनिजीकरण में उल्लेखनीय वषद्धि होती है। विभिन्न उर्वरकों को लम्बे समय तक उपयोग करने पर कार्बन सीक्वेसट्रेशन क्षमता वषद्धि हेतु उर्वरकों का क्रम इस प्रकार है – एफवाईएम, एनपीके, एनपी, पीके, एनके, एन, पी, के।
- रोपण के पश्चात 10, 25, 40 और 70 दिनों के पश्चात 1:1:1:1 भागों में पोटाशियम के उपयोग से उत्पादकता, गुणवत्ता तथा सिंचित अल्फीसोल में उगाए जाने वाली एफसीवी तम्बाकू में पोटाशियम उपयोग क्षमता में वषद्धि होती है।
- तम्बाकू पत्तों में पोटाशियम मात्रा के निर्धारण के लिए एक सरल कम खर्चीली जल निछोड पद्धति विकसित किया गया जो विविध पादपों में पोटाशियम निर्धारण हेतु उपयुक्त पाया गया।
- *एजोस्पिरिलियम, बी. सबटिलिस* एवं *एफ. औरनटिया* के तीन टीकों से मष्दा में मैक्रोबियल संख्या में वषद्धि तथा वर्टीसोल में उगाए गए फ्लू–क्यूरड् तम्बाकू की उपज एवं गुणवत्ता में सुधार देखा गया।
- मूल्यांकित किए गए 18 जीनोटाइपों में से आरटी–57–1, आरटी–51–2, एनएलएसएच–1, एबीएल–8–1, आरटी–42–1, एबीएल–49–1, आरटी–46–1, आरटी–62–1, टोबियोस–2 तथा आरटी–102–1 में उच्च नाईट्रोजन उपयोग क्षमता के साथ उच्च उपज क्षमता भी दर्ज की गई।
- अत्यधिक जल दबाव से नाईट्रोजन, फासफोरस, पोटाशियम, कैलशियम, मैगनिशियम तथा सल्फर की खपत को कम कर दिया जो क्रमशः 20–64%, 17–59%, 19–58%, 10–67%, 4–63% तथा 5–61% है।
- जीसी–एमएस–एनसीआई मल्टी–रेसिड्यू इंसट्रूमेंटल पद्धति विकसित कर तम्बाकू में एक साथ 11 कीटनाशकों के अवशेषों के विश्लेषण हेतु मान्य बनाया गया।
- लिक्विड–लिक्विड–पार्टीशन सूत्र के आधार पर तम्बाकू से इमिडाक्लोप्रिड अवशेष निकालने एवं निध ार्रण करने हेतु एक नई पद्धति का विकास किया गया। इस पद्धति को मानक बनाकर रैखिकता, संवेदनशीलता, सुस्पष्टता, परिशुद्धता, मेट्रिक्स प्रभाव एवं पद्धति की अनिश्चतता आदि की पुष्ठि करने के बाद एचपीएलसी–यूीव द्वारा विधि मान्य बनाया गया।

जैविक दबाव का समेकित प्रबंधन

- तम्बाकू नर्सरियों तथा फेरोमोन ट्रैप से रोपित फसलों में तम्बाकू सूंडी *स्पोडोपटेरा लिटूरा* के मानिटरिंग से ज्ञात हुआ कि पतंगा संख्या और कीट का आक्रमण में उल्लेखनीय सह–संबंध है जिससे बीज क्यारियों एवं फसल को हानि पहुंचती है। पतंगा पर मौसम का कोई प्रभाव नहीं पड़ता है।
- तम्बाकू सूंडियों *एस. लिटूरा* को इमामेकटिन बेंजोएट, नोवोलूरान तथा लूफेनुरान से बने कीटनाशक से प्रभावकारी रूप से नियंत्रित किया जा सकता है। यह संरक्षण क्लोरपैरीफोस से तुलनीय है।
- नए कीटनाशक क्लोरोफेनापैर 10 एससी 0.01% दर से तथा मेटाफ्लूमिजोन 22 एससी 0.04% दर से उपयोग तम्बाकू नर्सरियों में एस.लिटोरा के प्रति प्रभावी पाया गया जब कि एफसीवी तम्बाकू में जूं के ग्रसन को नियंत्रित करने में स्पाईरोटेट्रामेट के साथ इमिडाक्नोप्रिड 240 एससी 0.018% दर से उपयोग प्रभावी पाया गया।
- तेल बीज फसल के रूप में तम्बाकू में कैप्सूल बेधक से आर्थिक क्षति एक तिहाई लार्वा/पुष्पगुच्छ पाया गया।
- सिफारिश की गई मात्रा में इमामेकटिन बेंजोएट तथा फ्लूबेंडियामाइड अंड पारासिटोयड के लिए ठीक है।
- अगस्त माह में रोपित बुर्ले तम्बाकू में कीटों से कम क्षति हुई तथा उपचारित पत्तों की उच्चतम उपज प्राप्त हुई।
- बुर्ले तम्बाकू खेती में अजैविक खाद की तुलना में केंछूए की खाद तथा नीम की खली देने पर कीटों का ग्रसन कम पाया गया।
- नोवालूरान, स्पैनोसेड,एसीफेट, इन्डोक्साकार्ब, इमामेकटिन बेंजोएट तथा एण्डोसल्फान के उपयोग करने पर राजमंद्री समिष्ठी की तुलना में *स्पोडोपटेरा लिटूरा* क्रमशः 7.09, 1.27, 1.44, 2.57, 1.65 तथा 2.68 गुना अधिक एलसी$_{50}$ स्तर दर्शाया है। गुंटूर समिष्टी की तुलना में राजमंद्री समिष्टी ने राइनैक्सपैर तथा फिप्रोनिल के उपयोग से क्रमशः 1.31 और 2.06 गुना अधिक एलसी$_{50}$ स्तर दर्शाया है।
- एच. अर्मिजेरा के प्रति 11 कीटनाशकों की प्रतिरोधी क्षमता के मूल्यांकन में निम्नतम एलसी$_{50}$ स्तर इमामेकटिन बेंजोएट में तथा इसके बाद का स्थान इन्डोक्साकार्ब, स्पैनोसेड तथा रेनाक्सीपैर का था जो निम्न घनत्व में अपनी क्षमता दर्शाते हैं।
- आशाजनक जूं प्रतिरोधी वंशक्रम 45–1, 10–2 तथा 59–2 चेक किस्म हेमा की तुलना में उपज की सभी प्राचलों के संदर्भ में बेहतर पाया गया है।
- सूंडी प्रतिरोधिता जांच में वंशक्रम आर–136 (कोई क्षति नहीं), आर–130 तथा आर–142 (कम क्षति) की पहचान सहिष्णु/प्रतिरोधी किस्मों के रूप में की गई।
- सूंडी प्रतिरोधी आशाजनक वंशक्रम 47–1, 59–2, 62–2 तथा 151–2 चेक किस्म हेमा की तुलना में उपज की सभी प्राचलों के संदर्भ में बेहतर पाया गया है।
- तम्बाकू खेत में बेरियर क्राप के रूप में बाजरा दो पंक्तियों में लगाकर फसल रोपण के 45 दिनों के बाद *वर्टीसिल्लियम* 3 X 10^{11} सीएफयू/हे. के छिड़काव से तम्बाकू जूं *मैजस निकोटियाने* ग्रसन नियंत्रण की तुलना में 77.98% कम हुई।
- *स्पोडोटेरा लिटूरा* की प्राकर्षतिक ग्रसन परिस्थितियों में तम्बाकू के 307 वंशक्रमों में किए गए जांच में कंचन, एफसीएच–201, एफसीएच–222 तथा संकर केएलएसएच–10 में क्रमशः 4.33, 4.00, 3.66 तथा 2.33% जूं का ग्रसन पाया गया।

- इन्टमोफेज क्षेत्र में उगाए गए फसलों में से सबसे अधिक परभक्षी मक्का (39/वर्गमीटर) तथा इसके बाद बाजरा (32), गेंदा और आरंडी (30), ज्वार, लाल चना, बल्लार (29) में पाए गए।
- केएलएस के तम्बाकू आधारित फसलीय अनुक्रम (रबी) में कीट ग्रसन पर किए गए एक सर्वेक्षण से ज्ञात होता है कि *हेलिकोवर्पा अर्मिजेरा* का दलहनों पर, विशेषकर बल्लार, लाल चना तथा लोबिया में कम ग्रसन पाया गया जब कि *स्पोडोटेरा लिटूरा* और *अफिस क्रोकिवोरा* ग्रसन 5 प्रतिशत क्षति से भी कम पाया गया।
- ट्रे नर्सरी अंकुरों को नेमेटोड परजीवी कवकों *पेसिलोमैसेस लिलासिनस* 50 ग्रा/ट्रे की दर से सवंर्धित करने पर खेत परिस्थितियों में रूट नॉट इन्डेक्स तथा कुल मष्दा गोल कर्षमियों में क्रमशः 52.4 और 50. 6% कमी आयी है। इससे अनुपचारित चेक किस्म परम्परागत अंकुरों की तुलना में 14.8% अधिक उपचारित पत्तों की उपज प्राप्त हुई।
- उन्नत प्रजनन वंशक्रमों एफसीआर–6 (वी–4388), एफसीआर–8 (आरएस–10), एफसीकेएच–1 (एसएच–12), एफसीएच 233 एवं एफसीएच 235 में आरकेआई <_ 1.0 दर्ज किया गया और ये ग्रसित क्षेत्र स्थितियों में रूट नॉट नेमेटोड के प्रति आशाजनक पाए गए हैं।
- एफसीएल तम्बाकू उगाए जाने वाले क्षेत्र में किए गए गहन सर्वेक्षण में मुख्य खेत में तम्बाकू फसल से जुड़े पांच मुख्य पादप परजीवी नेमेटोड नामतः मेलोयडोजाइन एसपीपी, रोटीलेंचुलस रेनीफॉरमिस, हेलकोटिलेंचस एसपीपी., प्राटिलेंचस एसपीपी. तथा टाइलेंचस एसपी पाये गए। रूट नॉट नेमेटोड का अधिकतम औसत संख्या पेरियापटना में तथा इसके बाद हंसूर, अरकलगूडा एवं एच.डी. कोटे में देखा गया।
- एन. रस्टिका प्रकार के तम्बाकू का असम के स्थानीय किस्म बेंगथुली में लगातार तीन वर्षों तक हालो स्टाल्क रोग प्रतिक्रियाओं के प्रति प्रतिरोधिता देखी गई।

वैकल्पिक फसलों की पहचान तथा तम्बाकू के वैकल्पिक उपयोग हेतु अन्वेषण

- वैकल्पिक उपयोग हेतु परीक्षण किए गए विभिन्न तम्बाकू किस्मों में से एचडीबीआरजी चयन में उच्च बायोमास तथा सोलेनसोल दर्ज की गई। जीनोटाइप टीआई–163 X ए–145 तथा जीटी–7 X ए–145 में उच्च निकोटीन जब कि ए–145 X जीटी–7 में उच्च प्रोटीन पाया गया।
- तम्बाकू बीजों के तेल में मूंगफली एवं सूरजमुखी तेलों की तुलना में क्रमशः 74.70 तथा 19% अधिक लिनोलेक एसिड पायी गई।

Executive Summary

Central Tobacco Research Institute is mandated to conduct research on different types of tobaccos, with a special focus on productivity enhancement and product quality improvement. The research focus of the institute during the period has been on tobacco cultivar development, development of agro technology for sustainable tobacco production, management of resource constraints for production efficiency and product quality, integrated management of biotic stresses and identification of alternative crops and exploiting the tobacco for alternative uses. The salient research achievements are highlighted hereunder.

Tobacco Cultivar Development

- A total of 59 exotic FCV germplasm accessions, 447 new *Rustica* germplasm lines and 37 wild *Nicotiana* species were added to the germplasm bank.

- A proforma with 53 morphological traits was designed for comprehensive DUS testing of tobacco germplasm and documentation of the released varieties.

- A number of promising advanced lines/ hybrids suitable for different agro-ecological situations were evaluated and most promising lines identified. These include FCV tobacco lines TBST-2 and V-4219 for Vertisol; NLSH-1 (low tar hybrid), JS-117 (low tar line), and NLST-2 for Alfisols; YB-4 for burley tobacco areas of Andhra Pradesh; chewing tobacco hybrid VDH-3 for Tamilandau, DJ-1 for *Jati* tobacco tracts of West Bengal.

- In the bulk evaluation trials, FCV entries TBST-2 (TMV resistant line), Tobios-2, A-13, NLST-2, FCH-222, NLSH-1(CMS hybrid), Chewing hybrid VDH-3 *Jati* tobacco DJ-1, and *Natu* entries Sel 47, Sel 45, and 45-90 were found significantly superior over their respective check varieties.

- In different replicated yield trials conducted for three consecutive years, somaclones NLCR-1-11-10, NLCR-4-7-15, NLCR-6-10, NLCR-8-2-2 and breeding lines V-4954, V-4852, V-4948, V-4955, V-4848, V-4853, V-4934, V-4908, V- 4914, V-4910, V-4915 and V-4939 recorded significantly higher cured leaf yield (7-25%) than respective check varieties. Hybrids, TBSH-75, TBSH-91, TBSH-81 and CMS hybrid MSH-5 recorded significantly higher standard heterosis for cured leaf yield over checks Siri and Kanchan, respectively.

- In a trial conducted with 15 entries for seed yield, SY-2 gave significantly higher seed yield (1562 kg/ha) than better check, A-145 (1292 kg/ha).

- Two ALP primers that differentiate CMS and fertile lines were identified and validated in 28 CMS lines and their 19 fertile counterparts.

- Twenty isolates of causative agents of damping-off disease were isolated from infected tobacco nursery fields of CTRI Research Stations, Rajahmundry, Jeelugumilli, Dinhata and Hunsur. Sequence analysis of the amplified fragments of ITS region revealed that majority of the pathogens belong to *Pythium aphnidermatum* and a very few to *P. myriotylum*.

- A total quantity of 9666 kg foundation seed of seven different varieties was produced

Development of agro-technology for sustainable tobacco production and strengthening TOT

- Tray seedlings showed significant improvement in yield owing to minimum gaps, rapid growth and good establishment as compared to nursery seedlings in traditional black soils.

- Pre-emergence incorporation of Alachlor @ 1000 and 1500 g a.i./ha, Metribuzin at 263 and 394 g a.i. /ha controlled the weeds and gave optimum number of seedlings.

- Drip fertigation with tray seedlings increased the yield by 16.8% over drip fertigation with conventional nursery seedlings in irrigated Alfisols.

- Post-emergence application of Quizalofop-ethyl @ 60g a.i./ha at 15+75 days after planting effectively controlled the grassy weeds and also gave higher yields when compared to weed-free check. Pre-emergence application of Pendimethalin @ 750 g a.i./ha 3 days before planting ensured field free of weeds (except nut grass). But the yields were reduced by 4% when compared to weed-free check.

- Agronomic-use-efficiency of N and K, K use efficiency, physiological efficiency of N, nutrient harvest index of K and internal efficiency of nitrogen were slightly higher for CH 1 than cv. Kanchan, whereas physiological use efficiency of K, nutrient harvest index of N and internal efficiency of K were slightly higher for cv. Kanchan than for CH 1.

- Application of bio-dynamic organic manures equivalent to 30 kg N/ha along with 90 kg N in the inorganic form produced tobacco leaf yields comparable to that of 160 kg inorganic N.

- Drip fertigation with 100% RDN and 80% RDN recorded a comparable first grade leaf yield (FGLY) and total cured leaf yield (TCLY). Higher net returns and B:C ratio was recorded with drip fertigation with 100% RDN.

- Topping at 20 leaves and adopting recommended spacing of 100 x 55 cm and application of normal dose of 60 kg N/ha was found ideal for increasing the leaf area and the cured leaf productivity as well as top grade leaf production in promising pre-release wilt resistant line FCH-222 in red sandy loam soils under KLS conditions.

- The RKI was found to be more under no potash treatment especially in the root-knot sick soils which was reflected in lower dry matter production and leaf productivity. Increased levels of K positively increased the productivity levels in the root-knot sick fields. The chemical quality characteristics of the cured leaf were not influenced by the K levels.

- The MOP as source of K applied @ 75 kg/ha was found optimum and economical for var. Chama and Podali types of *Jati* tobacco.

- On-farm evaluation of ABLs in FCV Tobacco revealed that the ABLs V-4219 and TBST-2 out–yielded better control Siri by 10.92 and 11.09%, respectively and maintained the same quality characteristics in NBS zone of A.P.

- Promising ABL of Burley tobacco YB-4 having true burley characteristics out-yielded the better control Banket –A1 by 23.67% in the on-farm trials.

- On-farm assessment of fertilization interventions conducted during 2010-12 i.e., application of potassium in four splits at 10, 25, 40 and 70 DAT in NLS zone of A.P. gave 1.92% additional yield and 4.18% additional bright grades over recommended practice.

Management of Resource constraints for production efficiency and product quality

- Soil and water quality in 13 villages of *Tanguturu* mandal of Prakasam district was assessed and mandal level water quality and village level soil fertility spatial maps were developed.

- Chewing tobacco growing soils of Nagapattanam, Cuddalore and Erode districts are moderately alkaline. EC values are normal and chloride content is <100 ppm in majority of chewing tobacco growing soils. Soils of Nagapattanam district are medium (71%) in available K where as majority of soils in Cuddalore (84%) and Erode district (75%) are high in available K.

- Long-term impact of fertilizer regimes on soil organic carbon pools and sequestration under *Motihari* tobacco production system

was assessed. The balanced NPK fertilizer regime showed a significant increase in C mineralization over all other unbalanced fertilizer regimes (N, P, K, NP, NK and PK). The C sequestration potential of different long-term fertilizer regimes followed the order: FYM > NPK > NP > PK > NK > N > P > K.

- Potassium application in four splits (1:1:1:1 at 10, 25, 40 and 70 Days after transplanting) improved productivity, quality and potassium use efficiency of FCV tobacco grown on irrigated Alfisols.

- A simple inexpensive water extraction method developed for determination of K in tobacco leaf was also found suitable for determination of K in diverse plant materials.

- Triple inoculation of *Azospirillum, B.subtilis and F.aurantia* increased the microbial population in the soil and improved the yield and quality of flue-cured tobacco grown in Vertisols.

- Among the 18 advanced breeding lines and hybrids evaluated, RT-57-1 RT-51-2, NLSH-1, ABL-8-1, RT-42-1, ABL-49-1, RT-46-1, RT-62-1 TOBIOS-2 and RT-102-1 recorded greater nitrogen-use-efficiency coupled with high yield potential.

- Excess water stress reduced N, P, K, Ca, Mg and S uptake varied between 20-64% and 17-59%, 19-58%, 10-67%, 4-63% and 5-61%, respectively.

- GC-MS-NCI multi-residue instrumental method has been developed and validated for simultaneous analysis of 11 insecticide residues in tobacco.

- New method for extraction and determination of imidacloprid residue in tobacco leaves was developed using the principal of liquid-liquid-partition. The method was standardized and validated by HPLC-UV, after confirming the linearity, sensitivity, precision, accuracy, matrix effect and uncertainty of the method.

Integrated management of biotic stresses

- Monitoring of tobacco caterpillar, *Spodoptera litura* in tobacco nurseries as well as planted crop with pheromone traps showed that there was a highly significant and positive correlation between moth catch, incidence of the pest and damage in both the seed beds and field crop. The weather parameters had no correlation with the moth catch.

- Tobacco caterpillar *S.litura* could be effectively managed with insecticide baits prepared with emamectin benzoate, novoluron and lufenuron. The protection provided was comparable to that of chlorpyriphos bait.

- New insecticides chlorfenapyr 10 SC @ 0.01% and metaflumizone 22 SC @ 0.04% were found effective against *S.litura* in tobacco nurseries and spirotetramet + imidacloprid 240 SC @ 0.018% effectively controlled tobacco aphid infestation in FCV tobacco.

- The economic injury level of capsule borer, *H.armigera* for tobacco as oil seed crop was found to be one third instar larva/panicle.

- Emamectin benzoate and flubendiamide at recommended doses were safe to the egg parasitoid, *Telenomus remus.*

- Burley tobacco planted during third week of August suffered minimum damage due to insect pests and gave highest cured leaf yield.

- Relatively less pest infestation and higher cured leaf was recorded in Burley tobacco treated with vermicompost and neem cake over inorganic fertilizers.

- The population of *Spodoptera litura* recorded 7.09, 1.27, 1.44, 2.57, 1.65 and 2.68 times higher LC_{50} values of novaluron, spinosad, acephate, indoxacarb, emamectin benzoate and endosulfan, respectively compared to Rajahmundry population. On the other hand the LC_{50} values of rynaxypyr and fipronil were higher by 1.31 and 2.06

times, respectively in Rajahmundry population compared to Guntur population.

- Out of the eleven insecticides with stomach action against which base line resistance data of *H.armigera* were generated, the lowest LC50 value was recorded with emamectin benzoate followed by indoxacarb, spinosad and rynaxypyr establishing their efficacy at very low concentrations.

- The promising aphid tolerant interspecific cross derivatives 45-1, 10-2 and 59-2 were significantly superior to the check variety Hema with respect to all the yield parameters.

- Under caterpillar resistant screening, the test lines R-136 (with no damage), R-130 and R-142 (with low damage) were identified as resistant/tolerant.

- The caterpillar resistant promising lines 47-1, 59-2, 62-2 and 151-2 were significantly superior to the check variety, Hema with respect to all the leaf yield parameters.

- Two rows of bajra border as barrier crop with one spray of *Verticillium lecanii* @ $3X10^{11}$ CFU/ha at 45 DAT reduced tobacco aphid, *Myzus nicotianae* infestation by 77.98% over control.

- Among 307 tobacco lines screened against *Spodoptera litura* under natural infestation, Kanchan, FCH-201 & FCH-222 and hybrid, KLSH-10 registered with 4.33, 4.00, 3.66 and 2.33% caterpillar infestation, respectively.

- Among the crops raised in Entomophage Park, maize harboured more predators (39/m^2) followed by bajra (32), *Tagetes &* castor (30), jowar, red gram & field bean (29).

- A survey on insect pest incidence in tobacco based cropping sequence (*Rabi*) of KLS revealed that *Helicoverpa armigera* incidence was less on pulses especially field bean, red gram and cowpea. Whereas, *Spodoptera litura* and *Aphis croccivora* infestations were below 5% damage.

- Tray nursery seedlings enriched with nematode egg parasitic fungi, *Paecilomyces lilacinus* @ 50 g/tray media caused 52.4 and 50.6% reduction in root knot index and final soil nematode population, respectively under field conditions. It also caused 14.8% increase in cured leaf yield compared to untreated check (i.e.) conventional seedlings.

- The advance breeding lines, FCR-6 (V-4388), FCR-8(RS-10), FCKH-1 (SH-12), FCH-233 & FCH-235 recorded RKI of d" 1.0 and were found most promising against root-knot nematodes under sick field conditions.

- Intensive survey in FCV tobacco growing regions of KLS revealed the presence of five major plant parasitic nematodes viz., *Meloidogyne* spp., *Rotylenchulus reniformis, Helcotylenchus* spp., *Pratylenchus* spp. and *Tylenchus* sp., associated with main field tobacco crop. Maximum mean population of root knot nematodes were found in Periyapatna region followed by Hunsur, Arkalgud and H.D.Kote.

- Bengthuli, an indigenous variety from Assam consistently exhibited resistant disease reaction for successive three years to hollow stalk of *N. rustica* type of tobacco.

Identification of Alternative Crops and Exploiting Tobacco for Alternative Uses

- Among the different tobacco types tested for alternative uses, HDBRG selection recorded higher biomass and solanesol. Genotypes TI-163 x A-145 and GT-7 x A-145 gave higher nicotine, while A-145 x GT-7 produced higher protein yield.

- Tobacco seed oil showed 74.70 and 19% of higher linoleic acid compared to groundnut and sunflower oils respectively.

- From the nutritional point of view, the tobacco seed oil is of superior quality due to high content of linoleic acid. The oxidative deterioration of tobacco seed oil showed nearly similar trends with that of sunflower oil.

Introduction

The Central Tobacco Research Institute (CTRI) is mandated to undertake basic, strategic and applied research on various types of tobacco grown in the country with special emphasis on exportable types of tobacco. Six regional stations situated at Guntur, Kandukur, Jeelugumilli in Andhra Pradesh; Vedasandur in Tamil Nadu; Hunsur in Karnataka; and Dinhata in West Bengal and a Research Centre at Kalavacharla in Andhra Pradesh are engaged in research to develop improved varieties and agro technologies so as to meet the location specific requirements of tobacco farmers in different agroclimatic zones. The All India Network Research Project on Tobacco with its four main centres and seven sub centres is carrying out multi-locational trials on various types of tobacco.

Owing to various changes in the recent past CTRI is thriving hard to meet the requirements of tobacco community with concerted research and developmental activities with the following mandate.

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 alternative to tobacco.
- To conduct research on diversified uses of tobacco and development of value-added products viz., phytochemicals.
- To produce and distribute quality seeds of notified varieties of tobacco.
- To publish and disseminate research findings and recommendations of latest technology for the benefit of the tobacco growers, scientific community, policy makers and development agencies.

RESEARCH PROGRAMMES

I. Tobacco cultivar development

(A) Developing Tobacco Varieties with Higher Leaf Yield and Quality

(B) Tailoring of tobacco plant type for optimizing the seed yield and phytochemicals

(C) Production and distribution of foundation seed of ruling tobacco varieties

(D) Germplasm resource management

(E) Biotechnology for tobacco improvement

II. Development of agro-technology for sustainable tobacco production and strengthening TOT

(A) Healthy seedling production

(B) Optimization of water and nutrient use for productivity enhancement of different tobacco types

(C) Evolving site-specific cultural management practices in different agro-ecological sub-regions

(D) Post-harvest product management (PHPM)

(E) Analysis of socio-economics for stratification and to formulate appropriate strategies

(F) Technology assessment

III. Identification of alternative crops and exploiting tobacco for alternative uses

(A) Identification of Alternative Crops to FCV and Non-FCV Tobaccos

(B) Agro-techniques for higher biomass and seed yield

(C) Identification of potential phytochemicals

IV. Management of resource constraints for production efficiency and product quality

(A) Evaluation of soil fertility, water quality and plant nutrition constraints for tobacco and their management

(B) Soil quality and nutrient-use-efficiency in relation to input management

(C) Characterization of soil biota and use of biofertilizers

(D) Evaluation of tobacco leaf and product quality

V. Integrated management of biotic stresses

(A) Monitoring of insect pests and diseases

(B) Development of IPM technology

(C) Screening for host plant resistance to insect pests and disease

(D) Monitoring and management of pesticide resistance and pesticide residues

STAFF POSITION AND FINANCIAL STATEMENT

STAFF POSITION AS ON 31.03.2013

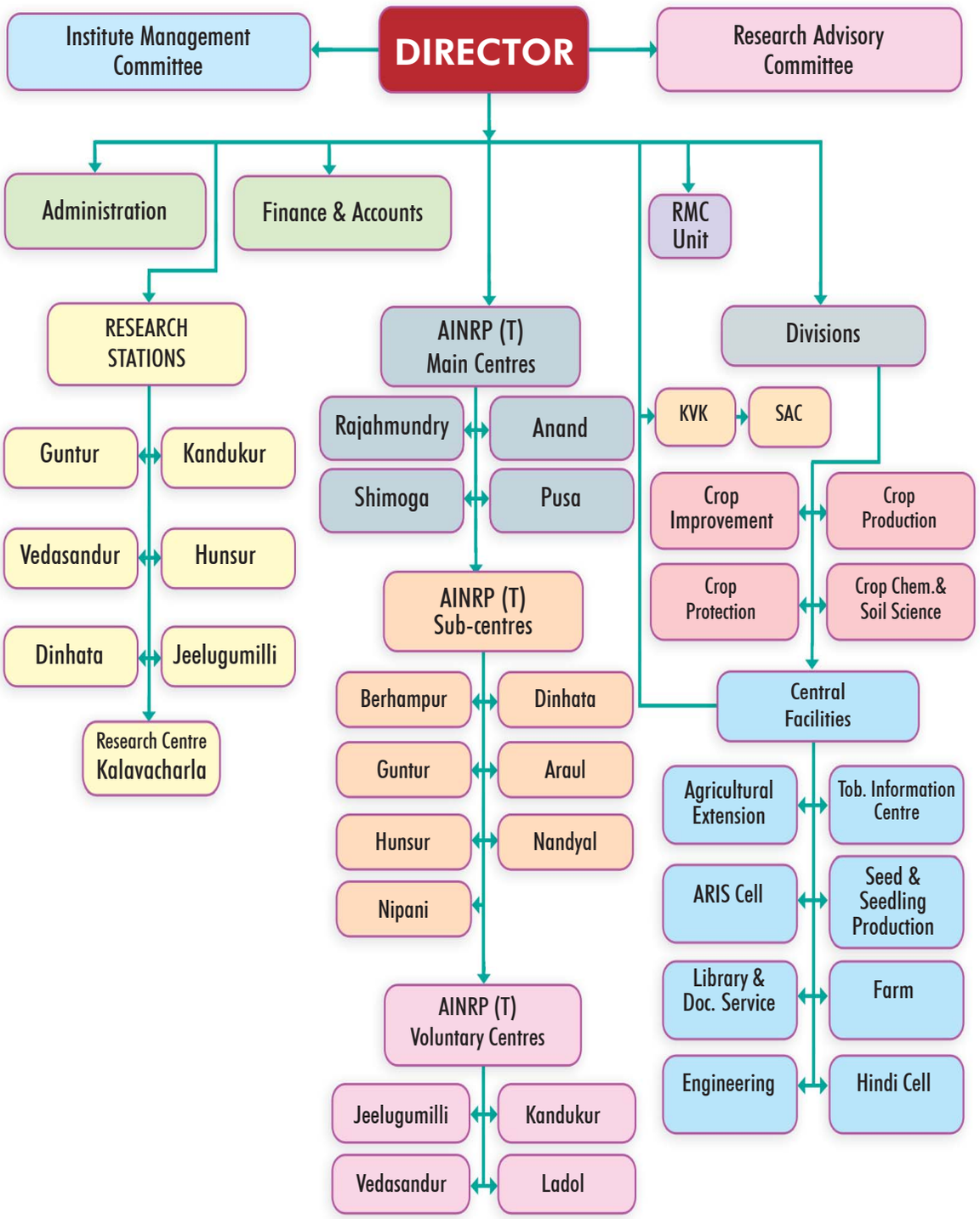
Sl. No.	Category	Sanctioned Strength	In Position	Vacancies
1.	Scientific	54+1*	32	23
2.	Technical	147	120	27
3.	Administration	70	56	14
4.	Skilled Supporting Staff	158	105	54

* RMP position

FINANCIAL STATEMENT FOR THE YEAR 2012-13

Head of Accounts	Rupees in lakhs	
	Budget Grant	Expenditure
Non-Plan	2935.00	2932.14
Plan	150.00	149.98
KVK	127.00	135.69
AINRPT	268.00	268.00
Pension & Retirement Benefits	900.00	899.98
Personal Loans & Advances	12.00	12.00
Recurring Deposit Schemes	30.46	24.79
Revolving Fund Scheme	143.06	98.56
Internal Resource Generation	30.46	4.26
Total	4595.98	4525.38
Revenue Receipts	Target 210.00	Achieved 233.68

INSTITUTE ORGANOGRAM



Research Achievements

I. Tobacco Cultivar Development

I. (A) Developing Tobacco Varieties with Higher Leaf Yield and Quality

Evolving superior varieties of FCV tobacco through hybridization [CTRI, Rajahmundry]
P.V. Venugopala Rao

SP-1: Evaluation of advanced breeding lines for yield and quality

Cured leaf yield: A replicated yield trial with ten advanced breeding lines viz., V-4835, V-4837 V-4846, V-4848, V-4852, V-4853, V-4854, V-4948 V-4954 and V-4955 along with two controls viz., VT-1158 and Siri was conducted for the third and final Year. Significant difference between the treatments was recorded in all the four yield characters viz., green leaf yield, cured leaf yield, bright leaf yield and grade index. Cured leaf yield was significantly superior in V-4954 (2849 kg/ha), V-4854 (2,511 kg/ha), V-4852, V-4948, V-4848 and V-4955 compared to the better control Siri (2017 kg/ha). Results of combined analysis revealed that the breeding lines differed significantly for all the yield characters studied. Among the selections significant cured leaf yield was recorded in V-4954 (2109 kg/ha) with an improvement of 23% over the better control Siri (1714 kg/ha) followed by V-4852 (2060 kg/ha) with 20% over Siri. Based on the performance of the selections over three years, among the selections V-4954, V-4852, V- 4948 and V-4955 with significantly superior yields of all kinds were the better entries.

SP-2: Evaluation of advanced breeding lines for yield and quality

Yield parameters: A replicated yield trial with ten advanced breeding lines viz., V-4994, V-4995, V-4996, V-4997, V-4998, V-4999, V-5000, V-5003, V-5015, V-5027, V-5029, V-5033, V-5039 and V-5041 along with two checks viz., VT-1158 and Siri for the second year. Significant difference between the treatments was recorded in all the four yield characters. Among the lines evaluated cured leaf yield was significant in V-5000 (2,282 kg/ha) followed by V-4998 (21,84 kg/ha), V-4999 (2,148 kg/ha) and V-5033 (2,147 kg/ha) compared to the better control Siri (1350 kg/ha) and the yield improvement over the Siri was 22, 17, 15 and 15 % respectively. The nicotine (%) in the entries ranged from 2.32 to 3.40. The reducing sugars (%) ranged from 11.02 to 16.66. Based on the over all performance V-5000, V-4998, V-5033 and V-4999 were better performers among the entries evaluated.

Preliminary evaluation of advanced breeding lines in row trial: Advanced breeding lines (43) were evaluated in a row trial along with the controls viz., VT-1158, Hema and Siri to identify the potential lines with higher yield. Thirty eight selections were made and selfed seed collected to take up for further evaluation during 2012-13. Another set of fifty seven F_4s were evaluated and twenty four selections were made and seed collected to raise F_5 during 2012-13.

Evaluation of advanced breeding lines for leaf yield and quality
K. Sarala, T.G.K. Murthy, P.V. Venugopala Rao and C.A. Raju

Replicated trial (2nd year): Four somaclones and nine advanced breeding lines were tested in a replicated trial for the second year along with two controls, VT-1158 and Siri. Lines RS 13 and RS 18, respectively recorded higher cured leaf yields (3401 & 3153 kg/ha) and grade index values (2865 & 2651) than the better control, Siri. The increase in bright leaf yields in RS 13, RS 17 and RS 18 ranged from 14-27%, cured leaf from 10-25%, and grade index 17-26%. Morphological characteristics of the lines with respect to plant height, total number of leaves, leaf length and leaf width found to be significant among the lines tested. The chemical quality characteristics of breeding lines viz. nicotine range from 1.96% in RS-17 to 3.51% in RS-12 and reducing sugars from 5.29% in RS-14 to 14.56% in RS-11. Chlorides in all these lines found to be in acceptable limits (0.77-1.35%).

Screening for higher leaf yield: Out of 17 lines tested at CTRI RS, Jeelugumilli, 14 recorded higher leaf yield than Kanchan. Out of 127 breeding lines assessed for yield under row trial

at Katheru farm, 60 lines found to be promising for yield. 74 advanced breeding lines were raised and seed collected for maintenance. 150 lines including breeding lines, germplasm lines and F_2s were screened for TMV resistance and resistant plants selfed and selfed seed collected.

Screening of somalcones for disease resistance: Twenty promising Kanchan somaclones and 12 VT-1158 somaclones were tested for black shank reaction under artificial conditions at Katheru Farm. In comparison to Kanchan (50%), all the somaclones of Kanchan recorded higher number of resistant plants (58.3-100%). Among the 12 clones of VT-1158, one clone recorded 100% resistant plants. Out of 46 somaclones tested for CMV, 28 lines found to resistant and others segregated. Recovery of CMV affected plants was observed in somaclones. Fifty four somaclones were tested for leaf curl resistance under artificial conditions at Rajahmundry. Two resistant plants selected in each clone and selfed seed collected.

Seed oil content: Seed oil content was estimated in 20 entries including two parents, A-145 and Jayalakshmi (ws), 15 white seed derivatives of cross A 145 x Jayalakshmi (ws) and three high seed yielding *N. rustica* lines. Jayalakshmi (ws) recorded higher seed oil content (39%) than A-145 (37). Among the derivatives, the seed oil ranged from 35.62-40.45%. Among *rustica* lines, NGPO 7/20 recorded highest oil content (38%).

On-farm trial with line JS-117: An advanced breeding line, JS-117 was tested in the on-farm trials at Buttayagudem, West Godavari District. The line recorded 27% increase in cured leaf yield (3,100 kg/ha) and 32% increase in grade index (2,200 kg/ha) than control Kanchan. The line also recorded higher leaf length (76 cm), leaf width (33 cm) and SLW (14.20 mg cm^{-2}) than Kanchan.

JS-117 - An advanced low tar breeding line

Evolving FCV tobacco varieties having high yield and better quality suitable for NLS area of Andhra Pradesh [CTRI RS, Jeelugumilli]

T.G.K. Murthy

Generation advancement & selection: Thirty F_5 progenies of crosses involving Kanchan as one of the parents were raised and 40 single plant selections showing plant type suitable to NLS besides having high leaf number (35-45 per plant) and/or resistance to TMV were selfed for conducting replicated yield trials. At Rajahmundry, 12 uniformly TMV resistant progenies having "Kanchan" plant type, derived from crosses involving Kanchan and TMV resistant lines (VT-1158, JMR) as parents were developed for further evaluation in NLS.

Preliminary evaluation of advanced breeding lines: A progeny-row trial was conducted with 136 lines (F_7) along with the check variety Kanchan. Seventeen lines with high yield potential (CLY 3620-4450 kg/ha against 1930 kg in Kanchan) and desirable leaf quality were identified. Twenty four of the lines were identified as resistant to TMV on artificial inoculation. Eighty six single plant selections showing good plant type and leaf characteristics suitable for NLS besides high yield potential, were advanced for further evaluation. In addition to high yielding selections, four semi-dwarf selections with compact plant type and very short internodes, suitable for close spacing were also identified and advanced for further study.

Replicated yield trials

(1) Trial RYT-11 (2nd year): Nine medium green/green cast advanced breeding lines were evaluated along with check Kanchan for yield and leaf quality traits in a RBD with three replications for the second year in succession. Three of the lines were 'flat' leaf types while others were 'Kanchan' type. Five of the lines

viz., SM12-2, ABL10-1, ABL13-1, ABL24-1 and ABL 45-5 were resistant to TMV. Analysis of data indicated significant differences in cured leaf yield as ABL10-1 (28%), ABL13-1 (40%), ABL8-1 (32%), SM26-1 (43%), SM12-2 (19%), ABL36-2 (18%), ABL 45-5 (19%), ABL24-1 (17%) over Kanchan.

(2) Trial RYT-12 (2nd year): Nine medium/ green cast advanced breeding lines were evaluated along with check Kanchan for yield and leaf quality traits in a RBD with three replications. Four of the lines were 'flat' leaf types while others were 'Kanchan' type. Three lines viz., RT19-1, RT9-1 and RT31-1 were resistant to TMV. Three lines viz., RT31-1, RT18-1 & RT19-1 showed significantly higher green leaf yield, cured leaf yield and grade index. The increase for different traits in these lines over check Kanchan was 25-50% in green leaf yield, 23-46% in cured leaf yield and 22-50% for grade index. Cured leaf colour, size and body in all the test entries were comparable with that of Kanchan. Chemical quality of leaf: nicotine and reducing sugars were within admissible limits while chlorides were slightly higher.

(3) Trial RYT-13 (2nd year): Thirteen medium green/ dark green cast advanced breeding lines were evaluated along with check Kanchan for leaf yield and quality traits in a RBD with three replications for the second year in succession. Five lines viz., F3-18-1, RT42-1, F3-20-2, RT36-1 and F3-23-1 showed significantly higher green leaf yield, cured leaf yield and grade index than the check, Kanchan. The increase for different traits over Kanchan was 21 to 38%, 19-37% & 19-40% for green leaf yield, cured leaf yield and grade index, respectively in these lines. Cured leaf colour, size and body in all the test entries were comparable with Kanchan. Chemical quality of leaf: nicotine and reducing sugars were within admissible limits while chlorides were slightly higher.

(4) Trial RYT-14 (1st year): In another new replicated trial, 13 medium/ green cast advanced breeding lines were evaluated along with check Kanchan for leaf yield and quality traits in a RBD with three replications. Five lines (RT-6, RT52-3, RT62-1, RT67-3 and F3-9-1) showed significantly higher green leaf yield, cured leaf yield and grade index than check, Kanchan. The increase over Kanchan was 25-32%, 22-29% & 20-30% for green leaf yield, cured leaf yield and grade index, respectively in these lines. Cured leaf colour, size and body in all the test entries were comparable with that of Kanchan. Chemical quality of leaf: nicotine and reducing sugars were within admissible limits while chlorides were slightly higher.

Evaluation of advanced burley breeding lines for productivity and quality [BTRC, Kalavacharla]

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

Replicated trial (Second Year)

A replicated trial was conducted to evaluate fourteen advanced breeding lines (YB-15 to YB-25) along with three controls (viz., Banket A1, Burley-21 and Swetha). The treatments differed significantly for green leaf yield and cured leaf yield. Significantly superior cured leaf yield was recorded for YB-19 with 2332 kg/ha cured leaf, an improvement of 51% over better control Banket A1 and this is followed by YB-22 with 2277 kg/ha (48%). Next better performers are YB-20, YB-23 and YB-21.

Evaluation of segregating material: Progeny row trial was conducted involving 30 progenies and fifty seven selections. Twenty seven selections were made based on the morphological characters like leaf size shape, colour of leaf, stem and veins, number of leaves, inter nodal length, spotting, etc., and these selections will be evaluated further during 2012-13. Out of eight selections (F_5) evaluated, three were selected and these selections will be further evaluated during 2012-13.

Incorporation of male sterility (CMS) in Burley varieties: The BC_7 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, VA-510, Banket-127. The seed was collected to raise the BC_8 seedlings during 2012-13.

Breeding FCV tobacco varieties for yield and quality characters under SLS conditions [CTRI RS, Kandukur]

A.R. Panda, K.C. Chenchaiah, P.V. Venugopala Rao, T.G.K. Murthy, A.V.S.R. Swamy and C.V.N. Rao

The significant progress under this project include: (1) A variant plant, isolated from Siri population on the basis of low internode length and wider leaf, was grown, (2) Among the crosses of H-13 (Candle x Hema), FCK-3 line was selected for Station Trial on the basis of uniformity and vigour, (3) From the crosses of aphid resistant lines: 15-2, 10-1, 16-1 with Siri and caterpillar resistant lines :155-2, 113-1, 326, 117-1, 115-1 and 119-1 with Siri and N-98 in F2 generation, 30 single plant selections were made for generation advancement and (4) New aphid and caterpillar resistant lines (47-1, 62-2 and 151-2) with good vigour were crossed with Siri and N-98 and the seed was collected.

Pedigree selection in chewing tobacco (*N. tabacum* L.) population with a broad genetic base [CTRI RS, Vedasandur]

A.V.S.R. Swamy

Yield and yield attributes: Twelve selections (HV.2009-1 to HV.2009-12) derived from the broad based genetic populations of diallel selective mating approach were grown in a replicated trial along with Bhagyalakshmi and Abirami for the third year for assessing their yield and quality. The selections exhibited significant differences for both yield as well as growth attributes such as leaf width and inter nodal length. The selection HV.2009-3 recorded significant superiority in total leaf yield of 4259 kg/ha followed by selection HV.2009-4 of 4099 kg/ha against the best checks Bhagyalakshmi and Abirami. The selections viz., HV.2009-12 and HV.2009-11 recorded significantly larger leaf width compared to the check variety Abirami. In inter node length selection HV.2009-4 exhibited significant superiority to the check Abirami. In the combined analysis over three seasons (2009-12), the selections exhibited significant differences for whole leaf, total leaf, leaf length, leaf width and stem girth against the controls.

Leaf yield: In total leaf yield, the selection HV.2009-3 recorded significantly highest total leaf yield of 4255 kg/ha against the controls, Bhagyalakshmi and Abirami. This was followed by selections HV. 2009-5,6,4 and 8's. With respect to whole leaf yield, selection HV.2009-5 registered significantly highest whole leaf yield of 3165 kg/ha against the controls Bhagyalakshmi and Abirami. This was followed by the selection HV.2009-3.

Growth attributes: In growth attributes, selection HV.2009-6 recorded significantly superior leaf length over the control Bhagyalakshmi. Selections HV.2009-12 and HV.2009-11 exhibited significant superiority in leaf width over the controls Bhagyalakshmi and Abirami. Seasons differed significantly for the yield and growth attributes except for plant height. Seasons x treatments showed significant differences for leaf width, inter nodal length and stem girth. On overall performance, selections HV.2009-3 and HV.2009-5 were selected for pre release bulk testing in farmers' fields in the ensuing season. The chemical analysis of data of broad based selections revealed that the selections exhibited acceptable range of nicotine, reducing sugars and chlorides percentage when compared with the controls.

Diallel analysis in *Motihari* (*N. rustica*) tobacco for breeding superior varieties [CTRI RS, Dinhata]

S. Amarnath and S. Roy

Six pedigree selections, 2 inter-se crosses and two intermating crosses were evaluated in a replicated trial along with 2 local cheeks during the crop season. Perusal of the data indicates that inter -se crosses (B.Q x Manda) x (B.Q. x Manda) recorded significantly higher cured leaf yield over both the checks (Dharla and DD-437), whereas inter-mating cross (B.Q x Manda) x (B.Q x DD.473) recorded significantly higher yield over DD.437 only. The pedigree selections (B.Q. x DD. 437) recorded on par cured leaf yield with the check Dharla and recorded 7.2% higher Cured leaf over check DD.437. All the crosses recorded lower first grade leaf yield than both the checks.

Evaluation of advanced breeding lines of *Jati* tobacco (*N. tabacum*) for yield and quality performance

S. Amarnath and S. Roy

Six breeding lines viz. DJ-1 to DJ-5 along with Podali (check) of *Jati* tobacco (*N. tabacum*) were evaluated in replicated trial for second year (2011-12) for their yield and quality. All the lines exhibited 5.6 to 50.7% higher cured leaf yield than Podali (check). Out of all the lines (DJ-1 to DJ-5), DJ-1 proved superior recording 50.7 % and 81.6 % higher cured and first grade leaf yield, respectively, over check Podali.

Pooled analysis: The pooled analysis for the years 2010-11 and 2011-12 for cured and first grade leaf yield respectively revealed that the breeding lines DJ-1 and DJ -2 were at par in registering higher cured leaf yields than rest of the treatments. The line DJ-1 exhibited significantly higher yield during 2011-12 than rest of the treatments. Line DJ-1 consistently proved its superiority over check (Podali) in terms of cured and first grade leaf yield.

Advanced Breeding Line - DJ-1

Improvement of Assam tobacco variety of *Motihari* tobacco (*N. rustica*) for yield by keeping the quality

S. Amarnath and S. Roy

Three progeny rows with 50 plant population each of the best selection were raised as F5 population along with two Assam and three local varieties as parent. Based on the plant habit, maturity, thickness of leaf, no. of leaves and maturity symptoms, five plants were selected in Bengthuli Sada x Torsa (F5) population. Selfed seed were collected from the selected plant which will be raised as F6 population in the crop season 2012-13 with 100 plant population each along with the parent Bengthuli sada, Torsa and Bitri (Local). The cured and first grade leaf yield data indicate that cross Bengthuli Sada x Torsa recorded 2312 and 1296 kg /ha for cured and first grade leaf yield, respectively with 56% quality leaf outturn which is 12% more than parent Dharla.

Interspecific hybridisation for tobacco improvement

Incorporation of aphid resistance from *N. gossei*, *N. repanda*, *N. umbratica* - *nesophila* and *N. benthamiana* - *repanda* [CTRI, Rajahmundry]

T.G.K. Murthy, U. Sreedhar and K. Siva Raju

Maintenance of interspecific cross derivatives: During 2011-12 season, a total of 92 stabilized aphid and caterpillar resistant / tolerant advanced lines derived from crosses involving *N. tabacum* as one parent and aphid resistance donors viz., *N. gossei, N. excelsior, N. x benthamiana-repanda,* and *N. umbratica* as the other parents, were grown in progeny rows along with 7 check varieties. Also, 11 derivatives developed from crosses, *N. gossei x N. tabacum* and *N. umbratica x N. tabacum,* screened and identified as tolerant to leaf curl disease in collaboration with Entomologist, were maintained. Also, 8 Lanka type derivatives were grown for evaluation of their suitability for cultivation.

Reaction to aphids under natural condition: In general aphid infestation was less during the season. Most of the derivatives (73) were free from aphid infestation.

Preliminary evaluation for leaf yield potential: Fourteen of the selections were found to be, medium cast and possessed "Kanchan" plant type suitable for NLS area. All these selections showed higher yield potential (18 – 35%) than the check, Kanchan (CLY = 1920 kg/ha). Thirty of the derivatives were light cast and possessed high leaf yield potential (15 – 35%) as compared to check variety, Siri (CLY- 2650 kg/ha).

Evaluation of advanced lines in RYTs

a) Trial TBL-4 (2nd year): A replicated yield trial was conducted with ten morphologically stable, aphid resistant/ tolerant advanced cross derivatives (TBST-32 to TBST-41) along with two checks, Siri and VT-1158 in a RBD with 3 replications for evaluation of yield potential and leaf quality. TBST-36 and TBST-41 showed significant improvement over the best check, Siri, 22 & 12% for cured leaf yield, 34 & 22% for bright leaf yield and 28 & 24% for grade index, respectively. Also, line TBST-34 showed significant improvement over the best check, Siri for bright leaf yield and grade index. The nicotine content varied from 1.96 to 4.47% while reducing sugars ranged from 4.03 to 14.13% among the lines.

b) Trial TBL-5 (2nd year): Another replicated yield trial was conducted with ten morphologically stable, aphid resistant/ tolerant light cast advanced cross derivatives (TBST-42 to TBST-51) along with two checks, Siri and VT-1158 in a RBD with 3 replications for evaluating their yield potential and leaf quality. Four of the derivatives (TBST Nos. 43, 48, 49, 50 & 51) showed uniform resistance to TMV also. Two lines, TBST-49 and TBST-51 showed significant improvement over the best check, Siri with 16 and 19% in cured leaf yield, 22 and 20% in bright leaf yield and 15 and 18% in grade index, respectively. The nicotine content varied from 2.4 to 4.07% while reducing sugars ranged from 5.03 to 10.48% among the lines.

c) Trial TBL-7 (2nd year): A replicated yield trial was conducted for the second year in succession with twelve morphologically stable, aphid resistant/ tolerant, advanced cross derivatives (TBST-52 to TBST-63) along with two checks, Siri and VT-1158 in a RBD with 3 replications for evaluating their yield potential and leaf quality. All the breeding lines were light cast in nature. Nine entries viz., TBST Nos., 52, 53, 56 to 62 were resistant to TMV also. Four lines (TBST-61, TBST-53, TBST-60 & TBST-57) showed significant improvement over the best check, Siri with 21 to 30% in cured leaf yield, 20 to 32% in bright leaf yield and 21 to 25% in grade index, respectively. The nicotine content varied from 2.81 to 4.36% while reducing sugars ranged from 5.59 to 13.28% among the lines.

d) Trial TBL-8 (2nd year): Another replicated yield trial was conducted with twelve morphologically stable, aphid resistant/ tolerant advanced cross derivatives (TBST-64 to TBST-75) along with two checks, Siri and VT-1158 in a RBD with 3 replications for evaluating their yield potential and leaf quality. All the breeding lines were light cast in nature. Eleven lines viz., TBST Nos. 64, 66 to 71 were resistant to TMV also. Six derivatives (TBSH-65, TBSH-67, TBSH-70, TBSH-71, TBSH-73 and TBSH-75) showed significant improvement over the best check, Siri with 21 to 37% in cured leaf yield, 23 to 48% in bright leaf yield and 20 to 39% in grade index, respectively. The nicotine content varied from 3.22 to 4.42% while reducing sugars ranged from 5.10 to 12.87% among the lines.

e) Trial TBL-9 (2nd year): Another replicated yield trial was conducted with twelve morphologically stable, aphid resistant/ tolerant advanced cross derivatives (TBST-76 to TBST-87) along with two checks, Siri and VT-1158 in a RBD with 3 replications for evaluating their yield potential and leaf quality. All the breeding lines were light cast in nature. Three lines viz., TBST Nos. 76, 83 and 86 showed resistance to TMV also. Only one line, TBST-85 showed significant improvement over the best check, Siri with 27% in cured leaf yield, 28% in bright leaf yield and 23% in grade index, respectively.

f) Trial TBL-6 (2nd year): A yield evaluation trial was conducted with 12 'Lanka' type selections. The lines were developed from the initial cross, *N. tabacum x N. gossei*. The derivatives were evaluated in a RBD with 3 replications along with check variety, Lanka Special for their yield potential and leaf quality. Performance of five lies viz., LK1 LK2, LK9, LK10 and LK11 was comparable with the check variety, Lanka Special.

g) Bulk evaluation: Advanced breeding line TBST-2 which showed superiority over check varieties at Rajahmundry, Guntur and Kandukur in multi-location trials was evaluated against Siri for yield and quality in a bulk trial. The cured leaf yield of TBST-2 (2810 kg/ha) was higher than Siri (2600 kg/ha). The physical and chemical quality traits of cured leaf in both the

Advanced breeding line - TBST-2

entries were within desirable limits. TBST-2 is resistance to TMV also.

Location specific evaluation of cross derivatives: Promising derivatives having resistance to tobacco aphid, caterpillar and those tolerant to leaf curl, identified under the project, were contributed to CTRI RS Kandukur (12 FCV lines) and CTRI RS Jeelugumilli (16) and CTRI RS, Hunsur (30) for further evaluation.

Maintenance of other important genotypes: The following genetic stocks/lines were developed under the project and maintained for future use: (i) Corolla-split variants (digenic), (ii) 'Asynaptic line', (iii) 'Translocation heterozygotes', (iv) Variegated mutants, (v) Cream coloured testa (The variant was digenic recessive to brown coloured seed coat),(vi) Probable genetic male sterile (vii) CMS sources (viii) Dwarf mutants (digenic recessive) and (ix) Enation mutant.

Development of hybrid tobacco

Developing hybrid tobacco suitable for Traditional black soils of Andhra Pradesh

T.G.K. Murthy, P.V. Venugopala Rao and K. Sarala

During the year two replicated yield trials were conducted with CMS hybrids. Also, other works like maintenance of CMS lines and effecting fresh hybridizations, were undertaken.

Replicated yield trial (1st year): The trial was conducted with 18 CMS hybrids along with check Siri in a RBD with 3 replications. Only one hybrid, TBSH-75 showed significant standard heterosis over the high yielding check, Siri for all the four leaf yield traits. It recorded 30%

CMS parental lines maintained

S.No	Cytoplasm	Genetic background
1.	*N. undulata*	MS Delcrest, MS SPG 28, MSVT1158, Hema, Kanchan, Hicks, Gauthami
2.	*N. plumbaginifolia*	MS 85, MSB, MS19
3.	*N. tabacum*	AP1-8, Hicks, Speight G 28, VT-1158
4.	*N. gossei*	6-6MS, MS34, CR73MS, 72-21MS, MS58, 140MS, 16-17-17MS
5.	*N. suaveolens*	MSH5, MSH3
6.	*N. megalosiphon*	7-9MS, 7-25MS
7.	Exotic sources	NC71, T-29, RGH-04, RGH-51, MS-87

standard heterosis for green leaf yield, 29% for cured leaf and 31% for bright leaf yield and grade index, respectively over Siri. The nicotine content varied from 2.37 to 3.76% and reducing sugars from 6.27 to 15.74% among the lines.

In another trial conducted with 18 CMS hybrids along with check Siri in a RBD with 3 replications. Analysis of data revealed significant differences for all the yield characteristics among entries. Two hybrids viz., TBSH-91 (CLY 34%) and TBSH-81 (CLY 20% increase) showed significant standard heterosis over the check, Siri for all the four leaf yield traits while three other hybrids showed significant heterosis for one or more traits. The nicotine content varied from 1.90 to 3.82% and reducing sugars from 6.15 to 18.32% among the lines.

Maintenance of CMS lines: A total of 35 CMS lines with varying cytoplasm sources were maintained.

All the lines were crossed with respective maintainer lines for further maintenance. Also, four crosses viz., MS-58 x HDBRG, MS-58 x VT-1158, MS-58 x A-145 and MS-58 x TI-163 (all in BC_5) were made to develop CMS parental lines with high biomass potential.

Molecular basis for cytoplasmic male sterility: In order to design a reliable marker system for differentiating the fertile lines from CMS counterparts, several nuclear and mitochondrial DNA primers were tested on 28 CMS lines and their fertile maintainer parents. Of all, two mitochondrial primers viz., NTM and ATP-2 could clearly distinguish the CMS and fertile lines of tobacco. With these primers, the normal fertile lines amplified a shorter band than the respective CMS counterparts. Allele size in normal fertile and CMS lines was 130-131 and 134-135 bp, respectively. Therefore, reliable molecular markers that distinguish CMS lines could be identified.

Developing hybrid FCV tobacco suitable for NLS area of Andhra Pradesh [CTRI RS, Jeelugumilli]

T.G.K. Murthy, P.V. Venugopala Rao and K. Sarala

Maintenance of CMS lines: Fifteen CMS lines in genetic background of ruling variety, Kanchan and other improved lines were maintained and back crossed to recurrent parent. High yielding CMS line, CMS-NC 71 was crossed with Kanchan and JS 62 (BC_5) for developing high yielding CMS parent.

Bulk evaluation of CMS hybrids: Three advanced breeding lines viz., A-13 (CLY 2438 kg/ha), NLST-2 (CLY 2464 kg/ha), FCH-222 (CLY 2339 kg/ha) and the CMS hybrid NLSH-1 (CLY 2800 kg/ha) that showed significant increase in yield over Kanchan (CLY 1861 kg/ha) in station replicated yield trials and AVT-2 were evaluated for leaf yield and quality in bulk plot along with check, Kanchan during 2011-12 season. The leaf yield in all the entries was more than that of Kanchan.

Replicated yield trial (MSH): Seven CMS hybrids, produced from crosses involving identified promising CMS lines and high yielding breeding lines were evaluated along with the check, Kanchan in a RBD with 3 replications. Only one hybrid showed significant standard heterosis for all the three yield traits over check, Kanchan. It showed 20% increase in green and cured leaf yields and 26% increase in grade index over Kanchan. Physical quality traits such as colour, body and weight of cured leaf were comparable to Kanchan in most of the CMS hybrids, while the physical leaf quality of MSH-6, MSH-5, MSH-4 and MSH-3 was superior to the check. Nicotine and reducing sugars were within admissible limits, while chlorides were slightly higher among the lines.

Evaluation of FCV tobacco hybrids for yield and quality under SLS conditions [CTRI RS, Kandukur]

A.R. Panda

Seven F_1 hybrids and 4 checks varieties were evaluated for yield in a RBD design with 3 replications for the third year. The test entries, Hema x NC- 3150, Siri x Bell-93 and Siri x NC-3150 were significantly superior to the best check variety Siri in respect of green leaf, cured leaf, bright leaf yields and grade index. The percent increase in cured leaf over siri is 24-33 % and in grade index over Siri ranged from 23 to

25% for the above three treatments. The chemistry of the leaf for nicotine, R. sugars and chlorides is also in admissible limit.

Pooled Performance FCV tobacco hybrids under SLS conditions (2009-10 to 2011-12): The pooled analysis revealed that Siri x F-212, Siri x Bell-93 and Siri x NC-3150 are significantly superior to the best check variety Siri with respect to all the yield characters and grade index.

Studies on heterosis in chewing tobacco (*N. tabacum* L.) [CTRI RS, Vedasandur]

A.V.S.R. Swamy

Bulk trial: The promising hybrid VDH-3 was grown in bulk plot in CTRI Research Station Vedasandur along with the best check variety Abirami for assessment of yield and quality. It performed well recording maximum cured leaf yield of 4397 kg/ha, an increase of 10.4 percent over the best check variety Abirami. With respect to morphological characters also, it was observed that VDH-3 recorded the maximum leaf area of 4105 cm^2 as against 3978 cm^2 of the check variety Abirami contributing for higher cured leaf yield.

Replicated yield trial: Ten F5 populations of promising hybrids (HV.2011-1 to HV.2011-10) were evaluated in a replicated yield trial along with Bhagyalakshmi and Abirami as controls for assessing their quality and yield. Significant differences were observed for plant height, leaf length, leaf width, whole leaf yield and total leaf yield. None of the selections were found significantly superior to the best check Abirami in whole leaf and total leaf yield, except the selection HV.2011-5 which recorded significant superiority registering 3272 kg/ha whole leaf against the check Abirami. However, selections HV.2011-5, HV.2011-2, HV.2011-1, HV.201-6 and HV.2011-7 recorded significantly higher whole leaf yields of 3272,3012,2914,2815 and 2790 kg/ha respectively against the check Bhagyalakshmi. In total leaf yield, selections HV.2011-2, HV.2011-5, HV.2011-1 and HV.2011-6 registered significant superiority recording 4395, 4296,4148 kg/ha total leaf respectively against the check Bhagyalakshmi and numerically superior to the best check variety Abirami. With respect to morphological characters, selections HV.2011-9 and 2011-7 were significantly superior to Bhagyalakshmi in leaf length. In leaf width, selections HV.2011-3, HV.2011-1, 2011-4, HV.2011-9, HV.2011-10 and HV.2011-6 were significantly superior to Bhagyalakshmi. All selections exhibited nicotine, reducing sugars and chlorides percentage in the acceptable range.

Development and evaluation of F_1 hybrids suitable to Karnataka Light Soil region [CTRI RS, Hunsur]

C. Panduranga Rao, M. Mahadevaswamy, S. Ramakrishnan

Eight promising advanced breeding lines derived from the cross combination of Kanchan, Bhavya, Rathna, Newdel, NC 12, PCT 8, Coker 48, Yellow Special, Hema and COR 3 were assessed during the season 2011-2012. All the entries were non-significant for any of the yield characters. Among the lines FCH-229, FCH-230, FCH-231, FCH-232 and FCH-233 looked promising though on par with Kanchan. The RKI in the advanced breeding lines ranged from 1.5 to 3.0 on 0-5 scale. All the entries were found susceptible to *Fusarium* wilt disease when tested in sick field. The chemical analysis of cured leaf showed values within the acceptable range.

Generation advancement: Nineteen progenies under F_4 generation derived from the cross combination of Rathna and Kanchan with Coker 371 Gold and NC 98 were grown under progeny row trial and 45 selections were made to advance the generation.

Developing tobacco cultivars resistance to biotic and abiotic stresses

Incorporation of disease resistance for tobacco mosaic virus (TMV)

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

Replicated yield trial: A replicated yield trial was conducted for the third consecutive year with fifteen TMV resistant advanced breeding lines viz., V-4856, V-4857, V-4890, V-4908,

V-4909, V-4910, V-4912, V-4914, V-4915, V-4917, V-4920, V-4934, V-4936, V-4937 and V-4939 along with the VT-1158, Siri and N-98 as controls. Among the selections 1 to 11 were the selections from Siri X VT-1158 cross and 12 to 15 were from N-98 X VT-1158. The results indicated that V-4917 (CLY 2,586 kg/ha), V-4910 (CLY 2,462 kg/ha) and V-4914 were better performers during 2011-12.

Combined analysis (2009-10 to 2011-12): Results of combined analysis revealed that the treatments differed significantly for all the yield characters studied. The seasons, treatments and seasons X treatments interaction were also differed significantly.

Significant cured leaf yield was recorded in V-4934, V-4908, V-4910, V-4914, V-4915 and V-4920. The yield was higher in V-4934 (2,291 kg/ha) with an improvement of 20% over the better control Siri (1,912 kg/ha). This was followed by V-4908 (2,242 kg/ha) with an improvement of 17% over Siri. The improvement in cured leaf ranged from 7 to 20%. The interaction between seasons and treatments is significant for all the yield characters recorded and the entries V-4908 performed uniformly during all the seasons and exhibited more plasticity. Based on the performance of the selections over three years, it is concluded that among the selections V-4934, V-4908, V- 4914, V-4910, V-4915 and V-4939 are better entries.

Incorporation of Black Shank resistance in FCV varieties / Advanced breeding lines: Black shank resistance incorporation in the recently released variety Siri and the advanced breeding lines N-98 and Cy-142 are in progress. These lines were crossed with the resistant donors Beinhart 1000-1 and 1129 SR. During 2010-11, 402 progenies were evaluated under artificial inoculation with the pathogen and data were recorded on all the plants in each progeny.

I (B) Tailoring of tobacco plant type for optimizing the seed yield and phyto-chemicals

Breeding for high seed and oil yield in tobacco
A.V.S.R. Swamy and C.V. Narasimha Rao

The F_2 generation of the following promising crosses were grown and selections were made for high seed yield and retained for further study.

S. N.	Cross	No. of selections made and retained
1.	A.145 x Bhagyalakshmi	22
2.	A.119 x Bhagyalakshmi	21
3.	A.119 x Abirami	31
4.	A.119 x NP-19	12
5.	A.145 x NP-19	12

I. (C) Production and distribution of foundation seed of ruling tobacco varieties

Seed sale during 2011 season: During 2011, about 9666 kg foundation seed of seven different varieties was sold to farmers through

Production and distribution of tobacco seedlings (2011)

S. No.	Variety	Number of tobacco seedlings supplied		Total
		Seed plots	CTRI Farm/ Jeelugumilli	
1	Hema	5,03,000	2,74,000	7,77,000
2	VT-1158	8,65,000	2,30,000	10,95,000
3	Siri	35,61,500	83,500	36,45,000
4	Gauthami	-	16,000	16,000
5	Kanthi	-	16,000	16,000
6	Lanka spl.	-	92,000	92,000
7	N-98	-	4,00,000	4,00,000
8	Kanchan	-	1,52,000*	1,52,000
9	Experimental Material		98,000*	98,000
	Total	49,29,500	13,61,500	62,91,000

CTRI, Rajahmundry and its Research Stations. An amount of ₹ 96,66,000/- was realized.

Variety-wise distribution of seedlings to farmers and distribution of seed multiplication plots during 2010-11 season are as follows:

I. (D) Germplasm Resource Management

Germplasm acquisition, maintenance, evaluation and utilization [CTRI, Rajahmundry]
T.G.K. Murthy

Acquisition: During the year 2011, 59 exotic FCV germplasm accessions, 447 new *Rustica* germplasm lines and 37 wild *Nicotiana* species accessions were added to the germplasm bank, thereby increasing the CTRI genetic resources 2992.

Maintenance of cultivated germplasm: A total of 1587 germplasm lines were maintained. They comprised 513 Flue-cured Virginia, 332 non-FCV lines, 430 *N. rustica* lines and 312 elite lines for various important traits.

Maintenance of wild *Nicotiana* species: A total of 190 accessions of 56 wild *Nicotiana* species and two subspecies were maintained in pots / experimental micro plots. Also, 9 exotic interspecific hybrids, 5 hybrids developed at CTRI and 4 amphidiploids were maintained. Eleven non-flowering accessions were rescued through *in-vitro* micropropagation.

Germplasm enhancement: Interspecific hybrids., viz., *N. sylvestris x N. tomentosiformis* and *N. sylvestris x N. otophora* which are considered as the progenitor crosses of cultivated *N. tabacum* were synthesised and their back cross progenies (BC_2) were advanced for infusing additional variation into the cultivated and enhancing the scope for further genetic improvement of the crop.

Conservation: A total of 1400 germplasm accessions of FCV, Burley, *Jati*, JAC, EAC, Oriental, Bulgarian, sources of root knot nematode resistance, and released varieties have been deposited at NBPGR for long term seed storage.

Distribution: During the year a total of 205 accessions of both wild and cultivated *Nicotiana* species were supplied to 14 different researchers/organizations.

Documentation: Preliminary data on morphological traits of 430 new *N. rustica* lines were collected. Data on morphological traits of all the 471 FCV varieties were collected. A proforma that comprises 53 morphological traits useful for comprehensive DUS testing of tobacco germplasm was designed. Data on 92 released varieties were collected for further analysis and documentation of the results.

Molecular Characterization: Genetic diversity among 12 *Natu* accessions was studied using 10 RAPD primers. Genetic similarity varied from 73 to 97%. Based on cluster analysis, the 12 *Natu* lines were divided into 2 main clusters. Varieties *Natu* Special and Pyruvithanam formed one cluster. The second cluster comprised 2 sub-clusters. The first sub-cluster was formed by Bhairavi, Vishwanath and WAF. The second cub-cluster consisted of Prabhat and Tokaku. These results confirmed the parentage of Bhairavi and Prabhat varieties. Using 16 SSR primers brought out 58 to 93% similarity among the *Natu* lines. Presence of 2 clusters and the parentage of Bhairavi were also confirmed by using SSR primers. Out of 37 microsatellite markers used on 10 different tobacco types, 25 were found to be polymorphic and can be used as markers for diversity analysis. Isozyme (PPO, Peroxidase, Esterase and MDH) analysis of *Natu* germplasm accessions identified genotypic specific biochemical markers.

Evaluation: (a) Screening against *Orobanche* infestation: Out of the 12 species screened under artificial field inoculation by the Plant Pathologist during the season, *N. repanda, N. x benthamiana-repanda* and *N. x umbratica-nesophila* showed high level of resistance against *Orobanche*.

(b) Screening against *Pythium* infestation: Lines Dixie Bright, Xanthi and AP-1 showed delayed symptoms of damping off under artificial inoculation.

(c) Screening against TMV disease: Thirteen lines, previously recorded as TMV resistant donors were screened against TMV disease under artificial inoculation for confirmation. All the lines were uniformly resistant.

(d) Physiological characterization: Among the 90 released tobacco varieties screened, the sources for high net photosynthetic rate (Pn), water use efficiency (WUE) and carboxylation efficiency (CE) were identified. Non-FCV types showed higher Pn than FCV. Among ruling FCV varieties, Kanchan and Siri recorded higher WUE and CE.

(e) Evaluation for seed yield and oil content: Fourteen advanced derivatives of eight crosses and one pureline selection made within HDBRG population were evaluated along with three check varieties viz., HDBRG, A-145 and GT-7, for seed yield, seed oil content, biomass potential and yield of phytochemicals. Seed yield varied from 850 kg (in SY-11) to 1562 (in SY-2) among the test genotypes, while it varied from 567 to 1292 among the check varieties. Varietal differences were significant. Only one derivative, SY-2 (a derivative of cross HDBRG x GT-7) gave significantly higher seed yield than better check, A-145 while 7 selections were on par with it. The seed oil content analysed by the NMR Spectroscopy showed narrow range (29.85 to 31.49). In another replicated yield trial conducted during 2010-11 season, seed oil content was estimated in 16 germplasm lines along with 3 check varieties. Differences were observed among the entries. The mean seed oil content varied from 31.79% in Erzegovina-93 to 38.66% in Lanka Special.

Germplasm maintenance of *Nicotiana tabacum* varieties / lines [CTRI RS, Hunsur]
C. Panduranga Rao

Active stock of 638 germplasm accessions is maintained. Under the periodical seed multiplication programme, 175 germplasm accessions were regenerated. Thirty aphid resistant lines were added to the gene bank during the year. The new lines were assessed for aphid incidence. Male sterile lines of Kanchan and Ratna were maintained.

Evaluation and maintenance of germplasm [CTRI RS, Vedasandur]
A.V.S.R. Swamy

Maintenance of germplasm: Eighty five chewing and 60 cigar and cheroot germplasm accessions were raised, self pollinated and seed collected for maintenance at CTRI Research Station, Vedasandur.

Maintenance of Male sterile lines: Cytoplasmic male sterile lines of Bhagyalakshmi, Abirami, Maragadam, PV-7, I-115, and VR-2 were crossed with their respective fertile counterparts and seeds collected for maintenance of the male sterile lines.

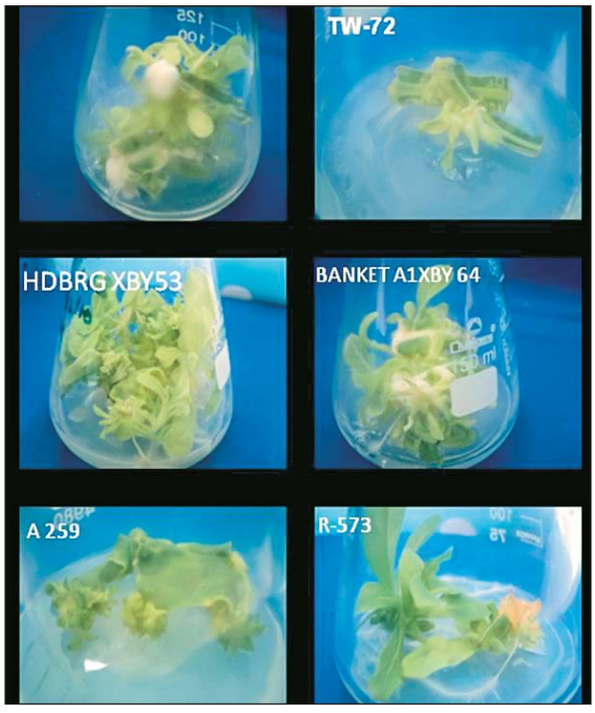
Collection, evaluation and maintenance of *Jati*, *Motihari*, Cigar Wrapper & filler tobacco germplasm [CTRI RS, Dinhata]
S. Amarnath

Maintenance of germplasm: 241 lines of *N. tabacum* (*Jati*, cigar wrapper and cigar filler) and 185 lines of *N. rustica* (*Motihari*) tobacco were raised and selfed, seeds of each line were collected.

I. (E) Biotechnology for tobacco improvement

Micropropagation of elite lines and other selections [CTRI, Rajahmundry]
K. Sarala and K. Prabhakara Rao

A total of 702 plantlets of various tobacco entries were micropropagated under *in vitro* during 2011-12. Around 30 plantlets were transferred to pots for maintenance and further studies.



Micropropagation of elite lines

Lines micropropagated under *in vitro*

S. No.	Entry	No. of plantlets maintained under *in vitro*
N. tabacum haploids		
1	A 145 x GT 7	61
2	GT 7 x A 145	10
3	HDBRG x GT 7	99
4	HDBRG x BY-53	259
5	Banket A1 x BY-64	94
6	VA 510 x BA-1	72
7	Nisnicotinony-121 X Kumkumathri	8
8	Candel X Nisnicotinony-121	7
Nicotiana species		
	VT-1158	26
	R-466	37
	R-573	3
	R-574	8
	Siri	18
	Total	**702**

Development of virus tolerant tobacco lines under *in vitro* [CTRI, Rajahmundry]

K. Sarala, C.A. Raju, G. Raghupathi Rao and K. Siva Raju

Characterization of promising Kanchan somaclones: Nine somaclones of Kanchan were tested for third year in a replicated trial along with Kanchan (control) at CTRI RS, Jeelugumilli. Clones, NLCR-6-10 and NLCR-1-11-10, respectively, recorded significantly higher yields of all types than Kanchan. The green leaf yield in these lines is 18236 & 18014 kg/ha, cured leaf yield 3038 & 2945 kg/ha and grade index 2060 & kg/ha; an increase of 17 & 16%, 21 & 17 % and 31 & 27%, respectively, over control, Kanchan. NLCM-4-7-15 recorded significantly higher grade index (1916 kg/ha) over control.

Pooled analysis: Pooled analysis revealed that leaf yields found to be significant among the lines, NLCR-1-11-10, NLCR-4-7-15, NLCR-6-10 and NLCR-8-2-2 than Kanchan. These lines recorded 10-24% increase in green leaf yield, 11-25% in cured leaf yield and 21-35% in grade index than Kanchan. All the clones except NLCR-5-8-1-3 recorded significantly higher grade index (12-35%) over Kanchan. The clone, NLCR-1-11-10 proved promising with significantly higher leaf yields in all the three seasons. Significant differences were observed for plant height, number of leaves after topping, leaf length and leaf width values. Differences were non-significant for internodal length. Most of the somaclones recorded higher leaf length (62-76 cm) and leaf width (26-38 cm) values than Kanchan. Number of leaves after topping was significantly higher in NLCR-6-10, NLCR-1-5(b)-7 and NLCR-2-6. Nicotine content ranged from 1.82-2.83%, reducing sugars from 12.77 to 17.52% and chlorides from 1.49-2.48% among the lines.

Bulk Trial with Tobios-2: Promising advanced breeding line, Tobios-2 was tested in bulk trial at CTRI RS, Jeelugumilli. The line, Tobios-2 recorded 13% increase in green leaf yield (15,333 kg/ha), 14% increase in cured leaf yield (2,530 kg/ha) and 14% increase in grade index (1,619 kg/ha) than control Kanchan. The line also recorded higher leaf length (64 cm) and leaf width (33 cm) than Kanchan. Leaf number after topping found to be same in both the lines. Both nicotine and reducing sugars are found to be in acceptable limits.

Advanced breeding line - Tobios-2

Molecular mapping of important tobacco traits [CTRI, Rajahmundry]

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

Characterization of parents used in developing mapping populations:

(a) TSNA: Molecular polymorphism studied in 11 burley lines (Banket-A1, SOTA 6506, Harrow Velvet, Burley resistant, By-64, By Sota 51, Ky-10, T-117, BSRB-II, Burley 21 and VA 510), two breeding lines and two crosses (Banket A1 X BY-64 and VA 510X Banket A1) using six chromosome specific SSR primers. Two SSR primers found to be polymorphic.

(b) Solanesol and Nicotine: Nine lines (HDBRG, Gauthami, Siri, BY-53, Candel, NC-55, Nisnicotinony-121, Kumkumadri and GT-9) differing in their Solanesol and nicotine and three crosses (HDBRG X BY-53, Nisnicotinony-121 X Kumkumathri and Candel X Nisnicotinony-121) were tested for their molecular diversities using six chromosome specific SSRs. Two SSR primers produced polymorphic bands between the tobacco lines.

(c) Phytochemicals: Five tobacco lines (GT-8, T1-163, HDBRG, GT-7 and A-145) and three crosses (A 145 x GT 7, GT 7 x A 145, TI-163 x A 145, HDBRG x GT 7 and HDBRG x BY-53) were assessed for their molecular diversity using six chromosome specific SSR primers. Two SSR primers produced polymorphic bands between the tobacco lines.

Characterization of mapping populations for solanesol and nicotine: Based on the solanesol and nicotine contents of the tobacco lines, genomic DNA of tobacco Lines with high solanesol (>2%) and low solanesol (<1%) were pooled separately and analyzed for molecular diversity along with the parents HDBRG and BY-53 and their F1. Likewise separate genomic DNA pools were made for tobacco lines with high nicotine (>2.5%) and low nicotine content (<1%) and studied their molecular diversity along with the parents Candel and Nisnicotinony-121 and F1 cross. A total of 25 SSR markers, designed from microsatellite regions were used for screening, out of which 14 markers were found to be polymorphic with differential banding pattern. One out of 14 polymorphic primers found to be associated with nicotine and difference observed in lines with high and low solanesol. Nicotine content was estimated for nicotine-molecular-mapping population along with seven parents and 6 F_1s. Nicotine in the mapping population found to be in the range of 0.31 to 3.76%. Out of 217 entries analyzed in the mapping population highest population found to be in 0.6-1.5% nicotine range. Among the parents, highest nicotine recorded in Kumkumathri (2.04%) and among the crosses, T 1 163 x A145 recorded highest (2.36). Solanesol content was estimated for solanesol-molecular-mapping population. Solanesol in the mapping population found to be in the range of 0.2 to 2.0%. Out of 70 entries analyzed in the mapping population highest population found to be in 0.6-1.0% solanesol range.

Development of mapping populations: For the development of mapping populations i.e. Recombinant Inbred Lines (RILs), 9 F_1s and 11 mapping populations viz., BY-64 x Banket A1 (F_6/ F_5), VA 510 x Banket A1 (F_6), HDBRG x BY-53 (F_5), HDBRG x GT-7 (F_6), TI 163 x A-145 (F_6/ F_5), Candel x Nisnicotinony 121 (F_6), Kumkumathri Nisnicotinony 121 (F_6), Nisnicotinony 121 x Kumkumathri (F_6), A 145 x GT 7 (F_7/ F_6), GT 7 xA -145 ($F_{6)}$ and A-145 x Jayalakshmi (ws) (F3) (a total of around 2200 plants) were raised and selfed seed collected. Haploid plants developed from 9 crosses and the efforts are on to develop dihaploid lines through mid-vein culture and colchicine treatment. Three dihaploid lines were developed from two crosses viz. HDBRG X BY-53 and Nisnicotinony-121 X Kumkumathri were maintained.

Transcript profiling and identification of candidate genes resistant to Damping-off in tobacco [CTRI, Rajahmundry]

K. Prabhakara Rao, K. Sarala, T.G.K. Murthy, C.A. Raju and K. Siva Raju

Isolation and molecular characterization of damping-off disease pathogen: Damping-off disease causative agent was isolated from infected tobacco nursery fields of CTRI Research stations at Rajahmundry, Jeelugumilli, Dinhata

and Hunsur. In all, 20 isolates were collected and the pathogen was isolated from the soil and cultured in PDA medium. Genomic DNA was isolated from all the cultured pathogen isolates, purified and analysed by agarose gel electrophoresis and quantified by spectrophotometry. Pure and intact genomic DNA of all the isolates were analysed with ITS (Internally Transcribed Sequence) specific primers in a polymerase chain reaction. The amplified fragments of ITS region from all the isolates were purified and sequenced. The sequences obtained were analysed using NCBI BLAST. The results from the BLAST hits revealed that majority of the pathogen isolates belong to *Pythium aphanidermatum* and a very few as *P. myriotylum*.

Electrophoretic characterization of tobacco - DNA finger printing of ruling tobacco cultivars [CTRI, Rajahmundry]

K. Siva Raju, T.G.K. Murthy and V. Krishnamurthy

DNA finger printing: Simple sequence repeats (SSR) markers, Inter simple sequence repeats (ISSR) markers were used to DNA fingerprints among the popular Flue-Cured Virginia (FCV) tobacco cultivars and one Burley tobacco variety. The cultivars used in the present study were Gouthami, VT-1158, Hema, N-98, Banket A1, NLS4, CM-12, 16/103, Cy79, Bhavya, Ratna, Hemadri and Siri. Thirty SSR markers distributed

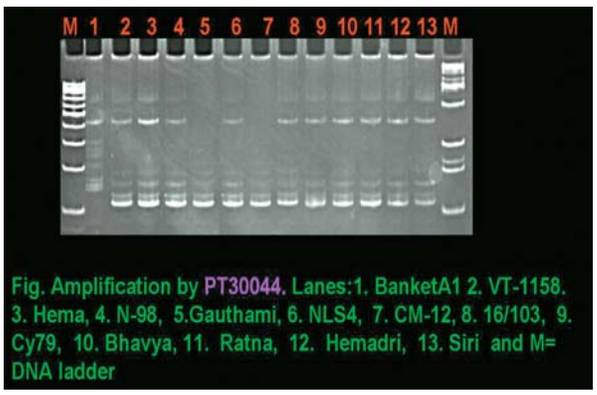


Fig. Amplification by PT30044. Lanes:1. BanketA1 2. VT-1158. 3. Hema, 4. N-98, 5.Gauthami, 6. NLS4, 7. CM-12, 8. 16/103, 9. Cy79, 10. Bhavya, 11. Ratna, 12. Hemadri, 13. Siri and M= DNA ladder

with at least one marker on each of 24 chromosomes and were used for development of DNA fingerprints of the varieties. Out of 25 SSR markers, primers PT30044, PT30095, PT30114, PT30156, PT30160 and PT30163 gave reproducible markers. ISSR marker UBC837 gave makers to six varieties

Computational Algorithm for micro-RNA prediction in plants [CTRI, Rajahmundry]

H. Ravi Sankar, K. Prabhakara Rao, K. Sarala and K. Siva Raju

A computational algorithm for prediction of micro-RNA in tobacco was developed using shell scripting under UNIX environment. General survey of available tobacco databases including EST, CDNA and GSS (Genome Survey Sequences) were carried out for their suitability to annotation.

II. Development of Agro-technology for Sustainable Tobacco Production and Strengthening TOT

II (A) Healthy Seedling Production

Investigations on coir pith utilization in tobacco seedling production [CTRI, Rajahmundry]

C. Chandrasekhararao and V. Krishnamurthy

Tobacco Seedlings were raised in bulk on coir pith medium (Coir Pith 75% and FYM 25%). Seedlings of 20-25 days old were transplanted in protrays filled with coirpith medium fortified with single superphosphate. Calcium ammonium nitrate and potassium nitrate solution was added regularly to these trays to supplement N and K. Seedlings of 60 days were transplanted in main field. Tray seedlings were evaluated in traditional black soils at CTRI Farm Katheru and also in irrigated light soils at CTRI RS Jeelugumilli.

CTRI Farm Katheru: At Katheru farm tray seedlings were compared with conventional nursery seedlings in bulk plots. Observations were collected on gap fillings and also the physiological parameters. In tray seedlings establishment was good, gap fillings were very minimum and growth is early compared to conventional seedlings. Leaf area index was more with tray seedlings and all other parameters viz., Net Photosynthetic rate, Stomatal conductance and Transpiration rate are comparable in both tray as well as in conventional seedlings. Green leaf yield, cured leaf yield and grade index were higher with tray seedlings.

CTRI RS Jeelugumilli: Field experiments were conducted at CTRI RS Jeelugumilli to study the integrated effect of tray seedlings with drip fertigation on yield and quality FCV tobacco. Results revealed that drip fertigation with tray seedlings showed 16.8% increase in yield over drip fertigation with conventional seedlings. Data on chemical quality parameters revealed that nicotine content was higher and reducing sugars were low in drip fertigation with tray seedlings.

Drip irrigation with tray seedlings

Performance of tray seedlings in filed

Integrated weed management in FCV tobacco nursery [CTRI, Rajahmundry]

S. Kasturi Krishna and S. V. Krishna Reddy

Comparative evaluation of herbicides: Four pre-emergence herbicides viz., Pendimethalin, Oxyfluorfen, Alachlor and Metribuzin were evaluated for weed control in nursery beds.

Weed control with alachlor @ 1000 g ai/ha

Among the different doses, alachlor @ 1000, 1500 Metribuzin at 263 and 394 g ai/ha controlled the weeds and gave optimum no. of seedlings. Pendimethalin @ 500 g ai/ha gave optimum no. of seedlings than other doses.

II (B) Optimization of Water and Nutrient Use for Productivity enhancement of Different Tobacco Types

Indices for N and K nutrient use efficiency in FCV tobacco grown in irrigated Alfisols [CTRI, Rajahmundry]

S. V. Krishna Reddy, S. Kasturi Krishna, D. Damodar Reddy, C. Chandrasekhararao and K. Nageswara Rao

Nutrient use efficiency of CH 1 and cv. Kanchan: The experiment consisted of two varieties viz. cv. Kanchan and hybrid CH 1 and five graded levels of N and K viz. 0, 40, 80, 120 and 160 kg/ha tobacco hybrid CH1, popular variety Kanchan were compared for their N and K use efficiency in irrigated Alfisols. FCV tobacco cv. Kanchan and hybrid CH 1 were on a par with regard to green leaf yield, cured leaf yield, grade index and grade index/ cured leaf (%) while, cv. Kanchan recorded higher green leaf/ cured leaf than CH 1. Green leaf yield and cured leaf yield increased progressively and significantly with application of graded levels of nitrogen from 0-160 kg N/ha where as grade index increased progressively and significantly with application of graded levels of nitrogen from 0-120 kg N/ha only. Green leaf yield, cured leaf yield, grade index and green leaf/ cured leaf increased progressively and significantly with application of graded levels of potash from 0-80 kg K_2O/ha with recommended dose of N and P and thereafter, the increases were not significant up to 160 kg K_2O/ha. All the interactions between varieties and N, K levels were not significant. Total N, P and K uptake pattern of both cv. Kanchan and Hybrid CH 1 was almost same. However, N uptake by cv. Kanchan was higher by 2.41 kg/ha (3.94%) as compared to CH 1 and K uptake by hybrid CH 1 was higher by 3.84 kg/ha (5.39%) as compared

Table II-1: N and K nutrient use efficiencies

Treatment	Agronomic use efficiency (kg cured leaf yield increased / kg nutrient applied)		Fertilizer use efficiency (%)		Physiological efficiency (kg cured leaf increased/ kg nutrient taken up from fertilizer		Nutrient harvest index or Translocation index		Internal efficiency (kg CLY/ kg nutrient taken up)	
Variety	Kanchan	CH 1	Kanchan	CH 1	Kanchan	CH 1	Kanchan	CH 1	Kanchan	CH 1
N level										
N_0 P_{60} K_{120}							51.73	51.09	50.17	53.15
N_{40} P_{60} K_{120}	20.18	21.33	61.66	61.16	32.72	34.87	52.33	51.83	39.58	41.38
N_{80} P_{60} K_{120}	15.83	17.00	55.98	56.55	28.27	30.06	52.87	52.39	34.03	35.38
N_{120} P_{60} K_{120}	12.98	13.81	51.75	52.13	25.07	26.49	52.80	52.42	30.21	31.23
N_{160} P_{60} K_{120}	10.77	11.34	46.73	46.76	23.04	24.26	53.41	53.05	27.82	28.69
K level										
N_{120} P_{60} K_0							56.52	57.95	58.33	61.16
N_{120} P_{60} K_{40}	8.08	8.6	80.68	98.68	10.01	8.76	70.42	74.62	33.89	31.19
N_{120} P_{60} K_{80}	5.66	6.06	63.45	72.64	8.92	8.35	73.47	76.96	27.85	26.17
N_{120} P_{60} K_{120}	4.33	4.73	48.18	55.46	9.00	8.52	73.77	75.60	26.40	24.72
N_{120} P_{60} K_{160}	3.5	3.76	39.91	46.26	8.77	8.13	74.12	75.59	25.15	23.28

to cv. Kanchan. Agronomic use efficiency of N and K, K use efficiency, physiological efficiency of N, nutrient harvest index of K and internal efficiency of nitrogen were slightly higher for CH 1 than cv. Kanchan, where as physiological use efficiency of K, nutrient harvest index of N and internal efficiency of K were slightly higher with cv. Kanchan than CH 1 (Table II-1). All these indices except translocation index/ nutrient harvest index for N and K were higher at lower levels of N and K and decreased with increase in the level of N and K. Nutrient harvest index for N and K gradually increased with increase in the N and K level.

Drip fertigation in chewing tobacco [CTRI RS, Vedasandur]

M. Kumaresan, A.V.S.R. Swamy and C. Chandrasekhararao

Growth and yield: Leaf length and width was significantly higher for drip with 100% RDN as compared to that for surface irrigation with 100% RDN. Leaf length and width with 100 % RDN and 80% RDN with drip irrigation were comparable. FGLY and TCLY significantly increased with drip+100% RDN as compared to the surface irrigation with 100% RDN. FGLY and TCLY increase was 15 and 34% respectively, with drip + 100% RDN as compared to the surface irrigation at 1.0 IW/CPE + 100% RDN. Higher gross return (₹ 169087/ha), net return (₹ 108195/ha) and B:C ratio (1.78) was recorded in drip with 100% RDN as compared to surface irrigation with 100% RDN.

Drip fertigation

Feasibility of producing organic tobacco in KLS [CTRI RS, Hunsur]

M. Mahadevaswamy

Leaf productivity and quality: Feasibility of producing organic tobacco using various organics (vermicompost @ 6 t/ha, use of bio-fertilizers @ 10 kg/ha, green manuring in *rabi* season with sunnhemp, use of neem based organics and bio-pesticides etc.,) was conducted at Hunsur farm. The study indicated that there was reduction in productivity of the cured leaf to an extent of more than 50% during the first year of the study in the 100% organic treatment compared to the conventional treatment with recommended NPK (Table II-2). The INM treatments involving organics and inorganics at 75:25 and 50: 50 resulted in lower

Production of organic tobacco

Table: II-2. Yield parameters (kg/ha) as influenced by organic treatments 2011-12

Treatments	Green leaf yield	Cured leaf yield	Top grade equivalent	% reduction
Fully organic	4,750	640	532	53.6
75% + 25%	6,160	862	656	37.2
50% + 50%	9,450	1,146	857	16.9
Recd. NPK	11,120	1,368	1,012	—

reduction in the yield (37.2 and 16.9%, respectively) compared to the check treatment. Similarly, the top grade leaf production was reduced by 47.5% in the organic treatment and by 35 and 15.5% in the 75:25 and 50: 50 INM treatments, respectively. However, the bright grade production was higher by 9% in the organic treatment. With respect to the cured leaf quality characteristics, the nicotine in the X position was lower (0.79%) in the organic treatment when compared to the conventional treatment (1.20%). The L position leaf also showed similar trends, with recommended NPK treatment recording the higher nicotine value of 2.35 compared to 0.90% in the organic. With regard to the disease incidence, there was reduction in the root knot incidence by about 60% in the organic treatment, while the incidence of wilt was very much negligible.

Effect of graded levels of K on the incidence of root knot & potassium uptake pattern of FCV tobacco in KLS [CTRI RS, Hunsur]

M. Mahadevaswamy, S. Ramakrishnan and V. Krishnamurthy

Tobacco response to K in the root-knot sick and free soils: Two replicated field trials with graded levels of K were taken up separately in root knot sick and root knot free soils in KLS for the second crop season. The second year results indicated that application of no potash resulted in 14.7% and 15.7% reduction in the leaf dry matter production compared to the application of 120 and 180 kg K_2O/ha respectively in the root knot sick soils while the reduction in the leaf dry matter production/ plant was around 9.3% in the root knot free healthy soils. The root knot incidence was significantly higher (3.52 RKI) in control (without K application) compared to that (2.58 RKI) with 180 kg K_2O/ha in sick soils. The productivity of cured leaf was significantly increased by 19.9 and 20.6% by application of K @180 and 240 kg/ha as compared to no potash treatment in the root knot affected soils, while the same was increased by 9-10% in root knot free soils possibly indicating greater amounts of K applications for the root knot sick soils. In general, the productivity levels were comparatively higher in the root knot free healthy soils compared to root knot sick soils.

Effect of fertilizer N sources on FCV tobacco under KLS: Different sources of N fertilizers such as Urea, Ammonium Sulphate, CAN, and Factomphos 20:20:0 (Complex) with CAN or Urea as top dressing and calcium nitrate were further evaluated to study their effect on incidence of pests/disease and productivity of FCV tobacco during 2012 season. In general, the wilt incidence was negligible, while the mean RKI incidence ranged from 1.50 to 2.20 and was not influenced by different sources of N tried. The shoot borer incidence or the bud worm infestation were below the threshold levels during the season and as such were not influenced by different N sources. The application of ammonium sulphate proved equally effective as that of recommended CAN in terms of leaf productivity as well as top grade equivalent production. Similarly the application of Factomphos (20:20:0) + CAN (As top dressing) proved superior in achieving higher productivity of both GLY & TGE. Calcium nitrate resulted in the lowest yield followed by the Urea as N source. Even though Factomphos (20:20:0) + urea (top dressing) increased the productivity of cured leaf, the top grade equivalent was comparatively lower. However the cured leaf quality characteristics were not altered much by the sources of N fertilizers. While calcium nitrate application recorded the lowest leaf nicotine, the highest leaf nicotine was observed in ammonium sulphate treatment.

Permanent manurial trial on *Motihari* tobacco [CTRI RS, Dinhata]

S. Amarnath and S. Roy

Crop yield, economics and quality: The results of permanent manurial trial on *Motihari* tobacco indicated that application of NPK each @ 112 kg/ha recorded significantly higher green leaf yield (14,352kg/ha) cured leaf yield (2,131 kg/ ha) and first grade leaf yield (1,093 kg/ha) as compared to the control with 10 t/ha FYM only. Application of 112 kg N + 112 kg K_2O/ha and 112 kg N + 112 kg P_2O_5/ha was ranked second and third followed by N alone. The percent recovery of first grade leaf was higher with NPK (51.2) followed by NK and NP. The percentage of nicotine varied from 4.25 - 4.71 % in N, NK, NP and NPK. The incidence of bacterial wilt, mosaic, TLCV and hollow stalk ranged from 0.30 – 0.50%, 0.30-1.0 %, 0.30 – 0.50 % and 0.30 – 0.50

%, respectively. Highest net return was realized in treatment NPK (₹ 28, 279 /ha) with benefit: cost ratio of 1.50:1 followed by NK (₹ 25, 090 / ha) with benefit: cost ratio of 1.46:1.

Optimization of source and dose of potassium for *Jati* tobacco (*N. tabacum*) varieties grown in alluvial soils of West Bengal [CTRI RS, Dinhata]

S. Amarnath, C. Chandrasekhararao and S. Roy

Potassium source and dose effects: The effect of MOP and SOP on cured leaf yield was found to be at a par. However, in case of first grade leaf yield the impact of SOP was found to be significantly higher than MOP. Application of 75 kg/ha of K_2O was significantly better for cured leaf yield when compared to 50 and 100 kg/ha. In case of first grade leaf yield 75 and 100 kg/ha were on par with each other. The variety Chama exhibited significantly higher yield over Podali both for cured (1,368 kg/ha) and first grade leaf yields (629 kg/ha). For both Chama and Podali types of *Jati* tobacco, the optimum and economic source of potassium was MOP @ 75 kg/ha. SOP is expensive and its availability is scarce. However, the use of SOP is recommended if the leaf of the var. Chama or Podali is used for smoking purpose.

II (C) Evolving Site Specific Cultural Management Practices in Different Agro Ecological Sub-regions

Effect of trap crops on the emergence of *Orobanche* in FCV tobacco under Vertisols [CTRI, Rajahmundry]

S. Kasturi Krishna and S.V. Krishna Reddy and C A Raju

Orobanche biomass and tobacco yield: Trap crops viz., green gram, sesame and sorghum were evaluated for their effects on the emergence of orobanche in tobacco and consequently tobacco yield. Cured leaf production was significantly higher where tobacco was grown after grain crops rotated for three years when compared to one and two year rotation. Sorghum - Sorghum - Sorghum - Tobacco recorded significantly higher bright leaf yield followed by Sesame – Sesame – Sesame - Tobacco which was on par with bright yields of tobacco grown after one and two year

Trap crops for *Orobanche*

rotation of sorghum and sesame. Tobacco grown succeeding green gram recorded lower bright leaf yields than sesame and sorghum. Sole tobacco recorded lower cured leaf and bright leaf yield. Considerable reduction in infestation (%) and fresh weight of orobanche was recorded where trap crops were grown for two years and three years and tobacco grown for two years and one year, respectively in four year experimentation.

Effect of spacing and nitrogen on yield and quality of ABL TBST-2 [CTRI, Rajahmundry]

S. V. Krishna Reddy, S. Kasturi Krishna and T. G. K. Murthy

Yield and quality: An experiment with ABL TBST-2 was conducted to evaluate three spacings viz. 70 X 50 cm (28571 plants/ha), 70 X 60 cm (23809 plants/ha), 70 X 70 cm (20408 plants/ha), and three nitrogen levels viz. 30, 45 and 60 kg/ha. The experiment was conducted at Black Soil Research farm, Katheru CTRI, Rajahmundry to find out optimum plant spacing, the optimum nitrogen dose and the interaction effect of spacing and nitrogen. Lower plant spacing of 70 X 50 cm (higher plant population) recorded significantly higher green leaf yield, cured leaf yield and grade index as compared to higher plant spacing of 70 X 60 cm and 70 X 70 cm. Green leaf /cured leaf, bright leaf/cured leaf and grade index/ cured leaf were higher/ at higher plant spacing (lower plant population) and decreased with increasing plant population/ decrease in plant spacing. Green leaf yield increased progressively and significantly with increase in N dose from 30 to 60 kg N/ha, while cured leaf yield increased significantly from 30

to 45 kg N/ha and there after the increase was not significant at 60 kg N/ha. Differences between treatments were not significant for bright leaf yield, grade index and green leaf/ cured leaf with regard to N dose. Bright leaf/ cured leaf and grade index/ cured leaf increased with increase in N dose. From the results it can be inferred that for ABL TBST-2 with a spacing of 70 X 50 cm and nitrogen dose of 45 kg N/ha are optimum.

Development and testing of Bio dynamic manures suitable for white burley tobacco production [CTRI, Rajahmundry]

P. Harishu Kumar, S. Kasturi Krishna, C. C. S. Rao, K. Siva Raju, M. Anuradha and D. V. Subhashini

Efficacy of organic manures: Different organic manures viz. Neem cake, Pongamia cake, FPC, Poultry manure, FYM and Vermi-compost in varying proportions equivalent to 30 kg N was prepared and compared with inorganic N application 120 and 160 kg N/ha. Application of D bio- dynamic organic manures (15 kg Neem cake, 15 kg Pongamia cake, 35 kg FPC, 15 kg Poultry manure, 20 kg FYM, 50 kg Vermicompost and 5 kg soil) equivalent to 30 kg N along with 90 kg N/ha in the inorganic form produced higher tobacco leaf yields.

Integrated weed management in FCV tobacco grown under irrigated Alfisols [CTRI, Rajahmundry]

S. Kasturi Krishna, S.V. Krishna Reddy and K. Nageswara Rao

Evaluation of Quizalofop-ethyl and Pendimethalin as herbicides: Quizalofop-ethyl as post-emergence application controlled the weeds 6-10 days after its application. Pendimethalin incorporation 3 days before planting provided effective control against all weeds, except nut grass, throughout the crop period. Integrated weed management practices including Pendimethalin and Quizalofop-ethyl recorded the green and cured leaf yields which were on par with that of weed free check. Spraying of Quizalofop-ethyl at 15+75 days after planting effectively controlled the weeds and also gave higher yields when compared to weed free check. Statistically lower yields were observed in the un-weeded check. In general, weed control efficiency was higher where ever integrated weed control was followed. Weed control efficiency on the basis of weed dry matter production was higher in the treatments including spraying of Quizalofop-ethyl at 60, 75 days, 60+90 days and in 75+125 days after planting. Leaf quality parameters were within the acceptable limits.

Integrated weed control

Performance of advance breeding lines of chewing tobacco under different levels of nitrogen [CTRI RS, Vedasandur]

M. Kumaresan and A.V.S.R. Swamy

The advance breeding line BSR-1 recorded significantly higher cured leaf yield by 6.79% as compared to the variety Kaviri (2505 kg/ha). 200 kg N/ha recorded higher cured leaf yield, net returns and B:C ratio as compared to 100 and 150 kg N/ha.

Agronomic evaluation of promising FCV tobacco varieties [CTRI RS, Hunsur]

M. Mahadevaswamy

The trials were conducted to study the effect of topping levels with recommended N level (70 kg/ha) on growth, yield parameters and the cured leaf quality in the proposed promising pre-release wilt resistant line FCH-222. Topping at 20 leaves increased the leaf area of 7th, 9th, 12th and 15th leaf by 13.6%, 20.4%, 27.3% and 7.1% compared to 22 leaves topping. The lower topping at 20 leaves increased the productivity of both CLY and TGE by 10.7 and 9.7%, respectively. Topping at 20 leaves increased the nicotine content to the desired levels in both

X and L position with optimum reducing sugars/ nicotine ratio.

II (D) Post-Harvest Product Management

Investigations on coir pith utilization in tobacco curing [CTRI, Rajahmundry]

C. Chandrasekhararao and V. Krishnamurthy

Agri waste briquettes as alternative fuel for curing tobacco: Briquettes prepared with saw dust and coir pith were obtained from the briquette factory and curing studies using these briquettes as a fuel for curing FCV tobacco were conducted at CTRI black soil research Farm, Katheru. Curing studies were conducted at CTRI Farm Katheru with coal, briquettes, fire wood and briquettes + fire wood. The fire bars in the barn were modified to increase the efficiency of briquettes. Observations on quantity of green leaf loaded, cured leaf obtained, total number of curing hours for each curing were recorded. The parameters like fuel consumed/kg cured leaf and cost of fuel/kg cured leaf was calculated. Data was presented in Table II.3. The quantity of briquettes consumed was less as compared to Fire wood, while the consumption of coal was less than that of briquettes. The cost incurred per kg cured leaf was similar with briquettes and wood, while it was low with coal. Combination of briquettes and Fire wood (50% each) was superior compared to wood alone in terms of fuel consumption and cost involved. Total no. of curing hrs was more with wood compared to briquettes where as with coal no. of curing hrs were less compared to briquettes. Combination of briquettes and fire wood definitely reduced the curing hours compared to wood alone. It can be concluded that briquettes can be used as an alternative to wood. In case of non availability of coal, briquettes can be used as a source of fuel for curing.

II (E) Analysis of Socio-Economics for Stratification and to formulate Appropriate Strategies

Situational analysis of tobacco farmers and changing scenario of cropping pattern of A.P. [CTRI, Rajahmundry]

K. Suman Kalyani and S.K. Naidu

Northern Light Soils (NLS): Tobacco is grown on the light soils in parts of East Godavari, West Godavari and Khammam districts of AP. The area cultivated is 24,945 ha.

Scenario in Northern Light Soils: The farmers of Northern Light Soils region are characterized by good socio-economic standard with sufficient knowledge, awareness and skills in tobacco cultivation and management practices. They have lower adoption constraints in comparison to the farmers of other soil regions. Cultivation of tobacco is highly expensive and risk-prone in the northern light soils (NLS) owing to soaring labour cost, market vagaries and natural calamities. The cost of cultivation ranged from ₹ 65,000 to ₹ 85,000/-. The FCV tobacco farmers in NLS area cultivate Virginia

Table II.3. Data on economics of different fuel sources.

S.No.	Fuel Source	Fuel (kg) / kg cured leaf	Cost (₹)/ kg cured leaf	Total No. of hrs for curing	Variety
Trial 1	Briquettes Wood	4.29 5.15	19.2 17.5	128 133	Hema Hema
Trial 2	Briquettes Coal	3.08 2.72	13.98 9.79	154 149	Gouthami,Hema,Siri Gouthami, Hema, Siri
Trial 3	Briquettes + Fire wood Fire wood	3.03 3.74	12.0 12.7	126 129	VT-1158 VT-1158

	ITK	Procedure	Use
1	Incorporation of tobacco residues in soil for termites and tobacco decoction for controlling other pests	Incorporation of tobacco stalks and roots in the soil, using disc harrow, which controls termites in the field due to nicotine content in the tobacco debris.	It controls termites in the soil and the decoction controls stem and pod borers.
2	Expulsion of maggots from the wound in cattle	Tobacco and custard apple leaf extract	The maggots will be expelled from the wound.
3	Foot lesions in cattle due to Foot and Mouth diseases (FMD).	Custard apple (Annona squamosa) leaves + Mushini (Strychnos noxvomica) leaves + Jatropa leaves + tobacco leaves25 gm leaves of each of the above are ground to a fine paste and applied to the foot lesions	This acts as medicine and relieves the foot lesions.
4	Insect repellents	Tobacco planted around the farm or poultry house repels snakes. Extract of fresh tobacco leaves mixed with water sprayed on crops also functions as insect repellant.	This is very efficacious on snakes, leaf hoppers and beetles.
5	Storage of tobacco seed	The dried tobacco plants along with the dried fruits will be cut from the field and tied up side down above the stove in the kitchen, in such a way that only smoke will reach the plant and not the flame. This smoke dries the plant protects from fungal attacks.	This is very effective in storage
6	Control of pests in vegetables	A mixture of fresh cattle urine and water a ratio of 1:1, and marigold leaves, pepper, and tobacco leaves are added and kept fermented for 2 weeks. This decoction is mainly used to control pests in vegetables.	Effective agent in controlling pests
7	Control of mites.	In tobacco growing areas, farmers spread fire cured tobacco leaves on the chicken coop floor to kill mites.	Effectively controls mites
8	Stem borer	An extract of tobacco waste with 250 g of soap solution in 200 ltrs of water and spray to control stem borer	Effective controlling agents
9	Control of aphids and whitefly in	4 kg of tobacco leaves and twigs are boiled in 40 liters of water	Controls aphids effectively

	citrus plants	for 40 minutes after cooling one kg soap powder is mixed and solution is diluted 7-8 times and sprayed to control aphids and white flies in citrus plants.	
10	Control of pests in pulses	Tobacco decoction mixed in soap emulsion is sprayed on pulse crops	Controls pests effectively
11	Boring ear and nose in women	Tobacco midrib is used in ear/ nose holes for curing wound created by boring	Acts as antibiotic
12	Tooth problems	Tobacco leaf is chewed during tooth- pain/ache	Acts as antibiotic and anti infectious
13	Itching and irritation due to lice in hair	Dried tobacco leaves are powdered, soaked in oil and applied to scalp.	Removes lice

tobacco varieties such as Kanchan, ITC special and Hybrids such as GL-26, CH-1 & CH-3. The management constraints of the zone include: application of higher dosage of nitrogen with untimely topping. The incidence of TMV and CMV is high among NLS. The non-availability of labour, agricultural equipment & non-availability of phosphorous fertilizers and increasing cost of fuel and labour are felt as constraints by the NLS farmers this year. Fertilizer cost has gone up to ₹ 1,000 from ₹ 500 per bag. On an average a progressive farmer gets 8-12 quintals of cured leaf per acre. The NLS farmers are cultivating the alternative crops viz., oil palm, coconut, cocoa, cashew, sugar cane and paddy. Majority of the tobacco farmers are adopting green manuring (sunnhemp) and vermicompost.

Market: The tobacco in NLS area has got its own brand value for its unique flavour in the international market. Lemon orange is in great demand in the western countries while pale lemon orange is most sought after in eastern countries. Bales are graded depending on their different shades after curing and the price is quoted accordingly. The spurt in the price during last two years led to a boom in tobacco cultivation in NLS, with a crop area of 62,000 acres. About 60 million kg of tobacco is expected to be produced in the area in the current season over 47 million kg last year.

Farmers' Feedback: The farmers felt that the debts could not be cleared due to the heavy crop damage because of heavy floods that happened last year. The farmers hoped to recover from debts this year as the crop condition was good. The cost of cultivation has increased to ₹ 85,000/ha on an average and the farmers felt unhappy this year. The price situation dampened the spirit of growers and they complained that the traders were forming into a cartel while trading tobacco. The farmers demanded for transparency in auctioning through the concept of e-auctioning.

Indigenous Technical Knowledge (ITK) in Tobacco: Some information on Indigenous Technical Knowledge pertaining to tobacco was collected from aged farmers in the NLS. As tobacco has its own importance in biological control, traditional use of tobacco decoction in control of certain pests & disease was obtained from the source of key informants of villages. By taking the experiences of the farmers, the technology has to be refined in the light of facts, figures and dosages.

III. Identification of Alternative Crops and Exploiting Tobacco for Alternative Uses

III (A) Alternative Crops to FCV and Non-FCV Tobacco in different agro-ecological sub-regions

Evaluation of crops alternative to FCV tobacco in NLS [CTRI RS, Jeelugumilli]

K. Nageswara Rao

Maize (*kharif* and *rabi)* and red gram were grown as alternative crops to tobacco at CTRI RS Jeelugumilli. The productivity of maize was comparatively low during *kharif* when compared to *rabi* season. The gross and net returns were more for rabi maize due to comparatively higher yield during *rabi.* Red gram cv. LRG-41 was sown in August 2011 and harvested in January 2012. From the results it is clearly understood that neither maize nor red gram are alternative crops to tobacco under the present circumstances.

Development and evaluation of Integrated Farming System model for rained eco-system of KLS [CTRI RS, Hunsur]

M. Mahadevaswamy

The Integrated Farming System (IFS) model initiated during 2005-06 crop season in 1.0 acre operational area at Hunsur Farm is being maintained and continued for the 2012 season also. The various activities like Agri-horticulture, silvipasture, with fodder production were maintained. The proven cropping systems involving Red gram + intercropping system (2:8 ratio) and Hybrid cotton were raised in individual cropping systems blocks. The subsidiary components involving vermicompost, vegetable production was taken up, while the border tree plantation was maintained. The IFS model developed is being demonstrated to several farmers including FCV tobacco growers for its sustainability and adoptability by the small & marginal farmers.

III (B) Agro-techniques for Higher Biomass and Seed Yield

Development of agro-techniques for higher bio-mass and seed yield [CTRI, Rajahmundry]

T.G.K. Murthy, S.V. Krishna Reddy, K. Siva Raju and S. Kasturi Krishna

Leaf and seed yield potential: Among the 15 crosses and three pure lines studied, HDBRG selection 1 recorded higher biomass followed by GT-7 and crosses A-145 x GT-7 and HDBRG x A-145. HDBRG selection 1 and HDBRG X GT-7 gave higher Solanesol, TI-163 x A-145 (P1) and GT-7 x A-145 (P4) gave higher nicotine sulphate, whereas A-145 x GT-7 (P1), HDBRG selection and GT-7 gave higher protein yield. Seed yield varied from 850 kg (HDBRG X GT7) to 1562 (HDBRG XGT 7) among the test genotypes, while it varied from 567 to 1292 among the check varieties. Varietal differences were significant. Only one derivative, SY-1 (a derivative of cross HDBRG x GT-7) gave significantly higher seed yield than better check, A-145 while 7 selections were on par with it. The seed oil content analysed by the NMR Spectroscopy showed narrow range (29.85 to 31.49).

III (C) Identification of Potential Phyto-chemicals

Biochemical characterization of tobacco seed oil [CTRI, Rajahmundry]

K. Siva Raju, C.V. Narasimha Rao, T.G.K. Murthy and V. Krishnamurthy

Fatty acid composition of tobacco seed oil: Tobacco seed oil contains both saturated and unsaturated fatty acids ranging from C16:0 to C18:3. The predominant fatty acids were palmitic, stearic, oleic, linoleic and linolenic acids (Table III. 1)). The content of stearic acid and palmitic acid ranged from 2.54 to 3.60% and 5.47 to 8.11%, respectively among the oil samples from different tobacco types. The content of oleic and linoleic acids ranged from 9.22 to 13.60% and 72.49 to 79.07%, respectively. Linolenic acid (1.3%) was observed in the oil of variety Siri. The saturated fatty acids found to be lowest in the variety Abirami whereas maximum in the varieties Manasi and GT-7. There was not much variation among the stearic acid content. Linoleic acid content was maximum in the oil of Dharla variety and minimum in the Banket A1 (Table III. 1). Another important feature of tobacco seed oil is that it also contains 1.30% of Ω-3-fatty acid which is an essential fatty acid for human body.

Comparison of tobacco seed oil with other edible oils: Saturated, monounsaturated and polyunsaturated fatty acids content obtained

Table III.1. Fatty acid composition of tobacco seed oil

Tobacco type	Palmitic acid (%)	Steric acid (%)	Oleic acid (%)	Linolieic acid (%)	Linolinic acid (%)
Dharla	7.18	2.62	9.97	79.07	-
Manasi	8.10	2.70	11.68	72.49	-
GT-7	8.11	2.54	11.16	75.79	-
HDBRG	7.83	2.59	10.85	75.65	-
Abirami	5.47	2.75	11.43	75.11	-
Banket A1	6.66	2.72	9.22	73.16	-
Siri	6.05	3.06	13.60	75.30	1.3

in the present studies was compared with sunflower and groundnut oils. Saturated fatty acid content varied from 8.22 to 10.80% among the tobacco seed oils. Maximum content of saturated fatty acids were found in the variety Manasi followed by GT-7 and HDBRG whereas the lowest in the variety Abirami. The saturated fatty acid content in tobacco seed oil (10.80%) was less than that of sunflower oil (12%) and groundnut oil (14%). Monounsaturated fatty acids ranged from 9.22 to 13.06% among the tobacco oils. The saturated fatty acids content of sunflower (24%) and groundnut oil (60%) which were 1.83 and 4.5 times higher than the tobacco seed oil respectively. Polyunsaturated fatty acids ranged from 72.84 to 79.07% among the tobacco seed oils. The oil of Dharla variety showed maximum content of lenoleic acid, while it was least in oil of the variety Manasi. Tobacco seed oil showed 74.70 and 19% of higher linoleic acid compared to groundnut and sunflower oils respectively. The lower iodine values of groundnut and sunflower oils indicate the lower levels of polyunsaturated fatty acids. From the nutritional point of view, the tobacco seed oil is of superior quality due to high content of linoleic acid, a polyunsaturated fatty acid which is essential for humans. The nutritional value of edible oil can be appreciated by the ratio between the polyunsaturated to saturated fatty acids. It is considered that a high quality of the oil has a ratio more than 2. According to the nutritional classification of oils made by Petrovski, edible fats are classified into 3 classes. Class 1 – most valuable fats from nutritional point of view, having the ratio more than 2. Tobacco oil has a higher ratio of polyunsaturated to saturated fatty acids than sunflower and groundnut oils.

Effect of storage period on oxidative deterioration of tobacco seed oil: Experiments conducted to study the extent of oxidative alterations in tobacco seed oil subjected to ambient and sunlight storage for a period of 90 days and compared with sunflower and groundnut oils. The magnitude of oxidative changes was monitored by periodical measurement of peroxide value (PV), free fatty acids (FFA), *p*-anisidine value (*p*AV), conjugated trienes (CT), conjugated dienes (CD) and iodine values (IV). Peroxide values significantly increased from 15 days of storage (1.13 meq/kg) and reaching a maximum value of 8.45 meq/kg at 90 days. Photo-oxidation (4.82 meq/kg) was significantly higher than auto-oxidation (3.80 meq/kg). The peroxide values were significantly different among the three oils with highest in tobacco seed oil (5.06 meq/kg) followed by sunflower oil (4.29 meq/kg) and groundnut oil (3.58 meq/kg). The *p*AV increased significantly with increase in days of storage attaining the maximum of 13.84 at 90 days. In photo-oxidation, *p*AV (7.34) was significantly higher than auto-oxidation (5.87). *p*AV in tobacco seed oil (7.27) and sunflower oil (7.18) were at par and were significantly higher than groundnut oil (5.36). Tobacco oil at 90 days of storage showed 2.9% and 7.19% higher content of CD over sunflower oil in photo and auto-oxidations respectively. FFA content in tobacco seed oil (0.153%) and sunflower oil (0.150%) were at par and are significantly higher than groundnut oil. Both the methods of oxidation were at par for different days of storage up to 60 days for FFA. The oxidative changes in tobacco seed oil showed nearly similar trends with that of sunflower oil. Magnitude of photo-oxidative change was significantly higher than auto-oxidation. Even though tobacco seed oil contains higher levels of unsaturated fatty acids, adopting suitable procedures of storage, packing and adding antioxidants, tobacco oil can be stored like any other edible oils.

IV. Management of Resource Constraints for Production Efficiency and Product Quality

Knowledge of natural resources and their production potentials and constraints is of paramount importance for optimizing resource use in an agro-ecosystem. The resource characterization and identification of soil and water related constraints to tobacco is critical not only for evolving soil and water management techniques but also for improving input use efficiency under tobacco production. Further, resource management is one of the important factors that determine the product quality.

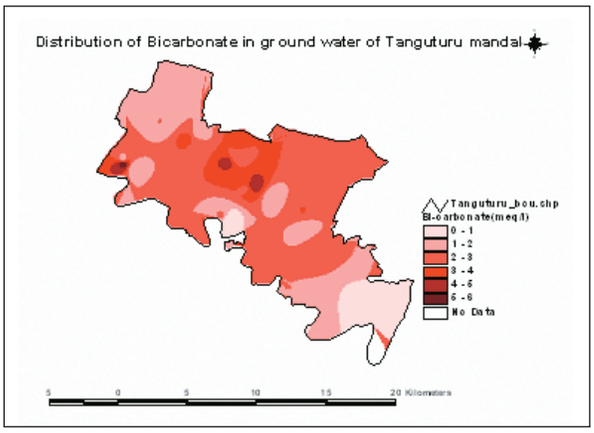
IV(A) Evaluation of soil fertility, water quality and plant nutrition constraints for tobacco and their management

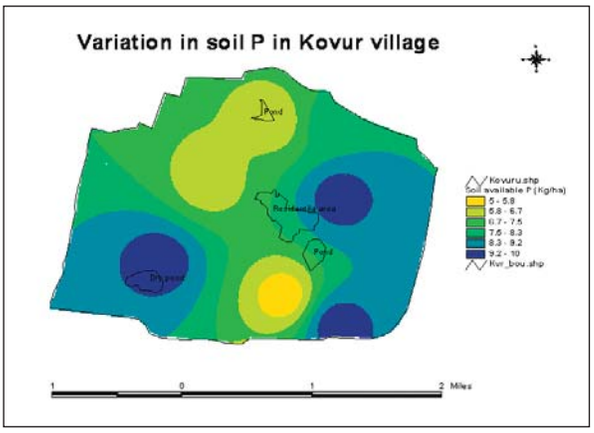
Investigations on soil fertility and ground water quality in SLS and SBS regions of Andhra Pradesh [CTRI RS, Kandukur]

L.K. Prasad, D. Damodar Reddy and V. Krishnamurthy

Natural resources i.e. land forms, soil types, water sources and cropping pattern of 13 villages of *Tanguturu* mandal (15^0 16'01.17 to $15^0$28'59.76 N latitude & $79^0$53'43.88 to $80^0$06'30.28 E longitude) of Southern Black Soil area were recorded. Soil and pre monsoon water samples were collected and their geo reference points recorded. Studies on physico-chemical and ionic concentration in ground water of villages of *Tanguturu* mandal indicated that pH of the ground water varied from 7.3 to 8.7. Most of the samples are in alkaline range. Highest pH recorded in ground water of *Vasepallipadu.* Chloride values are between 0.56 and 105.4 meq/l. Highest potassium content (2.36 meq/l) in ground water was found in *Mallavarapadu.*

High concentrations of chloride, carbonate and bi-carbonate ions are observed in irrigation bore wells and shallow bore wells. Sodium content in ground water samples in post monsoon samples was as high as 93.0 meq/l in *Anathasagaram*. Bicarbonate concentration was decreased in post monsoon samples compared to pre-monsoon samples. Post monsoon chloride concentration was decreased in ground water in coarse textured red soil areas. Soil quality of villages of *Kandukur* mandal showed that soil pH was slightly alkaline to moderately alkaline in nature. Organic carbon (%) content varied from 0.23 *(Vikkiralapeta)* to 0.57 *(Kandukur)* and reduced with depth. Available phosphorus varied from 6.8 (Kandukur) to 27.9 kg/ha (Jillelamudi). Available potassium ranged from 140 (M.Gopalavaram) to 551 kg/ha (Anandapuram). Soil fertility class of *Kandukur* mandal based mean values of organic carbon, available phosphorus and available potassium of different villages was Low-Medium-High. Chloride concentration in surface layer of the soil varied from 25.7(Oguru) to 717.0 ppm (Kovvur). Mean value of soil chloride of





Kandukur mandal was 148 ppm which is above normal limit for tobacco cultivation.

Soil Fertility Investigations: Preparation of Soil Test Summaries, Nutrient Indices and Soil Fertility Maps of Tobacco Growing Soils of India [CTRI, Rajahmundry]

V. Krishnamurthy C. Chandrasekhararao and A.V.S.R. Swamy

Soil quality in chewing tobacco growing soils of Tamil Nadu: A total number of 405 surface soil samples were processed and analyzed for pH, EC, chlorides and available potassium. Soil test summaries related to these parameters were prepared. Results revealed that 57% of Nagapattanam soils are moderately alkaline and 38% are neutral. In Cuddalore 78% are moderately alkaline and 19% are neutral. In Erode district 93% soils are moderately alkaline. EC values in all these districts are in normal range (<0.7dS/m). In Nagapattanam district 97% soils have chlorides <100 ppm. In Cuddalore 66% and Erode 73% soils have chlorides <100ppm. Soils of Nagapapattanam district are medium (71%) in available K status where as majority of soils in Cuddalore (84%) and Erode district (75%) are high in available potassium.

IV(B) Soil quality and nutrient use efficiency in relation to input management

Long-term Impact of Fertilizer Regimes on Soil Organic Carbon Pools and carbon Sequestration under *Motihari* Tobacco Production System in North Bengal [CTRI, Rajahmundry]

D. Damodar Reddy, V. Krishnamurthy and S. Amarnath

Long-term fertilizer regime effects on soil organic carbon mineralization: The soil organic carbon mineralization in terms of CO_2-C evolution from the soils of contrasting fertilizer regimes during the course of 56 d incubation is depicted in Fig. IV-1. In general, the amounts of cumulative CO_2-C evolved showed a rapid increase during initial 14 d period; thereafter the increase was less for the rest of the incubation period. All the fertilizer regimes showed similar trend, but the differences between them for cumulative CO_2-C became more conspicuous as the time progressed. The differences in the rates of C mineralization are indicative of the variable amounts of labile organic C accumulated in soil under different fertilizer regimes. The amount of C mineralized over the entire span of incubation was greater in FYM treatment followed by NPK treatment, while it was least in the unfertilized control. The balanced NPK fertilizer regime with 211 mg kg^{-1} cumulative CO_2-C evolved showed a significant increase in C mineralization over all other unbalanced fertilizer regimes (N, P, K, NP, NK and PK). The value of C mineralized in NPK treatment was 24.6, 34.8, 43.9, 12.7, 17.0 and 30.7% greater than those with N, P, K, NP, NK and PK treatments, respectively.

Effect of long-term fertilizer regimes on soil organic carbon and bulk density: The total organic carbon concentration of soil in both 0 – 0.15 and 0 – 0.30 m depth) differed significantly among contrasting long-term fertilizer regimes.

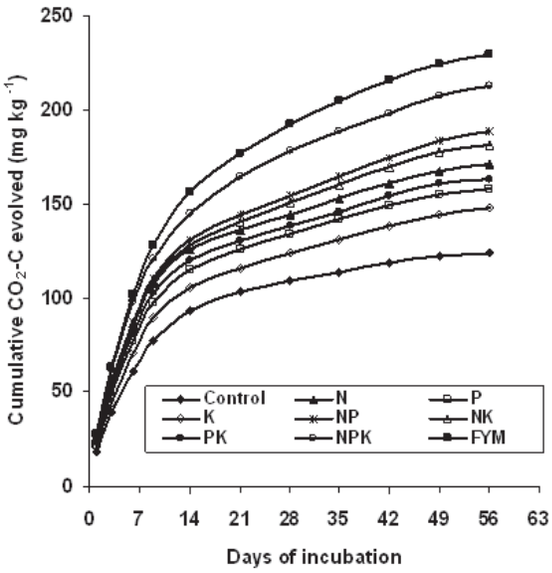


Fig. IV-1: Soil organic carbon mineralization pattern (CO_2-C evolved) as affected long-term fertilizer regimes.

The FYM treatment showed highest soil TOC concentration, while the control treatment resulted in the lowest TOC at both soil depths. Among chemical fertilizer treatments, the balanced NPK maintained higher TOC compared to unbalanced fertilizer regimes (N, P, K, NP, NK and PK). Irrespective of fertilizer regimes, the TOC concentration was higher in surface soil (0 – 0.15 m) than in sub-surface soil (0.15 –

0.30 m). The soil bulk density (BD) in surface layer was significantly affected by long-term fertilizer regimes, while it showed little change in lower depth. The FYM treatment maintained lowest BD value. All fertilizer regimes significantly decreased the BD in surface layer as compared to the control. Balanced NPK treatment had relatively lower BD than unbalanced fertilizer treatments. In general, the bulk density tended to increase with increase in soil depth.

Fertilizer regime effects on soil carbon storage and carbon sequestration: All fertilizer regimes led to a significant increase in total C storage (0 – 0.30 m depth) over the no-fertilizer control. However, FYM and NPK treatments resulted in relatively greater C storage as compared to other fertilizer treatments. Among unbalanced fertilizer regimes, the N, NP, NK and PK showed significantly greater C storage than the P and K treatments. The C sequestration in soil differed significantly between long-term fertilizer regimes (Fig IV-2). It ranged from 1.23 to 7.09 Mg ha^{-1}. The FYM and balanced NPK treatments promoted C sequestration more than all other treatments. The C sequestration potential of different long-term fertilizer regimes followed the order: FYM > NPK > NP > PK > NK > N > P > K.

Potassium supply strategies for improved productivity, quality and potassium use efficiency of FCV tobacco grown on irrigated Alfisols [CTRI, Rajahmundry]

D. Damodar Reddy, M. Anuradha and V. Krishnamurthy

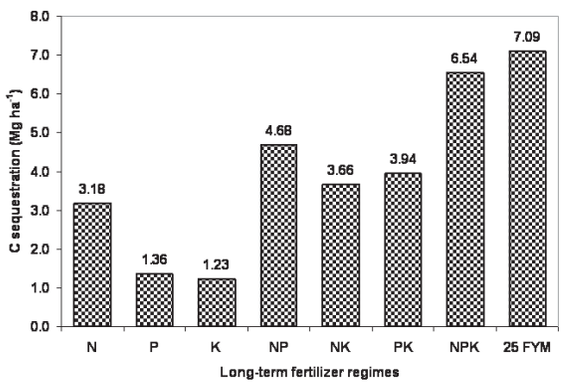


Fig IV-2. Effect of long-term fertilizer regimes on soil carbon sequestration

Potassium supply strategy effects on tobacco leaf yield and grade index: Application of potassium at the rate of either 120 or 80 kg K_2O ha^{-1} resulted in significant increase of green leaf yield, cured leaf and grade index of tobacco over the no-fertilizer control and NP fertilizer alone (-K). This indicated a clear crop response to K supply on Alfisols characterized by low native K reserves and low CEC coupled with high vulnerability to leaching losses. On an average, the K application rate of 120 and 80 kg K_2O ha^{-1} enhanced cured leaf yield by 52.9 and 29.5%, respectively over no-K treatment. The number of splits and timing of K application also had marked influence on tobacco cured leaf yield. For the 3 splits strategy (1:2:1) of K application, the tobacco yields did not differ between the timing of 10, 25 & 40 DAT and 25, 40 & 70 DAT at both rates of application. Potassium application in 4 splits (1:1:1:1 at 10, 25, 40 and 70 DAT) significantly increased the yields as compared to its supply in 3 splits (1:2:1 at 10, 25 and 40 DAT or 25, 40 and 70 DAT). On an average, the yield increase due to 4 splits over 3 splits was 17.3 and 16.9% for the K rate of and 80 kg K_2O ha^{-1}, respectively. Further, the cured leaf yield obtained with 80 kg K_2O ha^{-1} applied in 4 splits (1:1:1:1) at 10, 25, 40 and 70 DAT was at par with the yield recorded with the standard practice of applying 120 kg K_2O ha^{-1} in 3 splits (1:2:1) at 10, 25 & 40 DAT. Grade index was relatively greater with 4 splits than with 3 splits at both rates of K supply.

Nutrient uptake and efficiency in tobacco as related to K supply strategies: K application resulted in enhanced N, P and K uptake by tobacco over the no-K treatments. K applied in 4 splits resulted in relatively higher nutrient uptake compared to its addition in 3 splits. The harvest index of K remained more or less same (0.64 to 0.73) across all K supply strategies. This implied that about 64 to 73 % of total K uptake was trans-located to economic part (i.e. leaf) in all the treatments. K use efficiency under different K supply strategies was evaluated in-terms of partial factor productivity (PFP_K), agronomic efficiency (AE_K), physiological efficiency (PE_K) and recovery efficiency (RE_K). The PFP_K, AE_K, PE_K and RE_K values widely ranged from 19.14 to 28.79 kg kg^{-1}, 4.17 to 9.36 kg kg^{-1}, 14.79 to 24.95 kg kg^{-1} and 22.90 to 42.15%, respectively among different K supply

strategies. Application of K in 4 splits generally resulted in greater K use efficiency as compared to K addition in 3 splits only. The RE_K values were lower at higher rate of K application. The recovery efficiencies of N and P by tobacco were also markedly enhanced by K application at either rate in 4 splits as against 3 splits.

Leaf quality in relation to K supply strategies: The concentrations of nicotine and chloride for X and L position leaves, and RS X position leaf were significantly affected by K supply strategies, while K concentration of leaf at both positions did not vary significantly between K supply treatments. The chloride content of leaf was significantly low in all fertilized plots over the unfertilized control, apparently due to 'dilution effect' caused by yield response to applied nutrients. In general, the concentration of nicotine and K was higher in X position leaf than in L position leaf, while the RS followed the reverse trend.

Soil K availability in relation to K supply strategies: Soil samples drawn post-harvest from the different treatments at 90 DAT were analyzed for K availability (Neutral normal ammonium acetate extractable K). All plots receiving K application maintained higher K availability as compared to the control and minus-K plots. The soil K availability was more or less similar for 120 kg K_2O ha^{-1} and 80 kg K_2O ha^{-1} in the identical K application strategies. Further at a particular application rate, the K availability in soil was relatively high with the supply strategies having last split dose timed at 70 DAT.

Potassium Use Efficiency of Tobacco Genotypes: Potassium (K) is the key nutrient required in large quantity for optimum yield and quality of tobacco (*Nicotiana tabacum* L.) grown on K deficient Alfisols under NLS conditions. Identification and use of genotypes that are efficient in K uptake and utilization is a promising strategy to improve yield and reduce costly input of K fertilizers (SOP) in FCV tobacco production. A field experiment on K deficient Alfisols at CTRI Regional station, Jeelugumilli was conducted to evaluate FCV tobacco genotypes for their potassium use efficiency and responsiveness. The K efficiency of genotypes is expressed as agronomic efficiency (AE_K), Physiological efficiency (PE_K) and Recovery efficiency (RE_K). The AE_K, PE_K and RE_K varied between 2.00 to 7.94 kg cured leaf kg^{-1} K applied, 16.32 to 39.18 kg kg^{-1} and 13.90 to 44.03%, respectively among the genotypes. Based on the efficiency i.e. cured leaf yield obtained without K (K_0), and responsiveness (i.e. AE_K), the genotypes were classified into 4 groups viz., Efficient-responsive (ER), efficient-non responsive (ENR), non efficient-responsive (NER) and non efficient-non responsive (NENR). The genotypes viz., RT-51-2, RT-57-1, TOBIOS-2, ABL-8-1, NLSH-1 and RT-42-1, were found to be most K efficient and responsive to K application (Fig. IV-3).

Water Extraction Method for Determination of Potassium in Diverse Plant Materials: The conventional methods of plant sample preparation for K determination are often tedious and time-consuming and/or require chemicals making the analysis expensive. Recently, we proposed a water-extraction method for assaying K in tobacco leaf samples.

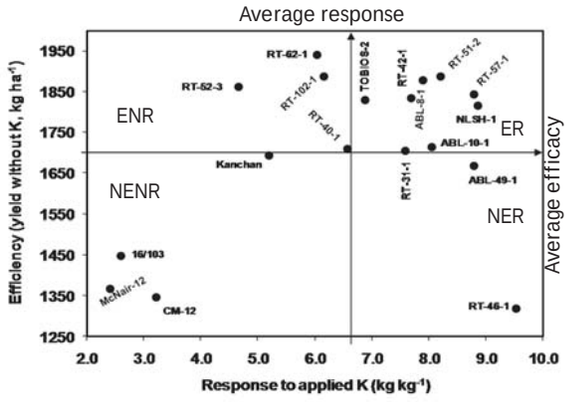


Fig. IV-3: Grouping of flue-cured tobacco genotypes based on their K efficiency and response to K application.

The method entailed extracting K from 0.5 g finely ground plant tissue (<0.5mm sieve) with distilled water at 1:100 ratio (sample weight to water volume, w/v) by shaking for 20 minutes and filtering before K measurement by flame-photometry. This water extraction method was further evaluated for its suitability in comparison to the standard methods (i.e. triacid digestion and 0.5 N HCl-extraction) for determination of K in diverse plant materials. A total of 20 different plant materials comprising

stover and grain samples of various crops were selected to have a broad range in potassium concentration in plant tissue and evaluated water extraction method vis-à-vis other established methods for determination of plant tissue K concentration. The range of K concentrations among 20 diverse plant samples was more or less identical for different methods, with the K ranging from 0.32 to 3.09% for triacid digestion, from 0.41 to 3.26% for HCl extraction and from 0.36 to 3.20% for the water extraction method. Though mean K concentration varied by a very small magnitude among different methods, it followed the order: HCl extraction (1.96%) > water extraction (1.82%) > triacid digestion (1.78%). The triacid digestion yielding relatively lower K concentration than the other methods might be due to possible loss of K resulting from sample drying and burning toward completion of digestion. In general, K concentrations obtained with the water extraction method tended to be in close agreement with those obtained with triacid digestion while being slightly lower than the K values for HCl extraction method. The water extractable K values averaged 102.3 and 92.9% of mean K obtained with triacid digestion and HCl extraction, respectively. This indicated that the water extraction method gave mean K concentration that was within 3 to 7% of that measured by established methods and thus was comparable in accuracy to the established methods. The K concentrations obtained with water extraction method were highly significantly ($p = 0.01$) correlated with K values measured by triacid digestion ($r = 0.996^{**}$) and HCl extraction ($r = 0.994^{**}$) methods. These correlations indicate a close agreement between the K concentrations obtained by water extraction method and other established methods. Regression of the K concentrations determined by different established methods (y) on K obtained by water extraction method (x) yielded the following linear regression equations:

Triacid digestion:
$y = 0.9147 x + 0.1234 \quad (R^2 = 0.9922) \quad (eq. 1)$

HCl-K extraction:
$y = 0.9768 x + 0.1895 \quad (R^2 = 0.9883) \quad (eq. 2)$

Very high R^2 (coefficient of determination) values for the linear regression equation 1 and 2 above also suggested that the K determined using the water extraction method was predictively related with K obtained by other established methods.

Nitrogen nutrition of flue-cured tobacco [CTRI, Rajahmundry]

M. Anuradha, K. Nageswararao, C. Chandrasekhararao and V. Krishnamurthy

Nitrogen use efficiency in FCV tobacco genotypes: A Field experiment was laid out at CTRI Research Station, Jeelugumilli with two levels of nitrogen (0, 120 kg N/ha) and eighteen flue-cured tobacco genotypes (16/103, Mc Nair-12, CM-12, Kanchan, TOBIOS-2, NLST-2, NLST-3, NLST-4, RT-31-1, RT-40-1, RT-42-1, RT-46-1, RT-51-2, RT-52-3, RT-57-1, RT-62-1, RT-102-1, ABL-8-1, ABL-10-1, ABL-49-1 and NLSH-1) in three replications to evaluate the genotypes for nitrogen use efficiency.

N stress effects on FCV tobacco genotypes: Nitrogen stress reduced the photosynthetic rate and chlorophyll content in all the genotypes. Among the genotypes grown with N, the net photosynthetic rate (pn) measured at 55 days after planting ranged from 20 to 26.5 $mmolm^{-2}s^{-1}$ and ABL-10-1 recorded greater Pn followed by RT-51-2. The total chlorophyll content varied between 1.97 to 3.03 mg g^{-1} f.wt among the varieties. Nitrogen stress reduced cured leaf yield in all the genotypes which ranged between 1606 to 2722 kg ha^{-1} with N and 786 to 1244 kg ha^{-1} with out N. Nitrogen stress reduced cured leaf yield and grade index. The reduction in cured leaf yield due to nitrogen stress ranged from 40.46% to 69.80%. Among the genotypes greater yield was recorded in RT-57-1, RT-51-2 and NLSH-1. Nitrogen content of leaf and stem reduced due to nitrogen stress and varied among the genotypes. Nitrogen uptake increased due to N application and it ranged from 50.83 kg ha^{-1} to 88.5 kg ha^{-1} and 15.34 kg ha^{-1} to 26.6 kg ha^{-1}, with and without N respectively. The reduction in nitrogen uptake ranged from 53.67% to 78.76% among the genotypes.

Nitrogen use efficiency: N use efficiency of genotypes is expressed as agronomic efficiency (AE), Physiological efficiency (PE) and Recovery efficiency (RE). AE, PE and RE varied between

5.74 to 15.14 kg cured leaf kg^{-1} N applied, 32.84 to 47.20 kg kg^{-1} and 22.94 to 54.03%, respectively among the genotypes. The genotypes, RT-42-1, RT-57-1, NLSH-1, ABL-8-1, RT-51-2, RT-46-1, TOBIOS-2, RT-102-1, ABL-49-1, RT-49-1, RT-62-1 and RT-40-1 recorded greater AE, NLSH-1, 16/103, RT-46-1, RT-42-1, ABL-8-1, RT-40-1, RT-51-2, TOBIOS-2, McNair-12 and ABL-10-1 recorded higher PE and ABL-49-1, RT-57-1, ABL-8-1, NLSH-1, RT-42-1, RT-31-1, RT-52-3, RT-102-1 and RT-52-1 recorded greater RE.

Impact of excess water stress and adaptive strategies to minimize its negative effects on productivity and quality of tobacco [CTRI, Rajahmundry]

M. Anuradha, D. Damodar Reddy, T.G.K. Murthy and K. Siva Raju

Field and pot culture experiments were conducted to study the influence of excess water stress, to screen the genotypes for excess water stress and to find out the possible mitigation measures to alleviate the effects of excess water stress in flue-cured tobacco.

Excess water stress effects: Pot culture experiment conducted with different periods (control, 6h, 12 h, 24 h and 48 h) of excess water stress showed that net photosynthetic rate decreased when plants were subjected to excess water stress for the period of 24 or more hours. Total chlorophyll content decreased with increase in period of excess water stress and the reduction was sharp at 48 h of excess water stress. The activity of peroxidase, polyphenol oxidase and acid phosphatase decreased with increase in the period of excess water stress. Soluble protein content and the activity of super oxide dismutase increased with increase in period of excess water stress up to 12 h and 24 h, respectively and later both showed a decline. The reduction in cured leaf yield, grade index and reducing sugar concentration in leaf was recorded due to excess water stress for a period of 24 hours or more.

Mitigation of excess water stress effects: Tray seedlings of flue-cured tobacco variety Kanchan were planted in 50 kg capacity porcelain pots filled with light soil. The plants were grown using recommended package of practices. At 60 days after planting the plants were imposed with excess water stress for 48 hours. Later the stress was relieved. One day after relieving stress the plants were treated with treatments T1 Control, T2 - Excess water stress, T3- Excess water stress + water spray, T4 - Soil application of KNO_3, T5 - KNO_3 spray, T6 - Hoagland solution spray, T7 - Foliar spray of salicylic acid, T8- Foliar spray of Kinetin. From the visual observations it was found that soil application of KNO_3 and foliar spray of kinetin found better among the treatments evaluated. Hence in another set of pots (150 kg capacity pots filled with light soil), the foliar sprays of kinetin, Hoagland solution, putriscine were tried in combination with soil application of KNO_3. The plants were allowed to grow and at the stage of harvest the leaves were harvested and cured in an electric barn. The cured leaf was processed and analysed for nicotine and reducing sugars. Excess water stress for a period of 48 h reduced the yield and quality. Among the nutrients/growth hormones / polyamines tested KNO_3 soil application and kinetin spray @ 50 ppm recorded greater cured leaf yield and grade index compared to other treatments. Among the treatments tested in combination with KNO_3 soil application, putriscine, kinetin and KNO_3 spray performed better compared to other treatments. No treatment could mitigate the ill effects of excess water stress completely.

Screening tobacco genotypes for excess water stress tolerance: Field experiment was conducted at CTRI Research Farm, Katheru to screen the genotypes for excess water stress. Ninety genotypes viz., Hema, Gouthami, VT-1158, Kanchan, Kanthi, Ratna, Thrupti, Hemadri, Siri, N-98, Sahayadri, Yellow Special, VA-259, Roberson, Speight G-23, Speight G-7, 95/4, TI-168, TRC-1-96, TI-1112, NOD-90EC, Shamboon, Virginia Aurea, Riwaka-1, Riwaka 4/280, Riwaka 4/281, Beinhart 1000-1, BSRB-2, AP-1, 324C, Karedu, Kanchana, Putcha, Rajkhand-1, Rajkhand-2, Rajkhand-3, Bawal, HNR-1, Adcock 1, American joiner, A-22, A-23, Bottom special, Bottom special-1, Bissettes, Bonanza, Bigorinoco, B-106, By-4, By-103, BY-104, By-03-1, Bell No-1, Bell No-2 Bell No-10, Bell No-15, Bell No-29, Bell No-93, Bell No-110, Bell W-3, Bell No-61-1, Broad leaf orinaca, Bell 1-9 No-1, Bell No 62-11 No-1, Banana leaf, Bright cospalia, B.S. resistant, Beerwah-35, B.Gram Reditto, Cash, Candel, Climax, Crutch, Crutcher, Curry, Conquerpr, Colleys special, CSIRO-37, Coker-48,

Coker-48, Coker-86, Coker-128, Coker-139, Coker-140, Coker-187(F), Coker-187, Coker-213, Coker-253 and Coker-254 were grown in experimental plot with two treatments T1-Control and T2 – excess water stress for 48 hours. All the genotypes were grown using recommended package of practices up to 60 days. The plants were subjected to excess water stress at 60 DAT for a period of 48 h. Ten days after imposing the treatments the plants which showed tolerance and susceptibility were selected and observations were recorded in those genotypes. Total chlorophyll content and dry weights of plant parts (leaf, stem and root) were recorded. From the observations shoot biomass and root/shoot ratio were computed. Biomass production was reduced in all the genotypes due to excess water stress. The reduction in leaf, stem and shoot biomass ranged 16 to 83%, 3 to 77% and 21 to 73% respectively. Among the genotypes Coker-213, Ratna, Thrupti, Coker-253, Rajkhand, Gauthami, Kanchan and Bell No 110 showed relatively better performance under excess water stress condition compared to other genotypes. Genotypes, AP-1 and Coker-86, Sahyadri and BY-103 showed more susceptibility compared to other genotypes.

Nutrient uptake: The plant samples (leaf and stem) collected from eleven released tobacco varieties Viz., Hema, Gouthami, VT-1158, Kanchan, Kanthi, Ratna, Thrupti, Hemadri, Siri, N-98, Sahayadri grown with and without excess water stress were processed and analysed nutrients (N, P, K, Ca, Mg and S. Nutrient uptake was computed on the basis of shoot biomass and nutrient concentration in the shoot. In all the genotypes nutrient uptake reduced due to excess water stress. The reduction in N, P, K, Ca, Mg and S uptake varied between 20-64% and 17-59%, 19-58%, 10-67%, 4-63% and 5-61% respectively.

IV(C) Characterization of soil biota and use of biofertilisers

Development of bioconsortia for optimizing nutrient supplementation through microbes for tobacco crop production [CTRI, Rajahmundry]

D.V. Subhashini, M. Anuradha, D. Damodar Reddy

Soil microorganisms play a key role in the biogeochemical cycling of both inorganic and organic nutrients in the soil and in the maintenance of soil quality. In particular, microbial activity in the rhizosphere is a major factor that determines the availability of nutrients to plants and has a significant influence on plant health and productivity. Nursery and field trials were conducted at CTRI Research Farm, Katheru to evaluate different bio-fertilizers and their combination on seedling growth of tobacco and to assess nutrient availability with the use of bio-fertilizers. The treatments included: T_1 = Control, T_2 = 100 % recommended dose of fertilizer (RDF), T_3 = 75% recommended dose of fertilizer (RDF), T_4 = 75% RDF+ *Azospirillum* @ 1x 10^8 CFU/g, T_5 = 75% RDF+ *Bacillus subtilis* @ 1x 10^9 CFU / g, T_6 = 75% RDF+ *Frateuria aurantia* @ 1x 10^9 CFU / g, T_7 = 75% RDF (*Azospirillum* + *B. subtilis*), T_8 = 75% RDF (*Azospirillum* + *F. aurantia*), T_9 = 75% RDF (*B subtilis* + *F. aurantia*), T_{10}=75% RDF (*Azospirillum* + *B. subtilis* + *F. aurantia*), T_{11}= 75%RDF+ *Azotobacter* + *B.subtilis* + *F. Aurantia,* T_{12}= 75%RDF+ *Azotobacter* + *F. aurantia*

Bio-consortia effects on tobacco seedlings: Combined inoculation of the all the three bioinoculants recorded maximum microbial population. The combined inoculation of *Azospirillum* + *B. subtilis* + *F. aurantia* and *Azotobacter* + *B.subtilis* + *F. aurantia* increased the seedling height, germination percent, dry matter production, nutrient content of the seedlings and number of transplantable seedlings. Combination of any two bioinoculants also showed the enhancement in the growth parameters over single inoculation of the bioinoculant and uninoculated control.

Inoculum establishment in the rhizosphere: The low level of fertilization resulted in a higher level of microbial population in the rhizosphere. Combination of all the three bioinoculants resulted in the highest population of introduced microorganisms exhibiting synergistic effect and positive interaction among the beneficial bacteria.

Bio-consortia effects on tobacco yield and nutrient uptake: The triple inoculation of rhizobacteria resulted in an increase of cured

leaf, bright leaf yield and grade index. The cured leaf yield varied from 1777 to 2400 kg/ha. Moderate increases in yield were due to increase of nutrients either in chemical or organic form. The fertilizer effect on plant growth was much more pronounced after inoculation of N- fixer and its combination with beneficial rhizobacteria. The maximum yield of cured leaf (2,400 kg/ha), bright leaf (1,112 kg/ha) and grade index (1461) were obtained with the treatment 75% RDF+ *Azospirillum* + *B. subtilis* + *F. aurantia* followed by 75% RDF+ *Azotobacter* + *B.subtilis* +*F. aurantia*. The *Azospirillum* seemed to be more effective than *Azotobacter* at the 75% recommended fertilization level. However, the effect of the two N-fixers at 75% of the recommended fertilization level on leaf yields was not significantly different. These results suggest that the triple inoculation of beneficial bacteria could compensate the deficiency in soils to some extent, besides making the unavailable form of P and K available to the plant. Triple inoculation also resulted in an increase of quality parameters, such as nicotine and sugars compared to dual or single inoculation of beneficial rhizobacteria.

IV (D) Evaluation of tobacco leaf and product quality

Monitoring of agrochemical residues in tobacco samples from different areas [CTRI, Rajahmundry]

C.V. Narasimha Rao and Rakesh Kumar Ghosh

Development of new method for pesticide residue analysis : A new and sensitive GC-MS-NCI method was developed for multiresidue analysis of 11 organochlorine pesticide residues viz., á- BHC, â- BHC, ã- BHC, ä- BHC, OP'-DDT, PP'-DDT, á-Endosulphan, â-Endosulphan, Endosulphan Sulphate, Chlorpyriphos and Endrin. Based on the boiling point and vapour pressure of individual pesticide, the temperature programming was: Injector: 250^{0}C; Ion source: 200^{0}C with interference temperature of 3200C; Oven ramping: 100^{0}C (0.5min hold time), then @ 35^{0}C min^{-1} upto 220^{0}C (no hold time), @ 20^{0}C min^{-1} upto 320^{0}C (4 min hold time). Calibration curve was drawn from 0.001 to 1 µg ml^{-1} concentration range, with high linearity (R^2 = 0.9998). The instrumental method was validated for intra-day and inter-day variations, and, in all cases RSD values were <20%. The minimum detection level was 0.002 µg ml^{-1}. The Figure IV-4. shows 11 pesticides with different retention time (R_t) of (1) á-BHC (4.723 min), (2) ã-BHC (5.012 min), (3) â-BHC (5.193 min), (4) ä-BHC (5.406 min), (5) Chlorpyriphos (5.731 min), (6) á-Endosulphan (6.603 min), (7) Endrin (7.09 min), (8) OP'-DDT (7.137 min), (9) â-Endosulphan (7.307 min), (10) PP'-DDT (7.438) and (11) Endosulphan Sulphate (7.672 min).

Monitoring of pesticide residues in tobacco samples: The residue analysis of FCV tobacco leaf samples received from different auction platforms of KLS, NLS, SLS, SBS and NBS (2011-12 season) revealed that organochlorine pesticide residues, in general, were within the

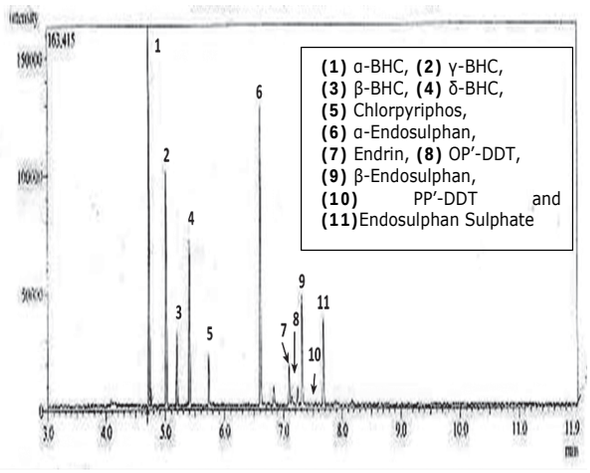


Figure IV-4. GC-MS-NCI multiresidue method for 11 pesticides.

Guidance Residue Level (GRL) except few cases (Table IV.1).

Determination of imidacloprid residue - Method development and validation by HPLC: An effective, faster and sensitive method for imidacloprid extraction from tobacco leaf, and analysis by high performance liquid chromatography (HPLC) was developed. A 5 g tobacco powder, spiked with imidacloprid, was homogenised in 50 ml acetone for 10h at room temperature (32±2^{0}C). Then samples were agitated for 45 min over an orbital shaker at

Table IV.1: Organochlorine Pesticide residues (ppm) in FCV Tobacco

Region	ã-BHC	BHC (á+â+ä)	Chlor-pyriphos	Dieldrin	Endrin	Total Endosulfan	Total DDT
KLS(89)	0.01 (ND-0.40)	0.04 (0.01-0.07)	0.03 (0.01-0.21)	ND	ND	0.08 (ND-0.96)	0.04 (0.01-0.10)
NLS(36)	ND (ND-0.01)	0.02 (ND-0.06)	0.06 (ND-0.50)	ND	ND	0.19 (0.02-0.84)	ND (ND-0.16)
SLS(42)	ND (ND-0.01)	0.01 (ND-0.03)	0.07 (ND-0.38)	ND	ND	0.07 (0.01-0.81)	ND (ND-0.20)
SBS(36)	ND (ND-0.05)	0.02 (ND-0.07)	0.05 (ND-0.18)	ND	ND	0.05 (0.01-0.52)	0.02 (ND -0.06)
NBS(7)	ND (ND-0.01)	0.02 (0.01-0.06)	0.02 (ND-0.06)	ND	ND	0.18 (ND-0.54)	ND (ND)
GRL	**0.50**	**0.07**	**0.50**	**0.05**	**0.05**	**1.00**	**0.20**

200 r.p.m., and vacuum filtered. The leachate was reduced to 2 ml under vacuum. Subsequently, 50 ml brine solution (10% NaCl) was added to the residuum, and liquid-liquid partitioning (L-L-P) was performed with 20 ml n-Hexane, thrice. The aqueous layer was further partitioned (L-L-P) by total 100 ml dichloromethane, thrice (50:30:20). The organic fractions were collected through anhydrous Na_2SO_4 layer and evaporated to dryness. The residuum was re-dissolved in 10 ml acetonitrile (ACN) and cleaned up through anhy. Na_2SO_4 -: Florisil bed: anhy. Na_2SO_4 -(1:4:1) column by eluting 50 ml ACN. Final volume was made in 25 ml ACN and analysed by HPLC. A Shimadzu LC-8A series HPLC coupled with UV-detector was used. The instrumental conditions were- Column: RP-18 at 30 ^{0}C; Isocratic mobile phase: ACN/H_2O (30:70, v/v); Flow rate: 0.7 ml min^{-1}; Injection volume: 20 ìL and Wavelength ($ë_{max}$): 270 nm. Imidacloprid standard showed sharp peak with the retention time (R_t) at 12.2 min. The analytical method was validated by testing calibration range, linearity, sensitivity, accuracy, precision, matrix effect and uncertainty as per the Single Laboratory Validation approach. This method has potential to increase the overall turnover of a testing laboratory, and thus has promise to be adopted in regular residue testing of tobacco. The current method is also relatively safer to the analysts due to nominal exposure to organic solvent.

Transformation and determination of imidacloprid by gas chromatography- electron capture detector (GC-ECD): A 5 ml imidacloprid solution (5 mg L^{-1}) was subjected to basic hydrolysis by adding 25 ml NaOH (0.1*N*) solution at 85 ^{0}C for 30 min. Then the reaction medium was cooled down to ambient temperature, and neutralized by 50% HCL (1:1 v/v) solution. Samples were extracted with 25 ml chloroform (thrice) by liquid-liquid partitioning technique. Organic fraction was collected through anhy. Na_2SO_4 layer and evaporated to dryness, under vacuum. The sample was finally made in 5 ml acetone and analyzed by GC-ECD. A HP Series II (model-5890) series GC system with ECD-detector was used. The analysis was performed by injecting 2 ìL on a packed column [30m (l) x 0.53mm (i.d.)]. The temperature programme was Injector: 250 ^{0}C ; Detector: 300 ^{0}C; Oven: 250 ^{0}C (1 min hold time), increased @ 20 ^{0}C.min^{-1} to 290 ^{0}C (3 min hold time); Helium flow rate: 1ml min^{-1}. Imidacloprid derivative showed sharp peak with the retention time (R_t) at 4.83 min.

The sensitivity and response of the imidacloprid derivative, 1-(6-chloro-3 pyridylmethyl)-imidazolidin-2-one was good. The reaction yielded single product, verified by TCL and GC-ECD. This transformation reaction can be validated for imidacloprid residue analysis in tobacco samples.

Evaluation of smoke constituents in tobacco and tobacco products [CTRI, Rajahmundry]

C.V. Narasimha Rao and Rakesh Kumar Ghosh

Comparison of smoke constituents among some smoke products: A study was undertaken to compare the main stream smoke yields and flavour compounds in cigarette, Kretek cigarette and *bidi*. Kretek cigarette is made with a blend of tobacco and 15 to 40% dry clove (*Eugenia carophyllus*) buds. *Bidi* is a hand rolled smoking product made by rolling the filler in *Tendu (Diospyrus* spp.*)* or *Ashitri (Bauhinia* spp.*)* leaf and *bidi* contains about 45% tobacco flakes. Nicotine-free dry particulate matter (NFDPM), nicotine and carbon monoxide (CO) were estimated using the standard smoking methods. The corresponding filler and smoke condensate pads were subjected to steam distillation followed by extraction with dichloromethane for isolation of the neutral volatile fraction for GC-MS analysis. Higher levels of smoke constituents were recorded in Kretek cigarette (TPM: 55.88 mg/cig; nicotine: 3.48 mg/cig; NFDPM: 43.02 mg/cig and CO: 22.25 mg/cig) as comparable to those from *bidi* (TPM: 52.16 mg/*bidi*; nicotine: 2.37 mg/*bidi*; NFDPM: 31.96 mg/*bidi* and CO: 23.15 mg/*bidi*). In the cigarette brand analysed, the smoke deliveries (TPM: 15.51 mg/cig; nicotine: 1.23 mg/cig; NFDPM: 13.21 mg/cig and CO: 12.69 mg/cig) were relatively low as compared to both Kretek cigarette and *bidi*. In cigarette blend, the composition of the neutral volatile fraction was typical of FCV tobacco. However, higher levels of neutral volatile compounds viz., neophytadiene (38.6%), 2, 3-dihydro-benzofuran (33.9%), megastigmatrienone (17.4%) and nootkatone (3.2%) were found in the smoke condensate with which could be attributed to pyrolysis during smoking. The neutral volatile fraction of *bidi* filler was conspicuously different from that of FCV tobacco with higher levels of caryophyllene oxide (43.0%), megastigmatrienone isomers (28.35%), dibutyl phthalate (10.40%) and solanone (6.95%). Higher levels of 2, 3-dihydro-benzofuran (42.8%), neophytadiene (27.9%), dibutyl phthalate (19.0%) and indole (10.2%) were observed in *bidi* smoke condensate which could be attributed to pyrolysis during smoking. In the Kretek cigarette blend, apart from the known tobacco neutral volatile compounds (namely, caryophyllene oxide, benzyl alcohol, megastigmatrienone isomers, dibutyl phthalate and neophytadiene), the following typical clove flavour compounds were identified: eugenyl acetate, coumarin, piperonal, vanillin, caryophyllenyl alcohol, alpha-humulene, methyl eugenol, abeo-humulinone, trans-anethole and cis-spiro-isohumulone I. The compound 1-menthol could be an additive. The neutral volatile fraction of Kretek cigarette smoke condensate was similar to the fraction isolated from the blend.

Studies on chemical constituents responsible for smoke flavor in FCV tobacco grown under different agro-climatic zones [CTRI, Rajahmundry]

C.V. Narasimha Rao and K. Siva Raju

Neutral volatile compounds: With the objective of analysing neutral volatile compounds responsible for smoke flavour in FCV tobacco, 33 samples (KLS: 21, NLS: 7 and SLS: 5) were subjected to steam distillation, the distillate was extracted with dichloromethane and concentrated to 1 ml for GC-MS analysis. Total Ion Chromatograms (TIC) of the samples were recorded between 50 to 500 m/z at a scan speed of 2500. As authentic standards of the compounds are not available for quantification, the area normalization method was adopted and the proportion of a particular compound in the total neutral volatile fraction was calculated. The neutral volatile compounds namely neophytadiene (30%), thunbergol (14%), viridiflorol (12%), megastigmatrienone isomers (8%), 3-hydroxysolavetivone (7%), duvatriendiol (6%), caryophyllene oxide (5%), solavetivone (4%), globulol (2%) and solanone (0.7%) contribute to smoke flavour. The other important compounds identified are: rishitin (2%), cycloisolongifolene (1%), valencene (1%),

lineolone (1%), 3-oxo-alpha-ionol (1%), nootkatone (0.9%), trimethyl-2,4,4 hexene-1 (0.5%), benzyl alcohol (0.5%), phenylacetaldehyde (0.3%), furfuryl alcohol (0.1%) and protoanemonine (0.1%). It is observed that the composition of the neutral volatile fraction varied in different agro-climatic zones with higher levels of neophytadiene (40.8%), which is considered as a flavour carrier, in NLS samples, while higher levels of 1-nonadecene (12.0%), 3-hydroxysolavetivone (12.0%) and dibutyl phthalate (20.2%) were recorded in KLS samples. These differences could be attributed to the climatic conditions and agronomic practices, the variety Kanchan being common. In the samples from SLS region, the levels of thunbergol (23.5%), viridiflorol (17.2%), caryophyllene oxide (9.6%) and duvatriendiol (9.2%) were high, thus implying the varietal effect, as Hema and Siri are predominantly cultivated in the region.

V. Integrated Management of Biotic Stresses

V (A) Monitoring of Insect pests and Diseases

Monitoring of insect pests of tobacco with pheromone traps [CTRI, Rajahmundry] U. Sreedhar

An experiment was conducted to monitor tobacco caterpillar, *S. litura* with pheromone traps to ascertain the influence of weather parameters on trap catch and to study its role in predicting pest incidence and damage due to the pest in tobacco nurseries.

Tobacco nursery: Perusal of correlation matrix showed that there was highly significant and positive correlation between trap catch, egg masses, larvae and per cent seedlings damaged during the season. The fitted multiple linear regression equation for moth catch in pheromone traps vs. weather parameters explains 56.1 % of variation in the moth catches. The linear regression equation fitted for per cent seedlings damaged vs. moth catch in the pheromone traps showed that 82 % variability of the seedlings damaged was explained by pheromone trap catch. The fitted multiple linear regression equation for per cent seedlings damaged vs. moth catch and weather parameters explain 90.8 % variability of the dependent variable by pheromone trap catch together with weather parameters (Table V.1).

Tobacco field crop: The results indicated that with the increase in the trap catch (lagged variable) there was an increase in the egg masses on the tobacco in the following week and subsequent increase in the larval population and damage two weeks after. During the crop season the trap catch was very less as compared to the previous seasons catch. It highest in the 2nd standard week (22.5/trap) followed by 8th (20/trap) and 3rd (18.25) standard weeks. The incidence of the pest and damage was low during the season. The highest damage recorded was 6.95 %. The correlation between trap catch, egg masses, larvae and increase in per cent plants damaged was not significant in any of the four blocks. It was highly significant only between the egg masses/plant and the larvae/plant. During the season there is no correlation between the weather parameters and trap catch. Perusal of correlation matrix shows that there is no correlation between trap catch, egg masses, larvae and increase in percent plants damaged The fitted multiple linear regression equation for moth catch in pheromone traps vs. weather parameters explains 78 % of variation in the moth catches in pheromone traps where as the linear regression equation fitted for per cent increase in plant damage vs. moth catch in the pheromone traps showed that 58.6 % variability of the seedlings damaged was explained by pheromone trap catch. The fitted multiple linear regression equation for increase in per cent plants damaged vs. moth catch and weather parameters explain 61.7 % variability of the dependent variable by pheromone trap catch together with weather parameters.

Survey for assessment of insect pest incidence in KLS tobacco (CTRI RS, Hunsur) P. Venkateswarlu and S. Ramakrishnan

Insect pest incidence in tobacco nursery: Survey of nurseries infested by tobacco caterpillar *Spodoptera litura* revealed 0-14%. Among the nurseries 15.6% infestation was recorded. The overall infestation of the pest in the entire area was 1.2%. Among the five *Taluks* surveyed, the overall infestation of the caterpillar was more in Hunsur (1.5%) followed

Table:V.1. Relationship between seedlings damaged vs. moth catch in traps and Weather parameters

Intercept (a)	Moth catch (x1)	Max.Temp (x2)	Min.Temp. (x3)	Rain fall (x4)	R.H. M (x5)	R.H.N (x6)	R^2
30.59	0.308	-0.835	0.545	-0.001	-0.267	2.846	0.908**

by Ramanathapura (1.4%), H.D.Kote (1.2%), Periyapatna (1.0%) and K.R.Nagar (0.9%).

Insect pest incidence in tobacco field crop: Four major pests of tobacco viz., aphid, (*Myzus nicotianae*), budworm, *Helicoverpa armigera,* stem borer, *Scrobipalpa heliopa* and tobacco caterpillar, *Spodoptera litura* were recorded in all the five taluks of KLS. The per cent fields infested by aphid, stem borer, budworm and caterpillar were 17.6, 15.6, 21.6 and 11.6, respectively. The average infestations of these pests in the infested fields were 9.0, 8.0, 10.2 and 7.4%, respectively. The overall infestations by these four pests in the area were 1.6, 1.3, 2.2 and 0.9%, respectively.

Weather based disease prediction model for brown spot of *Motihari* tobacco under North Bengal conditions (CTRI RS, Dinhata)

S. Roy and S. Amarnath

Brown spot disease progression: The progression of brown spot disease in normal and late planted *Motihari* tobacco was monitored under protected and unprotected conditions. Initiation of spotting was observed at the mean of 60 days of planting, thus characterizing the occurrence of the disease at senescence stage of the crop. In early planting date the frequency of occurrence of big spots: small spots was almost equal (48: 52). In case of normal date of planting the frequency of big versus small spots ranged from 62: 38%. Under normal check in which plants were protected recorded only small spots. In case of late planting, the frequency of occurrence of big vs small spots was in the ratio of 67: 33. The influence of macro weather variables like temp and RH influencing the progression of small and big type of spots in early planted crop indicated progression of big type of spots with rise in temperature and low RH. The progression of big type of spots was correlated to the rise in canopy temperature and low RH in early planted crop. Relationship between rise in canopy temperature and fall in canopy RH on the increment of big type of spots was also recorded in normal and late planted crop (Fig.V.1 to V.4).

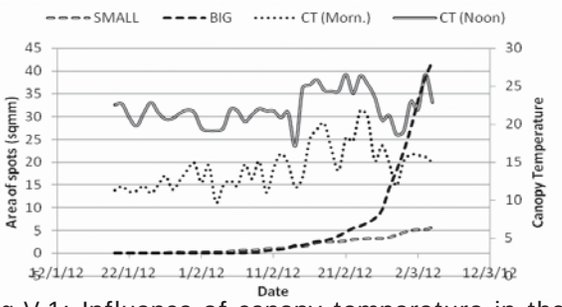


Fig-V-1: Influence of canopy temperature in the progression of small and big spots in early planted crop

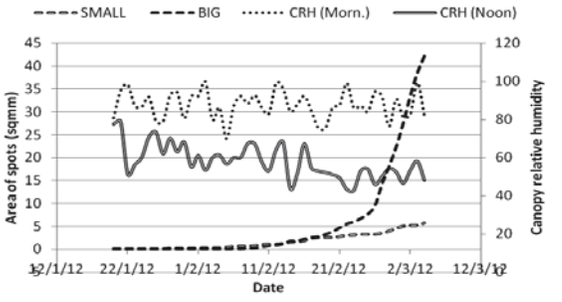


Fig-V-2: Influence of canopy RH on the progression of small and big spots in early planted crop

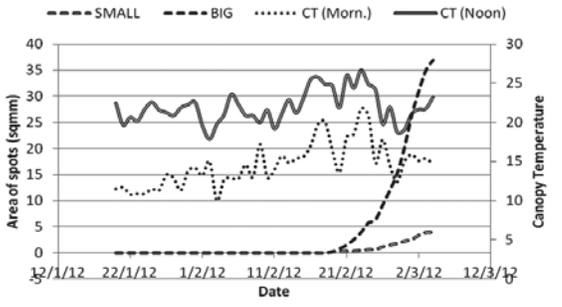


Fig-V-3: Influence of canopy temperature in the progression of small & big spots in late planted crop

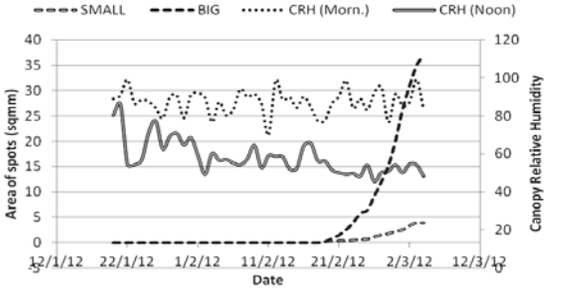


Fig-V-4: Influence of canopy RH in the progression of small & big spots in late planted crop

Survey for plant parasitic nematodes associated with tobacco *(CTRI RS, Hunsur)*

S. Ramakrishnan and P. Venkateswarlu

Plant parasitic nematodes in tobacco growing areas of KLS: Soil and root samples were drawn randomly from fields of different taluks viz., HD Kote, Hunsur, Periyapatna and Arkal. Results revealed the presence of five major plant parasitic nematodes viz., *Meloidogyne spp, Rotylenchulus reniformis, Helcotylenchus* spp, *Pratylenchus* spp. and *Tylenchus* sp., associated with main field tobacco crop. Maximum mean population of root knot nematodes were found in Periyapatna region followed by Hunsur, Arkal and H.D.Kote. Reniform nematodes, though found in large numbers in soil samples, they are not pathogenic to tobacco as compared to root knot nematodes (Table V.2). Severe galls with attached egg masses were found in crop infected with root knot nematodes.

V (B). Development of IPM technology

Management of tobacco caterpillar, *S.litura* with insecticides *(CTRI, Rajahmundry)*

U. Sreedhar and K. Nageswara Rao

Efficacy of insecticide baits against *S.litura* in NLS: Insecticides baits (insecticide + rice bran+ jaggery + water) prepared with lufenuron 5 EC, novoluron 10 EC, emamectin benzoate 5 SG *Sl* NPV + boric acid, *Bacillus thuringiensis* + potassium carbonate and chlorpyrifos were evaluated against *S.litura* on FCV tobacco. Emamectin benzoate bait provided maximum protection to tobacco leaves as shown by less number of leaves damaged (1.40 & 1.60) and was on par with the leaves damaged in novoluron (2.00 & 2.23) and lufenuron (2.33 & 2.40) bait applied plots which recorded significantly less leaves damaged as compared to Sl NPV (4.20 & 4.80) and *B.t.k.* (4.47 & 5.20) bait treated plots both at 4 and 8 DAT respectively. Among the treatments *B.t.k.* bait treated plots recorded highest number of leaves damaged followed by Sl NPV bait treated plots and was on par with that of control. As regards leaf area damaged at 4 DAT, emamectin benzoate recorded least leaf area damaged (7.65 %) which was on par with chlorpyrifos bait (9.63 %), novoluron (10.22 %) ,lufenuron (10.86 %) and all these were significantly superior to Sl NPV (16.17) and *B.t.k*. (17.19 %). Sl NPV and B.t.k were on par with each other and only Sl NPV was significantly superior to control. At 10 DAT similar trend was observed except that both Sl NPV and *B.t.k* were superior to control. Data on yield parameters showed that emamectin benzoate bait treated plots recorded highest cured leaf yield (2,318/ha) which was on par with novoluron (2306) and lufenuron (2129). Among the treatments *B.t.k*. bait plots recorded lowest cured leaf yield (1610) which was on par with Sl NPV (1625) and control plots (1484). Similar trend was observed for grade index also. Pooled analysis of data revealed that the infestation was least (10.64%) in the plots treated with emamectin benzoate bait at 4 days after treatment (DAT) followed by novoluron bait treated plots (12.26%) which was on par with lufenuron treated plots (13.60%). As regards the mean number of leaves damaged all the treatments recorded significantly less number of leaves damaged as compared to

Table V.2. Survey for plant parasitic nematodes infecting tobacco

Nematodes	Mean nematode population/100g.soil			
	HD Kote (15)	Hunsur (15)	Periyapatna(15)	Arkalgudu (15)
Meloidogyne spp.	45.3	66.6	105.3	51.9
Rotylenchulus reniformis	66.9	69.0	62.7	55.1
Helicotylenchus spp.	50.1	33.3	18.6	15.0
Tylenchus spp	10.5	9.6	4.5	0
Pratylenchus sp.	0	0	2.0	0
Xiphinema sp.	1.0	0	0	3.0
Free living	23.0	15.0	14.9	15.3

control (5.54 & 6.28) at both 4 and 10 DAT. Emamectin benzoate recorded least number of leaves damaged both at 4 and 10 DAT. It remained on par with novoluron at 4 DAT and was significantly superior to all the treatments at 10 DAT. The per cent leaf area damaged was also least in emamectin benzoate treated plots both at 4 and 10 DAT (8.43% & 9.59%) which was significantly superior to all the treatments except to that of chlorpyriphos (9.75 & 10.62). The highest cured leaf yield of 1982 kg/ha was recorded in emamectin benzoate bait treated plots followed by that in novoluron treated plots (1931). Lowest cured leaf yield was recorded in B.t. bait treated plot (1471 kg/ha) which was on par with that in SI NPV bait treated plot and both the treatments recorded significantly higher cured leaf yield as compared to that in control plots (1370 kg/ha)

Bio-efficacy and field evaluation of new insecticides against tobacco pests *(CTRI, Rajahumndry)*

U. Sreedhar, R.K. Ghosh and S.G. Rao

Bio-efficacy of new insecticides on tobacco caterpillar, *Spodoptera litura:* Commercial formulations of chlorfenapyr 10 SC, metaflumizone 22 SC, novoluron 10 EC, emamectin benzoate 5 SG, spinosad 48 SC, lufenuron 5 EC and chlorpyriphos 20 EC were evaluated for their efficacy against *Spodoptera litura.* Lowest LC_{50} (0.0012%) and LC_{90} (0.0019) values were recorded with emamectin benzoate followed by chlorfenapyr (0.0036 & 0.0060). Among others, IGRs lufenuron and novoluron recorded lower LC_{50} and LC_{90} values of 0.0037, 0.0039% and 0.061 and 0.060 respectively. The order of relative toxicity of various insecticides in comparison to LC_{50}& LC_{90} of chlorpyriphos was found to be emamectin benzoate> chlorfenapyr> novoluron > lufenuron> > metaflumizone > spinosad (Table V.3)

Evaluation of new insecticides against *S.litura* in tobacco nurseries: The insecticides viz. Chlorfenapyr 10 SC @ 0.01% , metaflumizone 22 SC @ 0.04% novoluron 10 EC @ 0.01%, spinosad

Table V.3: Toxicity of different insecticides on 8 day old larvae of *S.litura*

S.No.	Insecticide	LC_{50} % Conc.	Fiducial limits	Relative Toxicity * LC_{50}	LC_{90}% Conc.	Fiducial Limits	Relative Toxicity * LC_{90}
1.	Chlorfenapyr 10 SC	0.0036	0.0014-0.0053	7.44	0.0060	0.0058-0.0137	8.30
2.	Metaflumizone 22 SC	0.0046	0.0031-0.0131	5.82	0.0089	0.0079-0.0406	5.59
3.	Novoluron 10 EC	0.0039	0.0021-0.0050	6.87	0.0060	0.0058-0.0148	8.30
4.	Emamectin benzoate 5SG	0.0012	0.0010-0.0014	22.33	0.0019	0.0014-0.0024	26.21
5.	Spinosad 48SC	0.0056	0.0033-0.0069	4.78	0.0090	0.0076-0.0128	5.53
6.	Lufenuron 5 EC	0.0037	0.0030-0.0045	5.66	0.0061	0.0057-0.0070	8.16
7.	Chlorpyriphos 20 EC	0.0268	0.0219-0.0279	7.24	0.0498	0.0438-0.0577	1.00

*In comparison to chlorpyriphos

48 SC 0.01%, lufenuron 5 EC @ 0.006% were evaluated in a replicated trial in comparison with emamectin benzoate 5 SG @ 0.0025% and untreated control. At 2 DAS emamectin benzoate 0.0025% recorded least (6.19%) seedling damage followed by chlorfenapyr 0.01% (6.60) and novoluron 0.01% (7.01%). The seedling damage in the treatments of emamectin benzoate, chlorfenapyr, novoluron and metaflumizone was on par with each other. Lufenuron 0.006% and spinosad 0.01% recoded significantly higher damage than the above four treatments, though they recoded significantly less damage as compared to untreated control (32.14%). At 4 DAS more or less similar trend was observed except that metaflumozone (7.01) remained on par with lufenuron (8.08). Among the treatments spinosad recoded highest seedling damage (9.95%)

Evaluation of new insecticides against tobacco aphid Myzus nicotianae on FCV tobacco: Spirotetramet 150 OD @ 0.006%, 0.012%, 0.024%, Spirotetramet+ imidacloprid 240 SC @ 0.009%, 0.018% & 0.036% were evaluated against tobacco aphid, *M.nicotianae* on FCV tobacco in comparison with imidacloprid 200SL @ 0.005%. The results showed that 2 DAS aphid population was least (3.35) in spirotetramet + imidacloprid @ 0.036% and it remained on par (3.58) with its lower dose 0.018% and imidacloprid (3.81). At 4 DAS spirotetramet+ imidacloprid @ 0.018 and 0.036 and imidacloprid 0.005 % recorded cent per cent mortality and no aphids was recorded in these treatments. The treatment of spirotetramet+ imidacloprid @ 0.009 % recorded 4.18 aphids /plant which was significantly less as compared to all the doses of spiroteramet. The yield data showed that spiroteramet+ imidacloprid @ 0.036% treated plots recorded highest cured leaf yield (2015 kg/ha) and was on par with that of its lower doses @ 0.018% (2010 kg/ha) & 0.009% (1806 kg/ha) and imidacloprid @ 0.005% (1960 kg/ha). Regarding the bright leaf, the highest (1100 kg/ha) was recorded in spiroteramet+ imidacloprid @ 0.036% treated plots which was significantly higher than that in all other treatments except to that of its lower dose (1095 kg/ha).The highest grade index (1690) was recorded in spiroteramet+ imidacloprid @ 0.036 and it remained on par with that of its lower dose of 0.018% (1670) and imidacloprid (1550). The grade index in the plots treated with spiroteramet+ imidacloprid @ 0.009, spirotetramet 0.024% remained on par with that of imidacloprid.

Spatial distribution and pest succession of insect pests as influenced by cultural practices in burley tobacco in the plains of East Godavari (CTRI, Rajahmundry)

G. Raghupathi Rao

An experiment was conducted with five dates of plantings commenced from II week of July and subsequent four plantings at 15 days interval under protected and unprotected conditions.

Stem borer incidence: Incidence of stem borer at different stages of the crop revealed that the crop planted in 3rd week of August recorded significantly higher incidence of 2.10%, III week of September planted crop showed lower infestation at 10 DAP. First week of September planted crop showed significantly higher infestation of 10.2 % at 20 days after planting as compared to July and August planted crop. Stem borer infestation was significantly low in protected crop at all the stages. It was evident that the planted crop from 10 DAP essentially needs need based protection.

Tobacco caterpillar infestation: *Spodoptera litura* infestation in crop planted during III week September was significantly high at 40, 60 and 80 DAP as compared to other dates of plantings. As the infestation was significantly low in II week of July plantings and in subsequent plantings at 20 DAP, it can be inferred that early plantings was advantageous over the latter dates of plantings to avoid infestation. In general late planted crop i.e. September plantings exhibited significantly higher infestation in the range of 15-20 % infestation as against July planted crop.

Aphid infestation: The aphid infestation was significantly high at 45 DAP in the crop planted during I week of August as against 5.5 % in III week of September planted crop. Later on it was significantly high in August planted crop at 60 and 75 days after planting. It is evident that August planted crop showed relatively higher infestation.

***H.armigera* infestation:** Plantings during II week of July and I week of August showed significantly lower infestation of *H.armigera* at 50 and 60 DAP as compared to September plantings. Plantings in III week of August recorded significantly higher infestation at 70 and 80 DAP and the differences were significant. In general, the infestation increased with increase in the age of the crop from II week of July to I week of September dates of planting. The differences between protected and un protected plots were significant at 50, 60, 70 and 80 DAP. The interaction effects were non significant. III week of Aug plantings recorded significantly highest cured leaf yield of 1388 kg/ha followed by I week of Sept. plantings. The next best date of planting was III week of August for productivity, which was significantly superior to II week of July and III week of August plantings

Incidence of insect pests on other host crops: Incidence of *Spodoptera, Heliothis*, aphids and whiteflies on bhendi, gogu, tomato and beans crops was low during current season

Pest incidence as influenced by different organic amendments: Application of nitrogen (25% of recommended N) through organic sources viz. FYM, vermicompost and neem cake relatively reduced the incidence of stem borer, *S.litura* and *H.armigera* compared to check (100% N through inorganic form). Application of FYM and vermicompost, as organic source at 50 DAP resulted in significant reduction of *H. armigera* infestation. Similarly, the neem cakes applied at 70 DAP resulted in relatively lower infestation as compared to check. Cured leaf yield was relatively high in vermicompost and neem compost over check. Though, the differences are non- significant, the organic sources showed reduced levels of pest infestation.

Studies on influence of water quality on the efficacy of *B. bassiana* against *S.litura* in tobacco nursery (CTRI, Rajahmundry)
S. Gunneswara Rao

B. bassiana @ 10^8 spores /ml sprayed in aqueous solutions with EC ranging from 0.5 to 1 dS/m and p^H ranging from 7 to 8 were suitable for effective suppression of *S. litura* in tobacco nurseries.

Influence of crop rotations and tillage operations in tobacco on the diversity of plant and soil dwelling fauna (CTRI, Rajahmundry)
S. Gunneswara Rao

Diversity of insect and spider fauna was richer and equally distributed in soybean eco system than maize ecosystem. In soybean or maize ecosystems the species pertaining to Homoptera/ Hemiptera, Coleoptera and Arachinida orders showed higher diversity values in the recommended tillage plots**.** In case of Hymenoptera and Lepidoptera minimum tillage plots carried better diversity as indicated by Shannon-weiner index. In case of soil dwelling fauna also minimum tillage plots showed higher diversity index compared to recommended tillage plots in soybean, maize or tobacco ecosystems.

Life table studies of *H. armigera* on tobacco var., Siri

Age-specific life table: The life table spanned 43 days on the variety '*Siri*'. Life expectancy at the start of the life table was 11.60 days. There was 25 % mortality in the egg stage itself followed by a heavy mortality (50%) of 6 day old larvae.

***Life and fertility table of H.armigera*:** The immature stages and pre-oviposition period on Siri was 36.5 days. Female survivorship was only 0.04 at the start of the fertility table. Maximum net reproductive rate of 27.51 was recorded 3 days after commencement of oviposition

Life parameters of H.armigera: The reproductive rate of *H.armigera* on *Siri* was 115.01. Potential fecundity was 3917 eggs per female. Intrinsic rate of increase per female per day was 0.12 and the mean generation time was 38.20 days

Life table studies of *H. armigera* on Tobacco var., TI 165

Age-specific life table: The life table spanned 42 days on the variety TI 165. Life expectancy at the start of the life table was 9.21 days.

There was 20 % mortality in the egg stage, 15 percent mortality of neonates and 53% mortality of 5 day old larvae .Since there was no egg laying (or emergence) fertility table and life table parameters could not be prepared for *H.armigera* on TI 165. On tobacco var. Siri, *H.armigera* completed its life cycle and on TI this pest was unable to produce fertile offspring.

Studies on *Helicoverpa armigera* in tobacco with special reference to influence of plant variety, field ecology, ecotoxicology and seed production (CTRI, Rajahmundry)

S. Gunneswara Rao and U.Sreedhar

Determination of EIL of *H.armigera* to tobacco seed crop: An experiment was conducted with different levels of larval infestation of seed capsules in variety *Siri* to find out the EIL of *H.armigera* The per cent capsule damage ranged from zero in the completely protected plant to 37.82 where five larvae per plant were released . The correlation between number of larvae per plant and the percent capsule damage was positive and significant (r=0.98). There was reduction in grain weight increased with larval density. The seed weight in different treatments ranged from 12.26 to 21.37 g per plant.(92.60 to 272.19 kg/ha. The correlation between the number of larvae per plant and the grain weight was negative and significant (r= -0.85). Regression analysis showed that is per cent reduction in yield per incremental larvae was 10.52. The per cent reduction in seed weight caused by single third instar larvae per panicle was 40.23 compared to 0 in fully protected control. The per cent capsules damaged per incremental larvae was 7.18 /larva. The yield loss caused by single third instar larva was 100 kg per hectare in 2010-11 and 116 kg per hectare in 2011-12.

Integrated management of tobacco aphid, *Myzus nicotianae* under KLS conditions (CTRI-RS, Hunsur)

P. Venkateswarlu

Three treatments viz., border crop (bajra), an entomopathogenic fungus (*Verticillium lecanii* @ $3X10^{11}$ CFU/ha), recommended chemical pesticide (imidacloprid @ 50g a.i./ha) and their combinations were evaluated for integrated management of tobacco aphid, *Myzus nicotianae* in FCV tobacco for two consecutive years. Pooled analysis of data on aphid infestation, 10 days after second spray revealed that all the treatments were significantly superior in reducing the aphid infestation to an extent of 72.12 to 100 over control. Ten days after second spray, aphid population was nil both on top and middle leaves of chemical control plot and also in plots which received one spray of imidacloprid in combination with bajra border or with one spray of *V. lecanii*.

Natural enemy population: The treatments with chemical spray schedules showed drastic reduction in the population of natural enemies in tobacco Predator population was more (27.00 to 28.23/plant) in plots sprayed with *V. lecanii* alone or with border crop and was on par with untreated control (28.61/plant). In pesticide applied plots, predator population ranged from 3.26 to 9.91/plant. It indicated that entomopathogenic fungus has not shown any adverse effect on predator population. The natural enemy population on bajra border was also recorded. Of these, coccinellid predators were dominant followed by spiders, wasps and syrphid flies. The total predator population in bajra varied from 7.01 to 7.73/plant.

Bio-intensive management of root-knot nematode in FCV tobacco of KLS using tray nurseries (CTRI-RS, Hunsur)

S. Ramakrishnan

The coco-peat media used for raising tray seedlings were fortified with bio-agents viz., *Pseudomonas fluorescens*, *Trichoderma viride* and *Paecilomyces lilacinus* at dosage levels of 25 and 50 g / tray media. FCV tobacco seedlings raised in such tray medium enriched with above antagonistic organisms were evaluated against root knot nematodes on FCV tobacco under sick field conditions. The results revealed that tray seedlings treated with *Paecilomyces lilacinus* @ 50g/ tray media caused 12.1% increase in FCV tobacco cured leaf yield compared to check. It was also on a par with *Pseudomonas fluorescens* @ 50g / tray media in significantly reducing the root knot index at the time of final harvest to the tune of 51.5 %. Pooled analysis of data revealed that, *Paecilomyces*

lilacinus @ 50g/ tray media caused 52.4% reduction in RKI, 45.7% reduction in egg mass/ g root and 50.6% reduction final soil nematode population compared to untreated check. Subsequent increase in the cured leaf yield was to the tune of 14.8 % over untreated check (Table V.4).

Nursery and field evaluation of *Trichoderma viride* and *Pseudomonas fluorescens* to brown spot disease and yield and quality of *Motihari* tobacco (CTRI-RS, Dinhata)

S. Roy and S. Amarnath

The influence of bio-primed seedlings on the incidence of brown spot of *Motihari* tobacco revealed that the treatments Tv + SSP, Pf + SSP and Tv + Pf + SSP showed lowest incidence. The influence of biocides on recovery of healthy transplantable seedlings was non-significant. The cured and first grade leaf under different treatments showed significantly higher cured leaf yield in Tv + Pf and Tv + Pf + SSP. The range of per cent increase of cured leaf yield in different treatments was 0.30 – 24.3 %. Significantly highest first grade leaf yield was recorded in Pv + Pf + SSP followed by Tv + Pf. Compared to positive control (SSP), all the treatments registered increase in first grade leaf ranging from 2.3 to 43.3 % .

Table V.4: Effect of bio agents enriched tray media on FCV tobacco yield and root knot disease incidence under field conditions

S.No.	Treatment details	Green leaf yield (kg/ha)	Cured leaf yield (kg/ha)	Root knot index	No. of egg mass / g. root	Soil popu-lation / 100g. soil
1.	*Pseudomonas. fluorescens* @ 25g / tray media	13107	1454	2.22	15.0	84.3
2.	*Pseudomonas. fluorescens* @ 50g / tray media	13151	1478	2.00	12.0	82.5
3.	*Trichoderma viride* @ 25g / tray media	13020	1432	2.43	17.3	100.5
4.	*Trichoderma viride* @ 50g / tray media	13138	1385	2.22	15.3	96.0
5.	*Paecilomyces lilacinus* @ 25g / tray media	12783	1488	2.00	12.9	81.3
6.	*Paecilomyces lilacinus* @ 50g / tray media	13220	1539	1.89	12.3	75.0
7.	Un Treated tray media	12147	1377	2.40	15.3	118.0
8.	Conventional seedling + Carbofuran @ 1g / plant	12134	1451	2.31	14.6	108.0
9.	Untreated check	11940	1372	3.90	24.3	145.0
	S.Em CD (5%)	78.58 236.7	10.3 30.9	0.19 0.57	1.02 2.75	3.17 9.54

Multi-locational bulk testing of biocides for quality and yield of *Jati* tobacco *(CTRI-RS, Dinhata)*
S. Roy

T. viride + *P. fluorescens* + *SSP* and *T.viride* registered significant higher cured and first grade leaf yield over check Podali at all the locations. The per cent increase ranged from 6.9 - 27 % and 15.8 – 66 % for cured and first grade leaf yield, respectively.

V (C) Screening for host plant resistance to insect pests

Screening of tobacco germplasm against caterpillar, *Spodoptera litura (*CTRI-RS, Hunsur)
P.Venkateswarlu

A total of 307 tobacco varieties/lines including 230 germplasm accessions, 21 AVT and IVT entries, 30 aphid resistant lines, 15 root-knot resistant lines, 6 advanced breeding lines, 2 promising hybrids and 3 ruling varieties (checks) raised in nursery by Crop Improvement division were screened against caterpillar, *Spodoptera litura* under natural infestation. Among them, one ruling variety, Kanchan, two breeding lines namely, FCH-201 & FCH-222 and one hybrid, KLSH-10 registered caterpillar infestation with 4.33, 4.00, 3.66 and 2.33%, respectively. In rest of the lines, the infestation was nil.

Evaluation of FCV tobacco germplasm for the tobacco caterpillar tolerance under SLS conditions (CTRI RS, Kandukur)
K.C. Chenchaiah

Tobacco germplasm screened against *S.litura* under artificial infestation showed that 3 test entries, R-118, R-121 and R-147 rated as 2 and eight entries rated as 3 on a 0-5 scale. Extent of caterpillar damage in R-116, R-130, R-136, R-139 and R-147 was significantly low as compared to Hema.

Evaluation of four promising aphid tolerant lines (Trial-2)

Among four selected lines, 45-1, 10-2 and 59-2 were significantly superior to Hema with respect to green leaf, cured leaf yields and grade index, while 10-2 and 59-2 were significantly superior to *Hema* with respect to bright leaf yields. However, the chemistry of the leaf in the test entries was not in desirable range. Pooled analysis data confirmed the test lines 10-2 and 59-2 were significantly superior to Hema with respect to all yield characters.

Evaluation of two promising aphid tolerant lines (Trial-3)

The test line, 178-2 was significantly superior to Hema with respect to all yield characters. However, the chemistry of the leaf in the test entries was not in desirable range.

Evaluation of FCV germplasm for tolerance to *S. litura* (CTRI RS, Kandukur)
K.C. Chenchaiah

Eighteen tobacco germplasm were screened against *S. litura* under natural conditions. The test lines, 2010 R-136 and 2010 R-142 showed tolerance while R-119, R-130, R-138 and R-140 showed significantly lowest leaf damage as compared to Hema. The test lines, R-136, R-142 and R-130 were selected for yield evaluation trial.

Evaluation of six promising caterpillar *S. litura* tolerant lines for yield (Trial-2)

The test line 62-2 was significantly superior to the check variety Hema with respect to all the yield parameters and grade index, followed by the test line, 47-1 was significantly superior to Hema with respect to green leaf, cured leaf and grade index only. The chemistry of the leaf in the test entries was not in the acceptable range. Data on pooled analysis revealed that the test lines 47-1 and 62-2 were significantly superior to Hema with respect to all the yield parameters and grade index followed by 59-2 and 62-1.

Evaluation of two promising caterpillar tolerant lines (Trial-3)

Among two promising caterpillar tolerant lines, the151-2 was significantly superior to Hema with respect to all the yield parameters and grade index. The chemistry of the leaf in the test entries was not in the optimum limit.

Screening of tobacco germplasm against root-knot nematodes (CTRI-RS, Hunsur)

S. Ramakrishnan and C. Panduranga Rao

Thirty five advanced breeding lines were screened under natural conditions (sick field) against root-knot nematodes and the results revealed that FCR-6 (V-4388), FCR-8(RS-10), FCKH-1 (SH-12), FCH-233 & FCH-235 recorded RKI of d" 1.0 and were found most promising against root-knot nematodes. The varieties Rathna and Kanchan were included as susceptible checks.

Screening for resistance against brown spot and hollow stalk in germplasm accessions of *N.rustica* and *N.tabacum* in North Bengal *(CTRI-RS, Dinhata)*

S. Amarnath and S. Roy

Thirty entries of *N. rustica* were screened against brown spot under artificial conditions (sick plot) and the disease reaction ranged from 0 - 13.9%. However, 12 entries showed disease reaction in the range of 0 - < 2 %. Twenty one entries of *N. tabacum* were screened under artificial conditions against brown spot and showed brown spot disease reaction in the range of 0 to 10.71%. Six lines of *N. rustica* were screened against hollow stalk disease under artificial conditions and the entry bengthuli exhibited resistant to hollow stalk disease for three successive years.

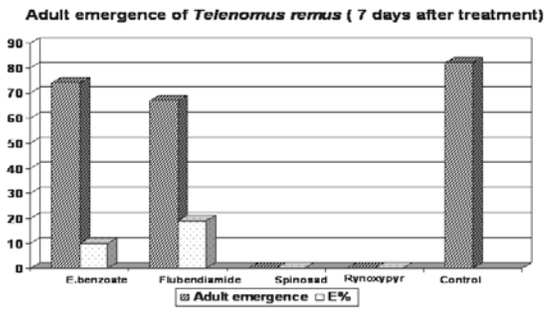
V (D) Monitoring and management of pesticide resistance and pesticide residues

Toxicity of some new insecticides against *Telenomus remus* Nixon (Scelionidae: Hymenoptera) under laboratory conditions (CTRI, Rajahmundry)

S.Gunneswara Rao and U.Sreedhar

Insecticide toxicity against *T.remus* at adult stage: The new insecticides viz.,emamectin benzoate 5 SG @ 0.0025 %**,** flubendiamide 480 SC@ 0.0012, spinosad 45 SC@ 0.00225% and rynaxypyr 25 SG@ 0.0075% were evaluated for their toxic effects on adults of *T.remus* and on different incubation stages of the parasite in host eggs. Emamectin benzoate and flubendiamide were slightly toxic only up to two days after application. In case of spionosad the mortality of T.remus adults was 100 % till third day and gradually reduced but continued up to 15 days after application. Rynaxypyr also showed residual toxicity till 15th day after application. Based on International Organization for Biocontrol (IOBC) classification of insecticide ecotoxicology spinosad and rynaxypyr were rated as slightly persistent, where as emamectin benzoate, flubendiamide were categorized as short lived persistency class of insecticide with respect to *Telenomus remus* adults.

Insecticide toxicity against *T.remus* at different incubation stages: Spinosad and rynaxypyr were harmful to *T.remus* at all stages of its incubation inside the host eggs , with total inhibition of parasite emergence at insecticide treatments imposed on 1st, 3rd and 7th day after parasitisation , where as flubendiamide was slightly harmful at 1st and 3rd day treatments (E >30%) and emamectin



benzoate was harmless with E % less than 30 % at one day old parasitized egg masses and is slightly harmful at 3 day old parasitized egg masses.

AE= Adult emergence from treated *S.litura* eggs.

E %: (1- Vt/Vc) x 100, where E is effect of insecticide on the biological control agent being measured as the reduction in adult emergence compared to untreated control. Vt is the

parasitism viability (AE) observed in each insecticide treatment and Vc parasitism viability (AE) observed in untreated control.

Class:
1: Harmless (E <30%)
2: Slightly harmful (E 30-79%)
3: Moderately harmful (E 80-99%)
4: Harmful (E >99)

Development of baseline-resistance data of lepidopteron pests of tobacco against conventional insecticides and insecticides with novel mode of action (CTRI-RS, Guntur)

J.V.Prasad and U.Sreedhar

Base line resistance data of three lepidopteran pests of tobacco viz., *S.litura* and *H.armigera* were generated against select insecticides with conventional and novel modes of action following standard bio-assays detailed by Insecticide Resistance Action Committee (IRAC). A comparison of base line resistance of two populations of *S.litura,* one from Guntur and another from Rajahmundry, was made (Table V.5). The Guntur population of Spodoptera *litura* recorded 7.09, 1.27, 1.44, 2.57, 1.65 and 2.68 times higher LC_{50} values of novaluron, spinosad, acephate, indoxacarb, emamectin benzoate and endosulfan respectively compared to Rajahmundry population. On the other hand the LC_{50} values of rynaxypyr and fipronil were higher by 1.31 and 2.06 times respectively in Rajahmundry population compared to Guntur population. Out of the eleven insecticides with stomach action against which base line resistance data of *H.armigera* were generated, the lowest LC_{50} value was recorded with emamectin benzoate followed by indoxacard, spinosad and rynaxypyr establishing their efficacy at very low concentrations (Table V.6).

Table V.5: Comparison of base line resistance of *S.litura* from Guntur and Rajahmundry to insecticides with stomach action

S.No	Insecticide	LC_{50} (mg/l) (Guntur)	LC_{50} (mg/ml) (Rajah-mundry)
1	Novaluron	2.74	0.39
2	Spinosad	230.45	180.2
3	Fipronil	52.65	108.5
4	Rynoxypyr	0.275	0.361
5	Acephate	2395.76	1652.59
6	Indoxacarb	25.25	9.80
7	Emamectin benzoate	0.078	0.047
8	Chlorpyriphos	219.88	213.23
9	Endosulfan	159.85	59.62

Table V.6:Base line resistance data of *H.armigera* (Guntur population) to insecticides (stomach action)

S.No	Insecticide	LC_{50} (mg/l)	LC_{90} (mg/ml)
1	Novaluron	2.76	6.18
2	Spinosad	1.24	2.34
3	Thiodicarb	36.89	79.8
4	Fipronil	3.21	5.85
5	Rynoxypyr	2.05	4.98
6	Acephate	440.34	901.25
7	Indoxacarb	0.543	2.728
8	Emamectin benzoate	0.0052	0.015
9	Chlorpyriphos	17.25	41.25
10	Endosulfan	22.34	44.56
11	Flubendiamide	12.35	30.69

Technology Assessed and Transferred

On-farm trial with new pipeline selections V-4219 and TBST-2 in comparison with Siri as control in NBS and CBS [CTRI, Rajahmundry]
S.K. Naidu, P.V. Venugopala Rao and Y. Subbaiah

On-farm evaluation of lines V-4219 and TBST-2: Evaluated the performance of advance breeding lines viz., V-4219 and TBST-2 in comparison to popular cv. Siri at two locations viz. Katavaram and Kunavaram villages in Sitanagaram Mandal of East Godavari district. Higher mean (over two locations) cured leaf yields were recorded in V-4219 (1,970 kg/ha) and TBST-2 (1,973 kg/ha). The yield improvement over better control Siri (1,776 kg/ha) was 10.92% and 11.09% respectively. Plant height, number of leaves, leaf length & width, were observed to be higher in V-4219 and TBST-2 as compared to that of Siri.

On-farm demonstration of production technology for Sabari Lanka tobacco [CTRI, Rajahmundry]
V. Krishnamurthy, Y. Subbaiah, S.K. Naidu, C. Chandrasekhararao and S. Nageswara Rao

Technology demonstration and farmers' feedback: The production technology for Sabari lanka tobacco involving recommended spacing (70 x 70cm), dose and method of N & K fertilizer application (300 kg N + 50 kg K) in three splits by dollop method), chemical control of suckers through application of 4% decanol (fatty alcohol) and IPM measures was demonstrated on-farm at Rekhapalli village, VR Puram mandal, Khammam district for improving yield and quality and to reduce cost of cultivation for Sabari lanka tobacco. The results for the season 2011-12 indicated that the demonstration plot out-yielded the control plot by 4.76%. The farmers are applying 300% extra nitrogen over and above the recommended N level. Leaf analysis data showed the perceptible variations in chlorides and reducing sugars of lamina and midrib. Further, cost of cultivation was reduced by 14.25% (₹ 30,512/ha) with an additional net returns of ₹ 41,345/- per hectare. The B: C ratio was 1.06 in Farmer's Plot and 1.30 in Demonstration Plot.

In general the quality of Sabari Lanka tobacco produced from Kunavaram village is more qualitative than that of Rekhapalli village. The economics were worked out considering the cost of cultivation and expected market price of ₹ 52,000/ per *garise* (720 kg). CTRI technologies on production of good quality Sabari Lanka tobacco were widely popularized through Print Media and Interface meetings. The demonstrations conducted over two seasons on Production Technology for Sabari lanka tobacco at Rekhapalli and Kunavaram villages of Bhadhrachalam Division, Khammam district created awareness about Demonstrated Technology Module among the farmers. Farmers have realized the importance of demonstrated technologies and majority of the farmers in the village have expressed their willingness to adopt demonstrated technologies.

On-Farm Testing of new lines in Burley tobacco [CTRI, Rajahmundry]
Y. Subbaiah, S.K. Naidu and P.V. Venugopala Rao

On-farm trials were conducted for two consecutive seasons to evaluate the performance of Burley ABL YB-4 with Banket–A1 as better check. Adopted all the good agricultural practices in both the experimental and control plots. Data were collected on incidence of pests and diseases, morphological

Advanced Burley breeding line - YB-4

characters, yield, quality, acceptability to the farmer and buyer, benefit: cost ratio and farmers' opinion.

Cured leaf yield: Cured leaf yield was higher by 21.98% in YB-4 when compared to better control Banket-A1 (1,915 kg/ha). Data on yield

parameters over the two seasons indicated that Burley ABL YB-4 out yielded the popular check cv. Banket-A1 by 23.67%. Leaf chemical quality parameters (nicotine, reducing sugars and chlorides) of ABL YB-4 were on par with Banket-A1. ABL YB-4 recorded markedly higher B: C i.e. 1.43 over Banket-A1 (1.19)

Farmer's feedback: As perceived by the farmers, the advantageous characteristics of YB-4 are as follows:

1. Medium height with small inter-nodal length
2. More leaf width and more leaf thickness
3. Acceptable colour with spotting
4. More waiting period between the harvests
5. True Yeleswaram Burley type
6. More stem girth and withstands strong winds

Further stated, YB-4 has given superior yield coupled with quality as compared to that of better control Banket A-1 and realized more prices in the market. YB-4 is acceptable to all the situations. Hence, the YB-4 may be preferred over Banket A-1.

Traders' preference: Traders expressed their acceptability for YB-4 and revealed YB-4 is true Yeleswaram Burley type with acceptable quality parameters.

Assessment of N and K fertilization in NLS area of Andhra Pradesh [CTRI, Rajahmundry]

Y. Subbaiah, D. Damodar Reddy, V. Krishnamurthy and M. Anuradha

On-farm trials were conducted at two locations in Ankalagudem and Buttaigudem villages during two consecutive seasons to assess four N&K fertilization treatments so as to identify the viable fertilization practice. The treatments included : T1 – Farmer's Practice ; T2- Recommended Practice (120 kg N ha + 120 kg K_2O ha^{-} in three splits (1:2:1) at 10, 25 and 40 DAT) ; T3 – Refined Intervention – I i.e. RI -I (120 kg N ha applied in three splits (1:2:1) at 10, 25 and 40 DAT + 120 kg K_2O ha^{-1} applied in four equal splits at 10, 25, 40 and 70 DAT) and T4 - Refined Intervention – II i.e. RI –II (120 kg N ha^{-} applied in three splits (1:2:1) at 10, 30 and 50 DAT + 120 kg K_2O ha^{-} applied in four equal splits at 10, 30, 50 and 70 DAT.

Cured leaf yield: Higher cured leaf yield was recorded in recommended practice (2,446 kg/ha), refined intervention I (2,493 kg/ha) and refined intervention II (2,514 kg/ha). The yield improvement over farmers practice (2,343 kg/ha) was 4.39, 6.40 and 7.29% respectively. Refined interventions I and II out-yielded the recommended practice by 1.92% and 2.78% respectively. Superior bright grade outturn was recorded in Recommended Practice (71.65%), Refined Intervention-I (74.65%) & Refined Intervention-II (72.15%). K/N ratio in lamina of green leaf of X and L positions was found to be 0.89, 1.19, 1.21 and 1.07 (X position); 0.96, 0.98, 1.13 and 1.07 (L position) for Farmers Practice, Recommended Practice, Refined Intervention-I and Refined Intervention-II respectively. Quality of tobacco was assessed in terms of nicotine, reducing sugars, chlorides and potassium concentration in lamina of X and L positions. The quality data was within the acceptable limits of good quality. Percent chlorides in lamina of X and L positions did not show variations. Potassium concentration in lamina of leaf is within the acceptable range in all the treatments. Based on B: C ratios for two seasons, it was concluded that recommended practice, refined intervention-I and refined intervention-II recorded markedly higher B: C ratio 1.47, 1.52 and 1.53 over the farmers' practice (1.30).

Designing Algorithms for Data Classification [CTRI, Rajahmundry]

H. Ravisankar

The software for weather data storing, retrieving and report generation was designed and developed for taking hard / soft copies of daily / fortnightly / monthly / yearly reports on various weather parameters.

Decision support system for transfer of technology [CTRI, Rajahmundry]

H. Ravisankar and Y Subbaiah

Development of Software for transfer of technology on tobacco production: The software in the form of website for effective transfer of technology in FCV tobacco production was developed. Information was incorporated with images into various web pages of this software. Hyperlinks were provided for all the web pages and connected to home page of this software.

Education and Training

Central Tobacco Research Institute has organized different extension activities viz., trainings, Scientist-farmer interface meetings, field days, kisan melas, exhibitions, workshops and meetings. Added emphasis has been accorded for collaborative activities with Tobacco Board, Tobacco Industry, State Line departments and Agricultural Universities to achieve increased productivity, enhanced quality and to get more net returns at real farm situation.

Advisories were extended to the farmers of East Godavari, West Godavari, Guntur, Khammam, Anantapur and Nalgonda districts regarding dissemination of various technologies including drudgery reducing weeders (50), solar energy devices (5), mushroom production technology (20), FCV tobacco management practices(15) through visits and through telephone calls. About 18 farmers were supplied with agricultural implements through research organizations (CRIDA, Hyderabad) and private industries (Rakhi Industries, Kakinada). The other important activities include:

- Farmers Day was conducted at CTRI Research Station, Jeelugumilli on 18.1.2013.
- CTRI Scientists including the officials of Tobacco Board visited the Neelam cyclone affected areas during 1-5 November, 2012 to asses the crop situation and to suggest remedial measures.
- Field IRC at CTRI Research Station, Jeelugumilli on 19.02.2013 from 9.00 AM to 6.00 PM to monitor the approved Institute/ AINRPT experiments and technical programme.
- Kisan Mela was organized on 03.04.2012 at Pedageddada village
- A one-day workshop on nursery management was organized by CTRI Hunsur and Tobacco Board for the farmers from the different auction platform areas at CTRI RS, Hunsur on 30.3.2012.
- A one day workshop on FCV Tobacco Crop Production Practices, drought management and good agricultural practices was organized by Tobacco Board, CTRI and ITC Ltd.,. on 20.6.2012 at PALA Hunsur in which Tobacco Board and trade officials,100 growers participated.
- One day training progaramme on "Post harvest Product Management/Grading /NTRM in FCV tobacco" was organized for Tobacco Board field staff/official and growers at CTRI Hunsur on 12.09.2012.
- Agriculture technology week was organised by KVK, Pundibari, (under Uttar Banga Krishi Viswavidayalaya, Coochbehar) from 25 to 28th Feb, 2013. The CTRI-RS, Dinhata displayed exhibits in stalls and educated farmers.
- Training programme on "Tobacco Nursery Management and Bio-fertilizer application" on 9th November, 2012.
- A three day training programme at CTRI RS, Dinhata (10-12 December, 2012) on "Production practices of tobacco and other *rabi* crops" was organized jointly by CTRI RS, Dinhata, and State Agrl. Dept (WB) - sponsored by AFTRDC (ACMART (Acad. For management and Rural Trg.-Farmers Training and Rural Development Centre) – an unit sponsored by NABARD & West Bengal State cooperative Ltd.
- Farmers and traders meet was organized at Muthu Naicken patty village on 27.2.13 (CTRI RS, Vedasandur)

S.N.	Training imparted	Resource person	Date and place
1.	Formulation of crop insurance scheme for FCV tobacco – Meeting with Agriculture Insurance Company of India Ltd	Dr. K. Nageswara Rao Dr. S.V. Krishna Reddy	12.04.2012 at 2.30 PM at Tobacco Board, Guntur
2.	Soil Testing Laboratory, Ongole	Dr. D. Damodar Reddy	21st and 22nd May, 2012

S.N.	Training imparted	Resource person	Date and place
3.	73rd Meeting of the Registration Committee	Dr. T.G.K. Murthy	28.06.2012 at 11.30 AM at Tobacco Board, Guntur
4.	Field Crop/Post harvest Management	Dr. M. Mahadevaswamy	22.08.2012 at bore Hosahally (PF 62)
5.	Post harvest Product Management	Dr.M.Mahadevaswamy	05.09.2012 at Kogilur (PF 62)
6.	OFT/Post harvest Product Management	Dr.M.Mahadevaswamy	07.09.2012 at H.Kaval & Anuwal (PF 62)
7.	One day training programme on Post harvets Product Management (Tobacco Board Oficailas)	Dr.C.Panduranga Rao Dr.M.Mahdevaswamy Dr.S.Ramakrishnan	12.09.2012 at CTRI Research Station, Hunsur
8.	One day Extension training programme for Tobacco Board staff on PHPM /Grading / NTRM	Dr.M.Mahadevaswamy	14.09.2012 at Periyapatna Auction plotorm
9.	OFT/Post harvest Product Manegemnt	Dr.M.Mahadevaswamy	14.09.2012 at K.M.Koppal (PF 61)
10.	Post harvest Product Managemnt	Dr.M.Mahadevaswamy	17.09.2012 at N.Settahally (PF 5)
11.	"Nursery Management"	Dr. S.K. Dam	21-09-2012 at Dippakayalapadu, K. Kannavaram and Pothineedupalem villages
12.	Tobacco Nursery Management Practices	Smt. N. Aruna Kumari Sri K. Seshasayi Sangaigudem	24.09.2012 at Bandapuram, Pallantal and
13.	Training programme on "Nursery Management, Pests & Disease control in seed beds"	Dr. S.K. Dam Sri P.E. Jemmy	26-09-2012 at Chinnaigudem, Vedullakunta, Gopalapuram and Peddapuram villages
14.	"Nursery Management"	Smt N Aruna Kumari Sri K. Sesha Sayi	27-09-2012 at Bandapuram, Pallantala, Devarapalli villages
15.	Training programme on "FCV tobacco Nursery Management"	Sri S. Nageswara Rao Sri K. Sesha sayi	04-10-2012 at Challavarigudem, Rowthugudem and Mulagalampalli villages
16.	Training programme on Nursery Management	Sri J. Siva Sai Dr. S.K. Dam	05.10.2012 at Jangareddygudem, Narasannapalem and Ramanujapuram villages

S.N.	Training imparted	Resource person	Date and place
17.	Training programme & field visit	A.R.Panda	11.10.12 at Maddivaripalem
18.	Training programme on Extension and developmental schemes on seedbed preparation, nursery management, Pest & Disease control in seedbeds	Smt. N. Aruna Kumari Dr. S.K. Dam	12.10.2012 at Rajahmundry rural and Mirthipadu
19.	2nd phase training programme on 'Main field management'	Dr. K. Nageswara Rao J. Siva Sai	29 & 30th October, 2012 at J.R.Gudem I & II
20.	Tobacco board e-auction and Exhibition stall	Dr.M.Mahadevaswamy Dr.C.Mahadeva Dr.S.Sreenivas	15 & 16.11.2012 at Periyapatna Auction platform
21.	Field Crop Management in FCV Tobacco Cultivation	Dr. S.V. Krishna Reddy Smt. N. Aruna Kumari	02.11.2012 at Vellachintalagudem Vadalakunta
22.	Training programme & Nursery visit	A.R.Panda	27.11.12 at DC Palli
23.	Training programme & field visit	K.C.Chenchaiah	18.12.12 at Chowtapalem
24.	Field Day	Dr. P. Venkateswarlu	24.01.2013 at Medarametla
25.	Training programme on 'Main field operation, plantings, inter cultivation & IPM'	Dr. S. Gunneswara Rao Dr. Y. Subbaiah	29.01.2013 at Raghudevapuram
26.	Field Day	Dr. P. Venkateswarlu	05.02.2013 at Chandrapadu
27.	Field Day	Dr. P. Venkateswarlu Dr. L.K. Prasad	06-02-2013 at Bandlamudi
28.	Field Day	Dr. P. Venkateswarlu	12.02.2013 at Mangamuru
29.	Field day	Dr. P. Venkateswarlu	13.02.2013 at Rachavaripalem
30.	Field day	L.K.Prasad	15.02.13 at Sarveyreddypalem
31.	Field day	Dr. P. Venkateswarlu	19.02.2013 at Doddavaram
32.	Training programme & field visit	K.C.Chenchaiah	25.02.13 at Kovur & Anathasagarm
33.	Field day	A.R.Panda	05.03.13 at Dubagunta

S.N.	Training imparted	Resource person	Date and place
34.	Field day	A.R.Panda	06.03.13 at Mahadevapuram
35.	Field Day	Dr. Y. Subbaiah	15.03.2013 at Katavaram village
36.	Meeting on "Development Activities in FCV tobacco cultivation in AP & Karnataka"	Dr. Y. Subbaiah P. Venkateswarlu	28-3-2013 at 2.00 PM at Tobacco Board, Guntur
37.	3rd phase training programme on "Topping & de-suckering, harvesting & curing, grading & PHPM" in NLS & NBS areas	Dr. Y. Subbaiah Dr. S.V. Krishna Reddy	13.02.2013 at Thorredu
38.	3rd phase training programme on "Topping & de-suckering, harvesting & curing, grading & PHPM" in NLS & NBS areas	Dr.K. Nageswara Rao Dr. S. Kasturi Krishna	07.02.2013 at Devarapalli
39.	3rd phase training programme on "Topping & de-suckering, harvesting & curing, grading & PHPM" in NLS & NBS areas	Dr. Y. Subbaiah Dr. M. Anuradha	12.02.2013 at J.R. Gudem – I
40.	3rd phase training programme on "Topping & de-suckering, harvesting & curing, grading & PHPM" in NLS & NBS areas	Dr. K. Nageswara Rao Dr. S. Kasturi Krishna	06.02.2013 at J.R. Gudem – II
41.	3rd phase training programme on "Topping & de-suckering, harvesting & curing, grading & PHPM" in NLS & NBS areas	Dr. K. Nageswara Rao Dr. S.V. Krishna Reddy	08.02.2013 at Koyyalagudem
42.	3rd phase training programme on "Topping & de-suckering, harvesting & curing, grading & PHPM" in NLS & NBS areas	Dr. K. Siva Raju Dr. M. Anuradha	11.02.2013 at Gopalapuram

Diagnostic Visits

Areas visited	Resource person	Date and places
Burley tobacco growing areas in Jaggampeta mandal	Dr. S. Kasturi Krishna Dr. K. SumanKalyani Sri. S. Jitendranath Sri. P.E. Jemmy	06.09.2012 Narendrapatnam, Kandregula, J. Kothuru, Manyamvaripalem
Burley tobacco growing areas in Rajanagaram mandal	Dr. S. Kasturi Krishna Dr. K. SumanKalyani Sri. S. Jitendranath Sri. P.E. Jemmy	17.09.2012 Gadarada and Seetharamapuram
Visit to FCV tobacco nurseries and planted crop to ascertain the damage caused by Neelam Cyclone	Dr. Y. Subbaiah Smt. N. Aruna Kumari	05.11.2012 FCV tobacco growing areas viz. Chityala, Peddapuram, Vellachintalgudem, Gopalapuram, Vadalagunta and Chinnayigudem

MONITORING TEAM VISITS

- The Project Monitoring and evaluation Team visited CTRI RS, Guntur and AINRPT Centre, Nandyal and farmers fields during 4-7 Jan., 2013.
- The Project Monitoring & Evaluation Team visited CTRI RS, Hunsur and AINRPT, Shimoga during 20-24 September, 2012 to monitor the progress of research work being carried out under the Institute and AINRPT projects and also to survey the FCV tobacco growing areas in KLS.
- CTRI Scientists including the officials of Tobacco Board visited the Neelam cyclone affected areas during 1-5 November, 2012 to asses the crop situation and to suggest remedial measures.
- The Project Monitoring and evaluation Team of CTRI visited CTRI RS, Dinhata during 3-5 April, 2012.

Radio Talks

S.No.	Name	Topic, Date of broadcast & Station
1.	Smt. J.V.R. Satyavani	Utilization of cashew apple and value addition (AIR, Vijayawada, 1.4.12)
2.	Dr. P.V.V.S. Siva Rao	Cultivation of fodders for high milk yield (AIR, Vijayawada, 13.4.12)
3.	Dr. C. Chandrasekhararao	KVK programmes for farming community (AIR, Vijayawada, 17.4.12)

S.No.	Name	Topic, Date of broadcast & Station
4.	E. Vijayaprasad	Integrated pest management in pulses (AIR, Vijayawada, 25.4.12)
5.	Dr. C. Chandrasekhararao	Income generation programmes through KVK to rural women (AIR, Vijayawada, 10.5.12)
6.	Smt. V.V. Lakshmikumari	Importance of nutritional balanced food to prevent of anemia in rural women (AIR, Visakhapatnam, 17.5.12)
7.	R. Sudhakar	Cup and plate making with bamboo waste (AIR, Visakhapatnam, 31.5.12)
8.	Dr. B. Johnbabu	Rearing of turkey birds (AIR, Visakhapatnam, 29.6.12)
9.	Dr.K.C.Chenchaiah	Pest and disease management in tobacco nursery (All India Radio, Vijayawada on 02.07.12)
10.	S. Jitendranath	Paddy cultivation with 'Drum seeder' (AIR, Vijayawada, 6.7.12)
11.	Dr. B. Johnbabu	Rearing of turkey birds (AIR, Vijayawada, 15.7.12)
12.	Dr. P.V.Venugopala Rao	FCV tobacco varieties suitable for NLS and black cotton soils (AIR, Vijayawada, 15.8.12)
13.	Dr.L.K.Prasad	*Fertiliser management in FCV tobacco cultivation (*All India Radio, Vijayawada on 14.09.2012)
14.	Smt. V.V. Lakshmikumari	Nutritional and personal hygiene during adolescence (AIR, Vijayawada, 16.9.12)
15.	Dr. P.V.V.S. Siva Rao	Important tips in calves rearing (AIR, Visakhapatnam, 18.9.12)
16.	Dr.K.C.Chenchaiah	Sucking pest control in Tobacco (All India Radio, Vijayawada on 27.09.12)
17.	E. Vijayaprasad	Plant protection measures in maize cultivation (AIR, Visakhapatnam, 28.9.12)
18.	S. Jitendranath	Modern agricultural implements in reducing the labour cost (AIR, Vijayawada, 1.11.12)
19.	S. Jitendranath	Modern agricultural implements in reducing the labour cost (AIR, Visakhapatnam, 7.12.12)
20.	Smt. V.V. Lakshmikumari	Minor millets- nutritive values (AIR, Visakhapatnam, 13.12.12)

S.No.	Name	Topic, Date of broadcast & Station
21.	E. Vijayaprasad	Integrated pest management in pulses (AIR, Visakhapatnam, 15.12.12)
22.	R. Sudhakar	Women empowerment programmes for rural women through KVK(AIR, Visakhapatnam, 20.12.12)
23.	Dr. V.S.G.R. Naidu	Importance of Parthenium control (AIR, Visakhapatnam, 19.12.12)
24.	Dr. P.V.V.S. Siva Rao	Importance of fodder grass in dairy farm management (AIR, Visakhapatnam, 26.12.12)
25.	E. Vijayaprasad	Integrated pest management in pulses for higher yields (AIR, Visakhapatnam, 28.12.12)
26.	Dr. V.S.G.R. Naidu	Orobanche weed – controlling measures (AIR, Vijayawada, 23.2.13)
27.	Smt. V.V. Lakshmikumari	Role of fruits, vegetables & leafy vegetables in prevention of nutritional deficiencies (AIR, Visakhapatnam, 24.2.13)
28.	Dr. P.V.V.S. Siva Rao	Cultivation of fodders for high milk yield (AIR, Vijayawada, 28.2.13)
29.	Dr. B. Johnbabu	Important tips in sheep rearing(AIR, Visakhapatnam,
30.	S. Jitendaranath	Maize cultivation in zero tillage method after rice (AIR, Vijayawada, 9.3.13)

Krishi Vigyan Kendra, Kalavacharla

The Krishi Vigyan Kendra of CTRI working under the aegis of Indian Council of Agricultural Research, New Delhi has disseminated proven scientific technologies related to agriculture and allied sectors including off-farm income generating activities in the East Godavari district of Andhra Pradesh. The KVK's approach to the technology transfer and sensitizing farming community on various farm related activities is through conducting/ organizing on-farm testing and front line demonstrations, training programmes, exposure visits, meeings, workshops helath camps etc. The salient achievements and other activities of KVK during the period under report are enlisted below

On-Farm Testings & Frontline Demonstrations:

- A total number of 17 On-Farm Testings (OFTs) and 23 Front-line Demonstrations (FLDs) were conducted.
- Rice variety JGL-11470 and Mugad SIRI-1253 recorded 20% and 42% higher yields respectively over local check BPT-5204
- Direct seeding in rice through drum seeder reduced the crop duration by 10 days and an amount of ₹ 11,625/- per/ha was saved in labour cost.
- In sugar cane, use of single budded chips as seed material recorded yield improvement by 29% and also reduced the cost of cultivation by 28,000/-/ha over the regular practice of set planting.
- Trelly method of tomato cultivation increased yields (35t/ha) with benefit: cost ratio of 1:2.6 compared to the farmers practice (26.25 t/ha) with a B: C ratio of 1:2.2.
- Capsicum variety "Arka Mohini" recorded yield of 8.2 t/ha with a B:C ratio of 2.95
- China Astar 'Kamini' variety performed well (6.5 t/ha) compared to other varieties and chrysanthemum (6.2 t/ha).
- Small size tubers (< 500 gm) as seed material in Elephant Foot Yam resulted in yield increase (66 t/ha) with 1:3.1 B:C ratio compared to farmers practice with (63.75 t/ha) and 1:3.1.
- Viral disease management in Papaya and Banana increased the yields by 45% and 32% respectively over check.
- Supplementation of poultry feed with Azolla (10%) reduced the feed cost by ₹ 2/kg feed.
- Jodipi sheep were introduced in the local flocks.
- De-worming in lambs reduced the mortality by 10%.

Vocational Training Programmes:

- Training programme on 'First aid to milch animals' was conducted during 7-27th June, 2012 to 28 rural youth in Konaseema area of East Godavari (Dist.) in collaboration with NABARD (Kamadhenu Milk Federation).
- Conducted various vocational training programmes on livelihood opportunities to rural women.

Garment making

- Training on Coir Yarn, Mesta and leaf plate/ cup making was organized by deputing Master trainers to different places

Training on leaf plate making

- Organized 'Parthenium Awareness Camp' to school children on 3rd October, 2012 at KVK, Kalavacharla.

Collaborative Programmes with Line Departments:

- In collaboration with ATMA, East Godavari, seven 'Capacity Building' training programmes on Zero Tillage In Maize, Rabi Vegetables-Cultivation Practices, Papaya Cultivation Practices, Fodder Production Technologies, Selection of Cattle Breeds for Milk Production, Value Addition to Fruits and Vegetables, Agro Based Income Generation Activities for Empowerment of Rural Women were organized.

- In collaboration with ATMA, organized training programmes on 'Direct seeding through drum seeder in Rice' at Amalapuram (01-11-2012) and Rajahmundry (11-12-2012).

- Two days training programme on 'Cashew Apple Utilization and Value Addition' was organized to the rural unemployed women at KVK, Kalavacharla on 14th -15th May, 2012, in collaboration with DCCD, Cochin.

- Animal Health Camps were conducted in collaboration with Andhra Bank institute of Rural Development (ABIRD), Rajahmundry

- Mass rodent management programme was conducted in East Gonagudem and Kalavacharla villages on 18th August 2012 in collaboration with State Department of Agriculture, Rajahmundry

- National Institute of Food Technology Enterprenuship and Management (NIFTEM), New Delhi (Ministry of Food Processing and Industries, Govt. of India), has implemented through KVK, Kalavacharla, a village development programme by adopting the Kalavacharla village. As a part of the academic programme, nine students and Mentor have carried this programme in association with KVK during 29.3.2012 to 03.11.2012 and 11.3.2013 to 16.03.2013.

- KVK in collaboration with NIFTEM, New Delhi and Agri-Biotech Foundation, Hyderabad has organized 4 days 'Awareness Campaign' on sanitation & health, education, food processing and renewable energy at KVK, Kalavacharla from 12.03.2013 to 15.03.2013.

Nutritional awareness workshop

'Kisan Mela' followed by 'Technology Week':

- Organized 'Kisan Mela' followed by 'Technology Week' with the financial support of ATMA-East Godavari during 01-03-2013 to 05-03-2013 with different themes and popularized improved production technologies on various crops. A total number of 1050 farmers/farm women/tribal youth from different mandals participated in the programme.

Exposure Visits:

- KVK organized 'Cashew Exposure Visit 2012' to Bhubaneswar, Orissa in collaboration with Directorate of Cashewnut and Cocoa Development, Cochin. Tribal farmers (50 nos.) from traditional cashew growing area of Vizianagaram were exposed to Cashew nurseries and Processing Units of Bhubaneswar from 21st – 27th March, 2013.

Exposure visit to tribal farmers

District level seminar on Cocoa

- KVK organized exposure visit of 20 rural women to participate in the Regional Research Extension Meet for Rural Empowerment' at BCT KVK, Yelamanchili on 9th November, 2012.

Meetings / Seminars / Workshops:

- Scientific Advisory Committee (SAC) meeting was conducted for Rabi 2012 on 16-08-2012.
- District-level seminar on Cashew was organized in collaboration with Directorate of Cashewnut and Cocoa development (DCCD), Cochin on 30-10-2012 at KVK, Kalavacharla.

District level seminar on Cashew

- District-level Seminar on Cocoa was organized in collaboration with Directorate of Cashewnut and Cocoa development (DCCD), Cochin at Sri Kothapalli Srimahavishnu's cocoa field at Madiki, Alamuru Mandal on 30.11.2012.
- Research-Extension-Farmers interface meeting was conducted on "Cattle Breeding Policy" at CTRI on 05-01-2013. Thirty scientists, extension functionaries and farmers were participated.
- Organized 'World Food Day'(16-10-2012) and 'Women in Agriculture Day' (04-12-2012) at KVK, Kalavacharla. One hundred and fifty farm women have participated. Fruit and vegetable seedlings were distributed to participants.

Distribution of seedlings on the occasion of World Food Day

Exhibition:

- KVK Exhibition stall won 'Best Practices in Agriculture' award in National Convention – The Next Frontier of Agri Business and Technology' held at Gandhinagar, Gujarat organized by C.I.I., New Delhi from 3rd-5th September, 2012.

Health Camps:

- Organized 'Animal Health Camp' on 29th July, 2012 at Vadisaleru village.

- Organized Medical Camp on Dental, Eye and General Health at KVK, Kalavacharla on 16.3.2013 in collaboration with 'Srujana' Lions Club, Rajahmundry.

Seed & Seedlings/ Others:

- Produced and supplied 64 quintals of rice seed and 7.5 t of fooder slaps to needy farmers
- Produced and supplied 11 tonnes of Sugar cane seed material to farmers
- A total number of 6,650 mango grafts and 8,200 cashew grafts were prepared supplied to needy farmers
- Supplied 5870 fertile eggs of poultry, turkey and quail to popularize back yard poultry in the district.
- A total no. of 13 Banana Fibre Extraction machines were supplied to different entrepreneurs
- Provided mobile advisory services to farmers and others on various agricultural and allied aspects.
- Thirteen T.V shows telecasted & 16 radio talks were broadcasted.

Publications:

- Technical Bulletin in telugu entitled 'Grafting Methods in Cashew and Other Horticultural Crops' by J.V.R.Satyavani, Dr.V.S.G.R. Naidu and Dr.T.G.K.Murthy was released on the occasion of 'District level Seminar on Cashew' held at KVK, Kalavacharla on 30.10.2012.
- Technical Bulletin in telugu entitled 'Cocoa Cultivation – Scientific Management Practices' by J.V.R.Satyavani, Dr.V.S.G.R. Naidu and Dr.T.G.K.Murthy was released on the occasion of 'District level Seminar on Cocoa' held at Madiki village, Alamuru Mandal on 30.11.2012.
- KVK released technical bulletin in telugu entitled 'Technologies for Better Farming' in Agriculture' by Dr.V.S.G.R. Naidu and Dr.T.G.K.Murthy during 'Kisan Mela' - 'Technology Week' held at KVK, Kalavacharla during March 2013.
- A leaflet in Telugu on 'Parthenium Weed Management' by Dr. V.S.G.R. Naidu and S.Jitendranath was published during 2012.
- Leaflet in Telugu entitled 'Rodent Control in Rice' by Dr.V.S.G.R. Naidu and S. Jitendranath was published during 2012.

Popular Articles:

- 'Rice cultivation through drum seeder' by S.Jitendranath, V.S.G.R. Naidu and T.G.K.Murthy in 'Vyavasaya Padipantalu' during August 2012, Pp:16-18.
- 'Ecofriendly cups from Bamboo' by R.Sudhakar, Dr.C.Chandrasekhararao and Dr.T.G.K.Murthy was published in ICAR News Letter (July-September 2012).

Krishi Vigyan Kendra, Kandukur

Renovated the allotted KVK Buildings and started the KVK on 21st June, 2012 in the premises of CTRI RS, Kandukur. Adopted Ooguru, Mahadevapuram and Machavaram villages. Identified and prioritized the problems and interventions for the adopted villages through participatory rural appraisal technique. Conducted 3 diagnostic visits, 8 training programmes, 1 OFT(YMV resistant black gram cultivar:PU-31), 1 FLD (PKM-1) and 1 vocational training activity (value addition to minor millets) in the KVK adopted villages. Procured a new tractor and farm implements worth of Rs 7 lakhs.

Awards and Recognitions

- Dr.L.K.Prasad, Sr.scientist received best trainee award of the ICAR sponsored 10 days short course on *Use of simulation modeling in climate change research: special reference to natural resource management* at IISS, Bhopal.
- CTRI-KVK Exhibition stall won 'Best Practices in Agriculture' award at National Convention – The Next Frontier of Agri Business and Technology' held at Gandhinagar, Gujarat organized by C.I.I., New Delhi from 3rd-5th September, 2012.
- Dr. H. Ravi Sankar is nominated as Editorial Board Member: International Journal on Advanced Computer Engineering and Communication Technology, India and International Journal of Research in Electronics & Communication Engineering, India.
- CTRI RS, Dinhata received the best stall award /prize in Krishi Mela and Exhibition of Stalls organized by State Agriculture dept. of West Bengal at Sitai Block under Dinhata sub-division of Cooch Behar District on 20th January, 2013.

Best Practices in Agriculture award to KVK

CTRI-KVK exhibition stall at CII, New Delhi

Linkages and Collaborations

CTRI has developed strong linkages with various organisations at regional, national and international level. At regional level, linkage between CTRI and various state government departments and Agricultural Universities in Andhra Pradesh, Tamil Nadu, Karnataka, Bihar, Gujarat and West Bengal was established to provide an effective thrust to Indian tobacco development. Central organisations like Tobacco Board, 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 NBPGR, New Delhi, CIAE, Bhopal and PDBC, Bangalore.

Sl. No.	Name of the Collaborating Agency	Project title/Activity
a) National Institutes/Agricultural Universities		
1.	Ministry of Health & Family Welfare, Govt. of India, New Delhi	Pilot project on "Alternative crops to *Bidi* and Chewing tobacco in different AESRs in the country"
2.	Bureau of Indian Standards, New Delhi	Development of Indian standards for tobacco and tobacco products
3.	Department of Biotechnology, New Delhi	Empowerment of tribals through agro-ecological conservation and bio-technological approaches in East Godavari district of Andhra Pradesh
4.	Tobacco Board, Guntur	Field Friends Programmes and on-farm trials for improving yield and quality of FCV tobacco in different zones
5.	National Bureau of Plant Genetic Resources, New Delhi	National Active Germplasm Site (NAGS)
6.	Directorate of Oil Palm Research, Pedavegi	Production technology for oil palm and intercropping of FCV tobacco in oil palm
7.	Department of Agriculture in different states	Transfer of technology in non-FCV types and supply of inputs
8.	Indian Meteorology Dept., Pune	Maintenance of meteorological observatories at different Stations
9.	M/s ITC Ltd. ABD-ILTD M/s. Godfrey Phillips India Ltd., M/s. VST Industries Ltd. and ITA, Guntur	Research and development activities, organising training programmes, field trials on latest packages, variety release proposals, manufacturing tests and storage tests
10.	PDBC, Bangalore	Coordinated trials in Biological control
(b) International Institutions		
1.	ISO-TC126, Berlin, Germany	Development of international standards for tobacco and tobacco products

All India Network Research Project on Tobacco

VII Group Meeting: The VII Group Meeting of AINRP(T) was held at CTRI, Rajahmundry on 8th & 9th July, 2012. All the scientists from various AINRPT centres and other delegates from all over India participated and presented the research results of 2011-12 and finalized the technical programme for 2012-13.

Varieties Released: FCH-222 (FCV – Hunsur) and VDH 3 (Chewing hybrid - Vedasandur) and Thungabhadra (Oriental – CTRI & VST).

Research Highlights: The most promising lines identified in Co-ordinated varietal trials conducted at different Centres were as follows:

INITIAL VARIETAL TRIALS

Centre	Promising line(s)
FCV tobacco	
Guntur	FCG 1, FCR 1, FCR 4 and FCR 7
Kandukur	FCKH-1, FCR-2 and FCG-3
Hunsur	FCR-4, FCJ-1 and FCJ-3
Jeelugumilli	FCJ-1, FCJ-4 and FCR-5
Rajahmundry	FCR-4, FCR-1, FCR-3, FCG-1 and FCR-2
Shimoga	FCR-1, FCJ-1 and FCJ-4
Bidi **tobacco**	
Anand	ABD 123, ABD 124, ABD 125, ABD 126, ABD 127 & ABD 128
Araul	ArBD-06, ArBD-07 and ABD-128
Nandyal	ABD 121, ABD 120 & ABD 123
***Rustica* tobacco**	
Anand	AR 106
Araul	ArR-27, ArR-26 and ArR-25
Ladol	AR 106

ADVANCED VARIETAL TRIALS

Centre	Promising line(s)
FCV tobacco	
Guntur	TBST-17
Kandukur	TBST-17, TOBIOS-4 and NLST-3 & HYBRID: SH 1
Hunsur	FCH-196, FCH-196 & HYBRIDS: KLSH 10, CH-96
Jeelugumilli	NLST-6, TOBIOS-7 and NLST-3
Rajahmundry	V-4278, TBST-2B, TBST-11 and V-4344
Shimoga	Tobios-6
Bidi **tobacco**	
Anand	ABD 115, ABD 116, ABD117, ABD 118, ABD 119, ABD 120 & ABD 122
Araul	SB-154, ArBD-04 and ABD-120
Nandyal	ABD 117 and ABD 115
***Rustica* tobacco**	
Anand	LR 65 and LR 64
Araul	SK-413, LR-64, ArR-24 and LR-68
Ladol	LR 58, R 101 and LR 65
***Chewing* tobacco**	
Dinhata	DJ 1

Centre-wise research achievements are presented below:

ANAND

- Topping at 21 and 24 leaves produced significantly higher yield than topping at 18 leaves. Nicotine content was higher at 200 and 220 kg N/ha than 180 kg N/ha.

- Use of 90 % green net was found to record high seed germination.
- The highest seed yield (1000 kg/ha) and oil content (38.60 %) were recorded with genotype 13-50-13-15, whereas the highest *khakhari* yield (2964 kg/ha) was recorded with genotype 60-29-40-14.
- The genotype 130-2-11-31-9 recorded highest green leaf yield at 90 days after transplanting, while highest protein yield (480 kg/ha) was recorded with genotype ABD 101.
- Hybrid variety MRGTH 1 applied with 260 kg N/ha recorded significantly higher green leaf yield, protein and nicotine yields at 90 days after transplanting.
- Studies on evaluation of different IPM modules for the management of *S. litura* and *H. armigera* revealed that module-II having castor and marigold trap crop and one spray of NSKS 2% reduced *S. litura* incidence up to 42%.
- Spray drench of the fungicide azoxystrobin @ 0.023% significantly reduced damping-off. It was at par with metalaxyl MZ. Azoxystrobin yielded significantly higher number of transplantable and total surviving seedlings compared to control.

BERHAMPUR

- Among seven genotypes of pikka tobacco tested, line 62-90 produced highest cured leaf yield (1311 kg/ha) which is 10% higher yield over the check variety 'Gajapati'.
- Pooled data of two years (2010-12), indicated planting on 1st August with a spacing of 75 x 50 cm recorded highest mean cured leaf yield (1375 kg/ha) and B: C ratio (1.91).
- Pooled data of two years (2010-2011) indicated 80-40-60 N P K kg/ha has the highest B: C ratio of 1.9.

NANDYAL

- Among the different crops tried as Alternative cropping system for *Bidi* tobacco growing areas, Fallow-Tobacco has recorded significantly higher net returns of ₹ 55,370/- per ha. With B.C. ratio of 2.21 followed by sole crop of Maize with net returns of ₹ 38,686/- per ha with B.C. ratio of 3.09.
- Significantly higher plant height (71.91 cm), leaf length (44.50cm)leaf width (18.82 cm) and cured leaf yield (2165 kg/ha) was recorded under the treatment of transplanting of Tobacco during second week of September. The 45 days old seedlings transplanted during second week of September recorded higher cured leaf yield (2217 kg/ha).
- Application of 150 kgN/ha and topping at 15 leaf stage recorded significantly higher leaf length, leaf width (20.56 cm) and cured leaf yield (2106 kg/ha). Significantly higher specific leaf weight (0.0364) was recorded under lower topping levels (12 leaves stage).
- New insecticides Rynaxypyr, Novaluran and Emamectin benzoate could effectively control *Spodoptera litura* infestation in *bidi* tobacco.

NIPANI

- Use of poultry manure as on alternate source of organic matter in various proporations and combinations along with inorganic fertilizers in nursery increased the number of healthy, transplantable seedlings.
- Vegetables (Bhendi, Radish, Cabbage, Cucumber) grown along with tobacco as intercrops recorded maximum yield but suppressed the growth and yield of tobacco drastically, whereas tobacco growth along with cluster bean, chilli, peas, garlic and onion was normal.

SHIMOGA

- Using an integrated barn comprising ventury furnace and modified flue pipe system, fuel use efficiency of 4.18 kg wood per kg of leaf was achieved.

- Coffee husk (30 kg) + areca husk (560 kg) + maize rinds (736 kg) were used successfully in place of wood for curing FCV tobacco.
- Out of 34 entries screened against frog eye leaf spot disease, Tobios – 6 and NLST – 6 were found resistant, while other FCV tobacco entries expressed moderate resistance.
- Among the 25 germplasm and advanced breeding lines screened against root-knot nematode, FCG-3 recorded least root-knot index (2.0).
- The treatment combination of *Paceliomyces* and poultry manure gave maximum transplants (662) with least root-knot index, closely followed by combination of *Trichoderma harzianum* and poultry manure.
- New chemical molecules such as emamectin benzoate, spinosad and novaluron were found promising for the control of larval number, leaf damage and per cent infestation of *Spodoptera litura* in chewing tobacco.
- Spot application of well decomposed poultry manure at 50 g/plant, 4 inches away from the plant at the time of planting was found effective for management of root knot nematode in FCV tobacco main field.
- For effective management of black shank disease of tobacco in field, application 2.5 kg *Trichoderma harizianum* along with 4.5 tonnes of farm yard manure before transplanting @ 250 g/plant was found promising.

VII Group Meeting of AINRP(T) held at CTRI, Rajahmundry on 8th & 9th July, 2012

Empowerment of Women in Agriculture

Women Empowerment Programmes

An externally funded project entitled 'Nutritional Security in Tribal Areas of East Godavari District, Andhra Pradesh through Community Based Approaches' with an outlay of ₹ 33.98 lakhs was sanctioned by the Department of Bio-technology, New Delhi for a period of three years (2012-2015). The project was initiated at CTRI from January, 2013 onwards. This project covers various women empowerment programmes helping the social, economic, cultural and technological upliftment of farm women. Socio-economic survey was carried out by using PRA techniques, health and nutritional problems were identified, solutions were sorted out and various strategies for women empowerment were proposed.

Rural women participating in Women Empowerment Programmes

1. Income generation through dairy unit: An improved variety of male buffalo was introduced in the tribal areas under an externally funded project, entitled 'Empowerment of Tribals of East Godavari District' sponsored by the Department of Bio-technology, New Delhi (2009-12). In interior tribal areas, lack of artificial insemination facilities, lack of awareness, lack of storage facilities of semen (cattle breeds), lack of technical expertise, location of tribal hamlets far from the insemination centers, has created an urge to introduce a male buffalo in the tribal area. By recognizing the importance, the investigators of the project have introduced this improved variety. Due to this activity, about 40 calves of murrah breed were born in the adopted villages and surrounding hamlets. The tribal families were benefitted by improving their family income of ₹ 5000/- per month per family both by purchase and consumption of the milk. The AP co-operative dairy society of Chekka Nimmalapalem village, Addategala Mandal got benefitted by introducing this buffalo in their dairy unit. Thirty percent (20) of the total buffalo population (60) in this dairy were conceived. Thus, the Murrah buffalo has created a success story in the tribal areas of the East Godavari District.

Income generation through dairy unit

2. Income generation through kitchen gardening: Improved varieties of dolichus(Arka vijay-IIHR), tomato, chilies, brinjal, bendi, ridge gourd, bottle gourd, bitter gourd, palak, amaranthus, methi, coriander, spinach, banana suckers (K.C.Keli, T.C.Keli), guava(A.safeda), papaya (Taiwan), moringa, coconut (ganga bondam) were supplied after imparting training on kitchen gardening. The trained women have established their back yard nutritional kitchen gardens are now earning an amount of ₹ 6000/- to ₹ 7000/- per annum. The health and nutritional status of tribal families was improved after introduction improved varieties.

3. Awareness programmes: Awareness programmes were conducted on identification of mal-nutrition (Kwashiorkar & Marasmus) in children, anemia in adolescents, personal hygiene-environmental sanitation, child care practices, communicable diseases, water and vector borne diseases, reproductive health, importance of Vitamins (A,B,C,D,E,K) and

minerals in adopted villages of Rampachodavaram and Maredumilli mandals.

Awareness programme on mal-nutrition

4. Nutrition and health education: Various training, awareness and skill oriented programmes were undertaken while imparting health and nutrition education to the tribal farm women. Training programmes and demonstrations were conducted in the areas of supplementary diets with locally available foods (22.11.2012), child rearing practices & health care and management (27.11.2012), demonstration on weaning foods for combating malnutrition (18.12.2012), preparation of balanced diets and menu planning with locally available food materials (05.01.2013), introduction of new paddy varieties in agency area (10.01.2013), communicable diseases & water borne diseases and their preventive measures in agency area (13.02.2013), backyard nutritional kitchen gardening in tribal hamlets & ashram schools (16.02.2013) etc. About 200 tribal farm women were actively participated & trained in the above aspects.

5. Value addition to MFP (Minor Forest Produce): Long Duration skill oriented training programmes were organized on Adda leaf plate making and hillbroom making in Devarapalli village in the month of February, 2013. Technical backup and marketing assistance was provided through A.P. tourism department for the established homestead units previously. The women were now earning an amount of ₹ 4000-5000/- per month by selling the adda leaf plates to the A.P. tourism resorts.

Skill oriented training programmes on 'Adda leaf plate making'

Workshop on Nutritional Awareness (Women Empowerment Programme)

Three day workshop on nutritional awareness was organized at Devarapalli, Maredumilli mandal, East Godavari District from 07.03.2013 to 9.03.2013. In this programme, a total of 200 tribal farm women, tribal youth and farmers participated and were trained in various aspects. Training was imparted on supplementary diets for children, precaution to be taken during pregnancy and lactation, vitamin and mineral deficiency disorders and diseases, protein energy malnutrition (PEM), communicable diseases and preventive measures, kitchen gardening, cattle and poultry management etc. Method demonstrations were also conducted on soya milk & paneer preparation, millet based bakery food products, supplementary weaning foods, vegetable and fruit preservation techniques. Officers from Integrated Child Development Services (ICDS), state department officials, scientists of CTRI and KVK were involved in the training. International women's day was also celebrated on 08.03.2013 with the theme of 'Women empowerment'. In this connection, quiz competitions were conducted, prizes & certificates were awarded for tribal participants and feedback was recorded from the respondents.

Training Programmes conducted by KVK

- Two weeks duration off-campus vocational training programme on Incense stick making was conducted to 15 tribal people of Sunnampadu village of Maredumilli Mandal, sponsored by ABIRD, Rajahmundry during 16 – 25th April, 2012.
- One week duration off-campus vocational training programme on Coir2-ply Yarn making over automatic machinery was conducted to 29 rural women of Munganda village, sponsored by ABIRD, Rajahmundry during 7 – 13th May, 2012.

- One week duration off-campus vocational training programme on Sisal Fibre Extraction and Products making was conducted to 22 rural women of Kotturu village of Srikakual Dist., sponsored by Forum for Integrated development, Hyderabad during 4 – 11th June, 2012.

- Two months duration off-campus vocational training programme on Skill upgradation in Garment making was conducted at K.Surampalem village for 30 Rural women during 15th June - 14th August, 2012.

- Two weeks duration off-campus vocational training programme on Paper cups making was conducted to 24 SC rural women of Timmapuram village, sponsored by ABIRD, Rajahmundry during 27th June- 06th July, 2012.

- One week off-campus training programme on paper plates and cup making for 20 rural women was conducted at Timmapuram village sponsored by ABIRD, Rajahmundry during 9 – 15th July, 2012.

- One week off-campus training programme on paper plates and cup making for 20 rural women was conducted at Nemani village sponsored by ABIRD, Rajahmundry during 29th August - 4th September 2012.

- One week duration off-campus vocational training programme on Paper Plate making was conducted to 20 farm women from Nemani village sponsored by ABIRD, Rajahmundry during 1 - 5th September, 2012.

- Two months duration vocational training programme on Skill upgradation in Garment making was conducted at K.Surampalem village for 36 Farm women during 11th September - 10th November, 2012.

- Two weeks duration off-campus vocational training programme on Coir Door mat making was conducted to 20 farm women from Korangi village under UNDT project sponsored by Forest Department during 12 - 25th September, 2012.

- Two weeks duration off-campus vocational training programme on Coir Yarn making was conducted to 20 rural youth of Yanam village, Sponsored by Nehru Yuvak Kendra during 10 - 24th December, 2012.

- One month duration off-campus vocational training programme on Banana Fibre Extraction and products making was conducted to 25 rural youth of Visakhapatnam, Sponsored by GAMANA voluntary organisations during 10th December - 09th January, 2013.

- One week duration off-campus vocational training programme on Mestha Fibre Products making was conducted to 20 rural women of Srikakual Dist., sponsored by Forum for Integrated development, Hyderabad during 19th – 26th January, 2013.

- One month duration off-campus vocational training programme on Banana Fibre Extraction and products making was conducted to 25 rural youth of Visakhapatnam, Sponsored by GAMANA voluntary organizations during 21st January- 20th February, 2013.

- Two months duration off-campus vocational training programme on Maggam Embroidery was conducted to 25 rural youth of Narendrapuram during 21st January - 20th March, 2013.

- One week duration off-campus vocational training programme on Mestha Fibre Products making was conducted to 20 rural women of Srikakual Dist., sponsored by Forum for Integrated Development, Hyderabad during 11th – 19th February, 2013.

- Five day duration on-campus training programme on Value Addition to Fish, Prawn and Meat was conducted to 25 rural youths of kalavacharla village during 25th- 29th March, 2013.

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List of Approved On-going Projects

Sl. No	Institute Code	Title of the project and Investigator(s)
CROP IMPROVEMENT		
1.	G.S.1:	Germplasm acquisition maintenance, multiplication, evaluation and utilization T.G.K. Murthy
2.	Br.6.1.4(a):	Incorporation of disease resistance for tobacco mosaic virus (TMV) Dr. P.V. Venugopala Rao, Dr. S.K. Dam
3.	Cy.7(iii) :	Tissue culture studies in tobacco (III) Micropropagation of elite lines and other selections. Dr. K. Sarala, Dr. K. Prabhakar Rao
4.	Br.2 :	Evolving superior varieties of FCV tobacco through hybridization Dr. P.V. Venugopala Rao
5.	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. U. Sreedhar, Dr. K. Siva Raju
6.	Br.7 :	Developing hybrid FCV tobacco suitable for traditional black soil area of Andhra Pradesh Dr. T.G.K. Murthy, Dr. P.V. Venugopala Rao, Dr. K. Sarala
7.	MB-9 :	Evaluation of advanced breeding lines for yield and quality Dr. K. Sarala, Dr. T.G.K. Murthy, Dr. P.V. Venugopala Rao and Dr S.K. Dam
8.	Biotech-6 :	Molecular Mapping of tobacco traits: Tobacco specific nitrosamines in burley Dr. K. Sarala, Dr K. Prabhakara Rao, Dr. T.G.K. Murthy, Dr. R.K. Ghosh, Dr. K. Siva Raju and Dr. P.V. Venugopala Rao
9.	Biotech 9:	Transcript profiling and identification of candidate genes resistant to Damping-off in tobacco Dr. K. Prabhakara Rao, Dr. K. Sarala, Dr. T.G.K. Murthy, Dr. S.K. Dam and Dr. K. Siva Raju
CROP PRODUCTION		
1.	A-78	Effect of *Rabi* crops on the emergence of Orobanche. Dr.S. Kasturi Krishna, Dr.S.V. Krishna Reddy and Dr. S.K. Dam
2.	A-80	Investigations on Coirpith utilization in tobacco production Dr. C. Chandrasekhararao and Dr. K.Siva Raju

Sl. No	Institute Code	Title of the project and Investigator(s)
3.	A-82	Effect of spacing and nitrogen on yield and quality of ABL TBST-2 Dr.S.V. Krishna Reddy, Dr. S. Kasturi Krishna and Dr.T.G.K. Murthy
AGRL. EXTN., AGRL. ENGG. & ARIS CELL		
1.	Ag. Extn. 36	Stress analysis of tobacco farmers and changing scenario of the cropping pattern Dr. K. Suman Kalyani
2.	Ag. Engg.8	Designing and testing of tobacco bale pressing and packing machine Dr. C. Chandrasekhararao, Dr. Kasturi Krishna and N.D. Suresh
3.	Ag. Extn. 48	Critical analysis of resource Utilization by the FCV tobacco farmers Dr. Y. Subbaiah
4.	Ag. Extn-49	On- farm demonstration of identified alternative Crops to FCV tobacco in vertisols of Andhra Pradesh. Dr. Y. Subbaiah and Dr. S. Kasturi Krishna
5.	Ag. Extn-50	On-farm evaluation of identified ABLs in NLS area of Andhra Pradesh Dr. Y. Subbaiah, Dr. T.G.K. Murthy and Dr. K. Sarala
ARIS		
1.	ARIS-12	Decision support system for transfer of technology Dr. H. Ravi Sankar and Dr. Y.Subbaiah
2.	ARIS-13	Computational Algorithm for micro RNA prediction in plants Dr. H. Ravi Sankar, Dr.K Prabhakara Rao, Dr. K. Siva Raju and Dr. K. Sarala
3.	ARIS 14	Expert system for dairy cattle management Dr. Ravi Sankar and Dr VSGR Naidu
CROP CHEMISTRY AND SOIL SCIENCE		
1.	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. C. Chandrasekhararao
2.	OC-10	Evaluation of smoke constituents in materials from some plant breeding experiments. Dr. R.K. Ghosh
3.	PR-1	Monitoring of pesticide residues in tobacco samples collected from different areas Dr. R.K. Ghosh

Sl. No	Institute Code	Title of the project and Investigator(s)
4.	BC-8	Electrophoretic characterization of tobacco cultivers Dr. K. Siva Raju and Dr T.G.K. Murthy
5.	BC-11	Biochemical characterization of tobacco seed oil Dr. K. Siva Raju and Dr T.G.K. Murthy
6.	PHY-72	Dynamics of potassium absorption, utilisation and re-translocation in FCV tobacco Dr. K. Nageswara Rao and Dr. M. Anuradha
7.	SSMB-11	Development of bio-consortia for optimizing nutrient supplementation through microbes for tobacco crop production Dr. D.V. Subhashini, Dr. M. Anuradha and Dr. D. Damodar Reddy
8.	OC-24	Studies on chemical constituents responsible for smoke flavour in FCV tobacco grown under different agro climatic zones Dr. K. Siva Raju, Dr.T.G.K. Murthy, Dr. R.K Ghosh and D. Damodar Reddy
9.	Phy-76	Impact of excess water stress and adaptive strategies to minimize its negative effects on productivity and quality of tobacco Dr. M. Anuradha, Dr. D. Damodar Reddy, Dr. T.G.K. Murthy and Dr. K. Siva Raju
10.	SS-31	Evaluation of crop residue and wood ashes effects on soil fertility and potassium nutrition of tobacco Dr. D. Damodar Reddy, Dr. R.K. Ghosh, Dr. S. Kasturi Krishna, Dr. M. Mahadevaswamy, Dr. L.K. Prasad and Dr. K. Nageswara Rao
11.	Phy-77	Secondary nutrient deficiency effects on tobacco nutrition Dr. M. Anuradha, Dr. D. Damodar Reddy and Dr. K. Siva Raju
CROP PROTECTION		
1.	E 74	Monitoring of insect pests of tobacco with pheromone traps Dr. U. Sreedhar
2.	E-78	Management of tobacco caterpillar, insecticide baits Dr. U. Sreedhar and Dr. K. Nageswara Rao
3.	E-80	Studies on *Helicoverpa armigera* with special reference to influence of plant variety, field ecology, eco-toxicology and seed production Dr. S. Gunneswara Rao and Dr. U. Sreedhar
4.	E-81	Bio efficacy and field evaluation of new insecticides against tobacco pests Dr. U. Sreedhar, Dr. R.K. Ghosh and Dr. 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-2	Developing new varieties of irrigated *Natu* tobacco for A.P. Dr. T.G.K. Murthy
3.	JL Br.3	Developing hybrid FCV tobacco suitable for northern light soils (NLS) of Andhra Pradesh Dr. T.G.K. Murthy, Dr. P.V. Venugopala Rao and Dr. K. Sarala
4.	JLA-35	Integrated weed management in FCV tobacco grown under irrigated alfisols" Dr S. Kasturi Krishna, Dr. S.V. Krishna Reddy and Dr. K. Nageswara Rao
5.	JLA-36	Indices for N and K nutrient use efficiency in FCV tobacco grown in irrigated Alfisols Dr. S.V. Krishna Reddy, Dr. S. Kasturi Krishna, Dr. D. Damodar Reddy, Dr. C. Chandrasekhararao and Dr. K. Nageswara Rao
6.	JL Phy-1	Assessment of topping response of FCV tobacco varieties and advanced breeding lines Dr. K. Nageswara Rao
7.	JL Phy-2	Maize, as an alternative crop to FCV tobacco in NLS Dr. K. Nageswara Rao
8.	E-82	Evaluation of insecticide application technology for the effective spray coverage on FCV tobacco in NLS Dr G. Raghupathi Rao, Dr U. Sreedhar and Dr. K. Nageswara Rao
BTRC, Kalavacherla		
1.	By.Br.1	Evaluation of advanced burley breeding lines for productivity and quality Dr. P.V. Venugopala Rao and Dr. T.G.K. Murthy
2.	By.Br.2	Evaluation of burley tobacco hybrids suitable for burley growing areas of Andhra Pradesh Dr. P.V .Venugopala Rao and Dr. T.G.K. Murthy
3.	EB-79	Spatial distribution and pest succession of insect pests as influenced by cultural practices in Burley tobacco in the plains of East Godavari Dr. G. Raghupathi Rao
4.	AB-30	Set row planting in burley tobacco Dr. C. Chandrasekhararao, Dr. D. Damodar Reddy and Dr. S. Kasturi Krishna

Sl. No	Institute Code	Title of the project and Investigator(s)
5.	AB 31	Effect of fertilizer sources of nutrients on yield and quality and bio-chemical properties of burley tobacco grown in uplands. Dr. S. Kasturi Krishna, Dr. S.V. Krishna Reddy and Dr. K. Siva Raju
CTRI RESEARCH STATION: GUNTUR		
1.	Br.14	Development of FCV tobacco varieties suitable for cultivation in SBS of AP C. Nanda
2.	G-13	Development of base line resistance data of *H. armigera S. litura* and *S. exigua* to conventional insecticides and insecticides with novel chemistries Dr. J.V. Prasad and Dr. U. Sreedhar
3.	Br-15	Development of high yielding FCV varieties with good leaf quality suitable for cultivation in SBS and CBS area of Andhra Pradesh C. Nanda and Dr. P. Venkateswarlu
CTRI RESEARCH STATION : KANDUKUR		
4.	K.Br.6	Breeding FCV tobacco variety for yield and quality under SLS conditions Dr. A.R. Panda, Dr. K.C. Chenchaiah, Dr. P.V. Venugopala Rao, Dr. T.G.K. Murthy and Dr. A.V.S.R. Swamy
5.	EK-14	Evaluation of FCV germplasm for Aphid tolerance under SLS conditions Dr. K.C. Chnachaiah
6.	EK-15	Evaluation of FCV tobacco germplasm for the tobacco caterpillar tolerance under SLS conditions Dr. K.C. Chnachaiah
7.	EK-16	Studies on population development of tobacco aphid, *M nicotiana* under SLS conditions Dr. K.C. Chnachaiah
8.	SSK-1	Investigations on soil fertility and irrigation water quality in SLS and SBS regions of Andhra Pradesh Dr. L.K. Prasad and Dr. D. Damodar Reddy
9.	EK-18	Management of *Bemisia tabaci* in FCV tobacco Dr. K.C. Chenchaiah
10.	K.Br-9	Evaluation of FCV Tobacco lines for yield and quality under SLS conditions Dr. A.R. Panda

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. Dr. C.Panduranga Rao and Dr. S.S. Srinivas
2.	P.3.2	Screening of tobacco germplasm against root knot nematode. Dr. S. Ramakrishnan and Dr. S.S. Srinivas
3.	N 1.1	Survey for plant parasitic nematodes infecting tobacco Dr. S. Ramakrishnan and Dr P. Nagesh
4.	BR-19	Development and evaluation of F1 hybrids of FCV tobacco suitable to Karnataka Light Soil region. Dr. C. Panduranga Rao, Dr. M.M. Swamy, Dr. S. Ramakrishnan and Dr. S.S. Srinivas
5.	A.37	Agronomic evaluation of promising pipeline varieties (FCH-196 and FCH-201) of FCV tobacco in KLS Dr. M. Mahadeva Swamy
6.	A.38	Feasibility of producing organic tobacco under KLS situation Dr. M. Mahadeva Swamy and Dr. S. Ramakrishnan
7.	EH-1	Survey for assessment of insect pest incidence in KLS tobacco Dr. P. Venkateswarlu, Dr. S. Ramakrishnan and Dr. S.S. Srinivas
8.	P-21	Monitoring the incidence and severity of pests and disease in nursery and field crop of KLS tobacco at different intervals of sowing and transplantation Dr. S. Ramakrishnan and Dr. S.S. Srinivas
9.	A-39	Effect of graded levels of K on the occurrence and intensity of root-knot incidence and K utilization pattern of FCV tobacco in KLS Dr. M. Mahadeva Swamy and Dr. S. Ramakrishnan
10.	N-20	Integrated management of root knot nematodes and soil borne fungal diseases in FCV tobacco nurseries Dr. S. Ramakrishnan
11.	N-21	Evaluation of bio-agents enriched tray seedlings against root-knot nematode – *Fusarium* wilt disease complex in FCV tobacco field crop Dr. S. Ramakrishnan
CTRI RESEARCH STATION: VEDASANDUR		
1.	G.S.1	Evaluation and maintenance of germplasm Dr. A.V.S.R. Swamy and M. Mohan
2.	B.48	Studies on heterosis breeding in chewing tobacco (*N. tabacum*) Dr. A.V.S.R. Swamy and M. Mohan

Sl. No	Institute Code	Title of the project and Investigator(s)
3.	B.49	Synthesis of broad-based gene pool in chewing tobacco (*N. tabacum*) enhancing selection gain. Dr. A.V.S.R. Swamy and M. Mohan
4.	B.50	Breeding for high seed and oil yield in tobacco Dr. A.V.S.R. Swamy and Dr. R.K. Ghosh
5.	BA-54	Performance of advance breeding lines of chewing tobacco with varying levels of nitrogen under Vedaranyam conditions Dr. M. Kumaresan and Dr. A.V.S.R. Swamy
6.	A-101	Drip fertigation in chewing tobacco Dr. M. Kumaresan, Dr. A.V.S.R. Swamy and Dr. C. Chandrasekhararao
7.	A 102	Crop productivity, soil quality and economic returns under chewing tobacco + Annual Moringa intercropping system in response to nutrient management Dr. M. Kumaresan and Dr. D. Damodar Reddy
8.	BA 55	Performance of broad based selections of chewing tobacco under different levels of spacing and nitrogen Dr. M. Kumaresan and Dr. A.V.S.R. Swamy
CTRI RESEARCH STATION: DINHATA		
1.	A-10	Permanent manurial experiment with *Motihari* tobacco Dr. S. Roy
2.	B-17	Dialliel analysis in *Motihari* tobacco (*N.rustica*). Dr. S. Roy
3.	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. Roy
4.	PP-10	Weather based disease prediction model for brown spot of *Motihari* tobacco under North Bengal conditions Dr. S. Roy

RAC, QRT, IRC and IMC Meetings

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QUINQUENNIAL REVIEW TEAM

The ICAR, New Delhi constituted the Quinquennial Review Team (QRT) vide Office Order No.1(5)/08-IA.III dated 21st May, 2008 for reviewing the research achievements of CTRI, Rajahmundry, its Regional Research Stations, AINRPT and KVK for the period from 2003 to 2008. The QRT reviewed the work and submitted its report. The Governing Body of ICAR accepted the recommendations made by the QRT with the comments of the Council. The next QRT (2009-13) will be constituted during 2013.

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INSTITUTE RESEARCH COMMITTEE (IRC) MEETINGS

The Institute Research Committee Meetings of CTRI were held from 25th to 27th July, 2012 at this Institute. Scientists of CTRI, its Research Stations, Tobacco Board officials and representatives of trade and industry participated in the meetings. The progress of research work carried out during the year 2011-12 was reviewed and the technical programme for the crop season 2012-13 was discussed and finalized.

Institute Research Committee Meetings of CTRI held from 25th to 27th July, 2012

INSTITUTE MANAGEMENT COMMITTEE

Dr. T.G.K. Murthy
Director-Acting & Chairman

46th IMC meeting was conducted on 23.6.2012 at CTRI, Rajahmundry.

Dr. N. Gopalakrishnan, MEMBER
Assistant Director-General (CC),
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Dr. R. Veera Raghavaiah, MEMBER
Associate Dean,
Agricultural College, ANGRAU,
Rajahmundry – 533 105

Sri H. Ganesha, MEMBER
Finance & Accounts Officer,
Directorate of Oilseed Research,
Rajendranagar, Hyderabad – 500 030.

Dr. C.V. Narasimha Rao, MEMBER
Principal Scientist,
Central Tobacco Research Institute,
Rajahmundry – 533 105

Dr. S.V. Rao MEMBER
Principal Scientist,
Directorate of Sorghum Research,
Rajendranagar, Hyderabad – 500 030

Dr. I. Srinivas, MEMBER
Sr. Scientist,
CRIDA, Santosh Nagar,
Hyderabad – 500 059.

Dr. K. Sivanarayana Varaprasad, MEMBER
Director,
Directorate of Oilseed Research,
Rajendra Nagar, Hyderabad – 500 030

Shri Cherukuri V. Swami, MEMBER
Peda Alvala Padu P.C.
Palli-Mandalam,
Prakasam district, Andhra Pradesh

Shri Ch. Suryanarayana, MEMBER
Dappalampadu Village & PO,
Gudluru Mandal,
Prakasam district,
Andhra Pradesh

Sri Y. Prabhakar MEMBER-
Asst. Administrative Officer, SECRETARY
Central Tobacco Research Institute,
Rajahmundry – 533 105

46th IMC meeting held on 23.6.2012

Participation of Scientists in Conferences, Meetings, Workshops and Symposia

Sl. No.	Participant (s)	Programme attended	Date and place
1.	Dr. K. Nageswara Rao Dr. S.V. Krishna Reddy	Formulation of crop insurance scheme for FCV tobacco – Meeting with Agriculture Insurance Company of India Ltd	12.04.2012 at 2.30 PM at Tobacco Board, Guntur
2.	Dr. D. Damodar Reddy	Verification of soil testing procedures at TB's STL	21st and 22nd May, 2012 at Ongole
3.	Dr.C.Panduranga Rao Dr.M.Mahadevaswamy	Scientific Advisory Committiee meeting	26.05.2012 at Krishi vigyana Kendra, Suttur, Mysore District
4.	Dr. T.G.K. Murthy	73rd Meeting of the Registration Committee, Tobacco Board	28.06.2012 at 11.30 AM at Tobacco Board, Guntur
5.	Dr. H. Ravisankar	National conference on 'Mathematics and computational sciences'	07.07.2012 at ANU, Rajahmundry
6.	Dr. H. Ravisankar	International conference on 'Computation and information technology'	13.07.2012 at Tirupathi
7.	Dr.M.Mahadevaswamy	Framers Mobile Advisory Service (*Namma Sandesha*) meeting	14.8.2012 at Regional Manager Office, Tobacco board, Mysore
8.	Dr. K. Sarala Dr. H. Ravisankar	International conference on 'Agricultural and horticultural sciences'	15.09.2012 at Hyderabad
9.	Dr.S.Ramakrishnan Dr.C.Mahadeva	Scientific Advisory Committiee Meeting	12.10.2012 at JSS, Krishi Vigyan Kendra, Suttur
10.	Dr.L.K.Prasad	ICAR sponsored short course on *Use of simulation modeling in climate change research: special reference to natural resource management*	3-12 October, 2012 at IISS, Bhopal
11.	Dr. V.S.G.R. Naidu	International Conference on Cashew	11-12 October, 2012 at Panjim, Goa

Sl. No.	Participant (s)	Programme attended	Date and place
12.	Dr. M. Mahadeva Swamy	Training programme sponsored by Tobacco Board, Guntur	22.10.2012 at CRIDA, Hyderabad
13.	Dr. U. Sreedhar Sri M.N.P. Kumar	NKN Annual Workshop	31st October & 1st November, 2012 at IIT, Bombay
14.	Dr. H. Ravishankar	National workshop "TECH ZANANA-2K12"	3rd November, 2012 at ANU, Rajahmundry
15.	Dr. C. Panduranga Rao	Inauguration of the E-auction project	16.11.2012 at Tobacco Auction Platform No.4, Periyapatna
16.	Dr Y. Subbaiah	VII National Conference on KVKs	20-22, November, 2012 at PAU, Ludhiana
17.	Dr. D.V. Subhashini	International Conference on "Microbial World : Recent innovations and future trends"	22-25 November, 2012 at Bhubaneswar
18.	Dr. D. Damodar Reddy Dr. S.V. Krishna Reddy Dr. S. Kasturi Krishna Dr. M. Kumaresan M. Mahadevaswamy	Third International Agronomy Congress	November 26-30, 2012 at New Delhi
19.	Dr. U. Sreedhar Dr. H. Ravisankar	International Conference on 'Plant Health Management for Food Security"	28-30th November, 2012 at Hyderabad
20.	Dr. T.G.K. Murthy Dr. K. Sarala Dr. K. Siva Raju	Training programme on "Management Development Programme in Agriculture	December 3-7, 2012 at NAARM, Hyderabad
21.	Sri Md. Elias	National Conference of Agricultural Librarians & User Community (NCALUC) 2012	December 5-7, 2012 at OUAT, Bhubaneswar
22.	Dr. U. Sreedhar	75th Meeting of Registration Committee for Growers and Others	07.12.2012 at Tobacco Board, Guntur
23.	Dr. K. Suman Kalyani	International Conference of Rural Health and Medicine on 'Challenges for Rural Medicine in the Global Villages'	10-12 December, 2012 at Kala Academy, Goa

Sl. No.	Participant (s)	Programme attended	Date and place
24.	Dr. M. Anuradha	National Seminar on Plant Physiology on "Physiological and Molecular approaches for development of climate resilient crops"	12-14 Dec., 2012 at Hyderabad
25.	Dr. C. Panduranga Rao	Golden Jubilee Celebrations of Cardamom Research Centre, Appangala Madikeri, Kodagu, Karnataka	20-22 December, 2012 at AppangalA MadiKeri
26.	Dr.M.Mahdevaswamy	Oragnic toabacco production in FCV toabcco in Tobacco baord sponsored training programme	26.12.2012 at CRIDA, Hyderabad
27.	Dr.M.Mahadevaswamy	Oragnic Tobacco Production in FCV toabcco in Tobacco Baord sponsored training programme	08.01.2013 at CRIDA, Hyderabad
28.	Dr. R.K. Ghosh	100th Indian Science Congress	3-7 January, 2013 at University of Calcutta, Kolkata
29.	Dr. M. Mahadeva Swamy	Training programme "Organic farming & rainwater harvesting and utilization for climate resilient agriculture in rainfed areas"	08-01-2013 at CRIDA, Hyderabad
30.	S. Ramakrishnan	National Conference on "Technology for wealth from waste".	8-9 January, 2013 at Loyola College, Chennai
31.	Dr. P. Venkateswarlu	Training on "Topping, de-suckering, harvesting, curing and grading in Tobacco"	18.01.2013 at Mallavaram
32.	Dr. J.V. Prasad	MPD Workshop on PME of Agricultural Research Projects	21-25 January, 2013 at NAARM, Hyderabad
33.	Dr.L.K.Prasad Dr.A.R.Panda	National symposium on Climate change and Indian agriculture: Slicing down the uncertainties	January, 22-23 at CRIDA, Hyderabad
34.	Dr. P. Venkateswarlu	Tobacco Board Meeting	31-01-2013 at 11.30 AM at Guntur
35.	Dr.M.Mahadevaswamy	Input committiee meeting for KLS	6.2.2013 at office of Director (Auction), Tobacco Board, Bangalore

Sl. No.	Participant (s)	Programme attended	Date and place
36.	Dr. S. Kasturi Krishna Dr. M. Anuradha	DST course on "Future Challenges to Society with Thematic of Resources and Development for Scientists and Technologies"	11-15th February, 2013 at NIAS, Bangalore
37.	Dr. U. Sreedhar Dr. S. Gunneswara Rao	IV International Insect Science Congress	14-17th February, 2012 at GKVK, Bangalore
38.	Dr. D. Darmodar Reddy	10th Meeting of Tobacco & Tobacco Products Sectional Committee, FAD 4 (BIS)	15.02.2013 at BIS, New Delhi
39.	Dr. A.V.S.R. Swamy	Training programme on "New dimensions in quality seed production technology with special reference to hybrid seed production of field and vegetable crops, IPR on PPV & FR Act"	February 18-27, 2013 at GBPUA & T, Pantnagar
40.	Dr. K. Prabhakara Rao	National Workshop on 'Foresight and future pathways of Agricultural Research through Youth in India'	March 1-2, 2013 at NASC Complex, DPS Marg, New Delhi
41.	Dr. D.V. Subhashini	General Management programme	4-15th March, 2013 at ASCI, Hyderabad
42.	Dr. T.G.K. Murthy & Heads of Divisions	Meeting of the Directors/Heads/ PCs of Crop Science Division	11.3.2013 at New Delhi
43.	Dr. D Damodar Reddy	Meeting of TSC, Ministry of Health & Family welfare	11.3.2013 at New Delhi
44.	Dr. T.G.K. Murthy	Directors' Conference	19.3.2013 & 20.3.2013
45.	Dr.M.Mahadevaswamy Dr.S.Ramakrishnan	National Conference on Agriculture Biotechnologies for Sustainable Food Security (sposored by DBT)	22-24, March 2013 at Pudukottaai, Tamil Nadu
46.	Dr.Y.Subbaiah Dr. P. Venkateswarlu	Meeting on "Developmental activities in FCV tobacco cultivation in A.P. and Karnataka"	28.03.2013 at Tobacco Board, Guntur
47.	Dr. S. Roy	Advisory committee meeting of AFTRDC (ACMART - Acad. For management and Rural Training-Farmers Training and Rural Development Centre)	14th Aug, 2012 at West Bengal
48.	Dr. S. Roy	SAC Meeting	12.02.2013 at KVK, Pundibari
49.	Dr. S. Roy	Advisory committee meeting of AFTRDC (ACMART - Acad. For management and Rural Training-Farmers Training and Rural Development Centre)	29.1.2013 at West Bengal

Workshops, Seminars and Farmers' Days organised by the Institute

- The Foundation Day of Central Tobacco Research Institute was celebrated on 02.04.2012 at this Institute.

Inauguration of CTRI Foundation Day

- A meeting of Tobacco Stakeholders was held on 25.7.2012 at CTRI, Rajahmundry

- Hindi Fortnight was celebrated at CTRI, Rajahmundry during 14-29 Sept., 2012.

Valedictory function of Hindi Fortnight

- "Kisan Mela" was conducted on 18th January, 2013 at CTRI RS Jeelugumilli. Chairman, Tobacco Board, Guntur presided over the function as chief guest. Director, HODs and Scientists of CTRI, Rajahmundry and its Regional Stations, officials from Tobacco Board, officials from ITC Ltd ILTD and GPI Ltd., Tobacco Growers Association Presidents, tobacco farmers, Press and Media attended the function. Scientists educated the farmers on improved technologies in FCV tobacco production and the farmers were shown the experimental and other Demonstration trials conducted at the Regional Station. An exhibition was also organized on FCV tobacco production practices for the benefit of the tobacco farmers. Stalls from different insecticides/pesticide companies' viz., Bayer, Syngenta, BISF, Bio-Fertilizers and KVK of CTRI were displayed. Pamphlets on package of practices for NLS tobacco crop, usage of green crop and incorporation, best curing and grading and usage of insecticides and pesticides were distributed.

Kisan Mela at Jeelugumilli

Farmers interacting with scientists

- Field IRC was conducted at CTRI RS, Jeelugumilli on 19th February, 2013 to review the institute & AINRPT experiments.

Field IRC

- Tobacco Variety Release Committee meeting for Tamil Nadu was held on 07.02.2012 at CTRI Research Station, Vedasandur in which the chewing tobacco varieties HV.2000-6 and VDH-3 varieties were approved for release for cultivation in Tamil Nadu.

Tobacco Variety Release Committee meeting

- Variety Release Committee meeting for Karnataka was held on 06.11.2012 at CTRI Research Station, Hunsur in which the FCV tobacco variety FCH- 222 was approved for release for cultivation in Karnataka.

- The 2nd meeting of 12th IJSC meeting was conducted at CTRI Research Station, Vedasandur on 15.12.2012. Various issues related to staff welfare were discussed in the meeting.

IJSC meeting at CTRI RS, Vedasandur

Distinguished visitors

S.No.	Date	Visitors
1.	21.06.2012	Dr. P. Muthuhashman, Professor & Head (Agronomy). Tamil Nadu Agricultural University, Coimbatore
2.	03.07.2012	Dr. V.M. Bhale, Head, Dept. of Agronomy and Associate Dean, College of Agriculture, Akola,Maharashtra, Dr. P. C. Bhargale, Head, TTD, CIAE, Bhopal, M.P
3.	03.09.2012	Dr. K. Ramaswamy, Professor, TNAU, Coimbatore
4.	09.01.2013	DR. Mahadevappa H.P., Project Coordinator (Palms), AICRP on Palms, CPCRI, Kasargod, Kerala.
5.	15.02.2013	O.A.K.P. Bayatmng, Area Manager, Ceylon Tobacco Company Pvt. Ltd., Srilanka and N.P.C. Desilva, Department of Agriculture, Srilanka
6.	14.03.2013	Dr. G. Jayaraj, Director, PG Centre, Andhra Layola Colleg, Vijayawada.
7.	16.03.2013	Prof. Swapan K. Datta, DDG(CS), ICAR along with Dr. R.C. Agarwal, Secretary General, Prot. of Plant Varieties & Farmer's Rights Authority (PPVFRA), Dr. A.C. Sinha, VC, UBKV, Pundibari and Dr. H. Bhattacharya, Dean (Horticulture) visited the CTRI RS, Dinhata
8.	21.03.2013	Dr.P. Joseph, Professor & Head, Department of Forestry, ANGRAU, Hyderabad

Visit of Prof. Swapan K. Datta along with other dignitaries to CTRI RS, Dinhata on 16.3.2013

Personnel (As on 31.03.2013)

Dr. T.G.K. Murthy, Director-Acting

DIVISION OF CROP IMPROVEMENT

Dr. T.G.K. Murthy, Principal Scientist & Head
Dr. A.V.S.R. Swamy, Principal Scientist
Dr. K. Sarala, Principal Scientist
Dr. P.V. Venugopala Rao, Sr. Scientist
Dr. K. Prabhakara Rao, Scientist
Smt. K. Santhinandivelu, Technical Officer T-6
Sri A.D.V. Prasad, Technical Officer T-5
Sri M. Trinadh, Technician T-4
Sri S. Rajeswara Rao, Technician T-4
Sri T. Lakshmana Rao, Technician T-3
Sri M.M. Ali, Technician T-3
Sri S. Ramaraju, Technician T-1
Sri A. Mutyam, Technician T-1
Sri R. Satyanarayana, Technician T-1
Sri K. Suryanarayana, SSS
Sri Y.N.V.V.S.N. Murthy, SSS

DIVISION OF CROP PRODUCTION

Dr. C.Chandrasekhararao, Principal Scientist & Head
Dr. S. Kasturi Krishna, Principal Scientist
Dr. S.V. Krishna Reddy, Sr. Scientist
Sri M. Nageswara Rao, Technical Officer T-7/8
Sri D.S.R. Sastry, Technician T-2
Sri Ch. Sudhakara Babu, Technician T-2
Smt. Y. Jaya Lakshmi, SSS
Sri S. Ganga Raju, SSS
Sri K.V.S.S. Bhaskara Rao, SSS

DIVISION OF CROP PROTECTION

Dr. U. Sreedhar, Principal Scientist & Head
Dr. J.V. Prasad, Principal Scientist
Dr. G. Raghupathi Rao, Sr. Scientist
Dr. S. Gunneswara Rao, Sr. Scientist
Sri K. Sesha Sai, Technical Officer T-6
Dr. S.K. Dam, Technical Officer T-5
Sri V. Narasimha Murthy, Technician T-4
Sri V.V. Ramana, Technician T-3
Sri A. Nageswara Rao, SSS
Sri V.V.P.L. Acharyulu, SSS

DIVISION OF CROP CHEMISTRY & SOIL SCIENCE

Dr. D. Damodar Reddy, Principal Scientist & Head
Dr. K. Siva Raju, Principal Scientist
Dr.(Mrs.) D.V. Subhashini, Principal Scientist
Dr. (Mrs.) M. Anuradha, Sr. Scientist
Dr. R.K. Ghosh, Scientist
Smt. Y. Ramabai, Technical Officer T-6
Smt. D.V.L. Satyavathi, Technical Officer T-6
Smt. J. Vasanthi, Technical Officer T-5
Smt. K. Padmaja, Technical Officer T-5
Sri B.V. Srinivas, Technician T-3,
Sri M. Satyanarayana, Technician T-3
Sri N. Johnson, Technician T-3
Sri P. Narayana Rao, Technician T-1
Smt. P. Satyavathi, SSS
Smt. P. Subbayamma, SSS
Smt. M. Srilatha, SSS
Sri K.V. Narasimha Raju, SSS
Sri B.S.S. Sai, SSS
Sri E. Radhakrishna, SSS
Sri Ch. Subba Rao, SSS

AGRICULTURAL EXTENSION

Dr. Y. Subbaiah, Principal Scientist
Dr. (Mrs.) K. Suman Kalyani, Principal Scientist
Sri S. Nageswara Rao, Technical Officer T-7/8
Smt. N. Aruna Kumari, Technical Officer T-7/8
Sri P.E. Jemmy, Technical Officer T-5
Sri D.V.S.C. Sastry, Technician T-3
Sri P. Girija Sankar, Technician T-3 (Asst. Proj. Operator)
Smt. K. Pushpa, SSS
Sri G. Sarveswara Rao, SSS

AKMU

Dr. H. Ravisankar, Sr. Scientist
Sri Md. Bajuddin, Technical Officer T-5
Sri M.N.P. Kumar, Technical Officer T-5
Sri K. Satyanarayana, SSS

PME CELL

Sri C.V.K. Reddy, Technical Officer T-7/8
Smt. Ch. Lakshminarayani, Personal Assistant

LIBRARY

Sri Md. Elias, Technician T-3

CTRI FARM, KATHERU

Sri T. Krishna Reddy, Technical Officer T-7/8
Sri V. Madhava Rao, Technical Officer T-5
Sri G.H. Mohanacharyulu, Technician T-4
Sri P.S.S. Prakasa Rao, Technician T-4
Sri K. Bhyravaswamy, Technician T-2
Sri M.S. Ashokan, Technician T-2 (Ele.)
Sri Y.V. Subrahmanyam Technician T-2
Sri K.V. Ramana, Technician T-1
Sri P.V.V.V. Prasad, UDC
Sri P. George, SSS
Sri D.V. Rama Rao, SSS
Sri B. Nageswara Rao, SSS
Sri D. Balarama Reddy, SSS
Sri A. Srinivas, SSS
Sri N. Kanakanandam, SSS

AINRPT

Sri M. Appa Rao, Technical Officer T-7/8
Smt. B. Krishna Kumari, Technical Officer T-5

SEED PRODUCTION

Sri G. Adinarayana, Technical Officer T-7/8
Sri N. Veerraju, Technician T-4
Sri Garaga S.N. Murthy, Technician T-4
Sri N. Endayya, Technician T-1
Sri P.V. Ramana, SSS
Sri G. Prasada Rao, SSS

AGRICULTURAL ENGINEERING

Sri G. Nagesh Kanth Rao, Tech. Officer T-6
Sri N. Sreedhar, Technical Officer T-5
Sri N. Gopinath, Technical Officer T-5
Sri V.V. Sivaram, Technical Officer T-5
Sri G.S.N. Murthy, Technician T-3 (Ele.)
Sri KVV Satyanarayana, Tech.T-3 (Carpentor)
Sri N.V.V. Satyanarayana, Technician T-1
Sri G. Kaleswara Rao, SSS
Smt. Y. Nirmala Kumari, SSS

TRANSPORT

Sri N. Ayyappa Naidu, Technician T-4 (Driver)
Sri Y. Yesu, Technician T-4 (Driver)
Sri M. Yesuratnam, Technician T-3 (Driver)
Sri P.Ch. S.N. Murthy, Technician T-3 (Driver)
Sri S. Ramakrishna, Technician T-2 (Driver)
Sri P.V.V.R. Srinivasa Rao, SSS
Smt. Ch. Papa, SSS

ADMINISTRATION

Smt. B. Swarna Kumari, Administrative Officer
Sri S.C. Sheet, Administrative Officerr
Smt. P.V.S. Bharathi, Fin. & Accounts Officer
Sri T.S.N. Murthy, Asst. Fin. & Accounts Officer
Sri A.V.G.K. Murthy, Asst. Administrative Officer
Sri Y. Prabhakar, Asst. Administrative Officer
Smt. V. Bhagyalakshmi, Asst. Admn. Officer
Sri D. Seethapathi Rao, Asst. Administrative Officer
Smt. N. Maheswari, Personal Assistant
Sri K.T.R. Singh, Personal Assistant
Sri N. Sambasiva Rao, T-4 (Gestetner Operator)
Sri V. Narayanacharyulu, Assistant
Sri P. Venkataratnam, Assistant
Sri V.S.R.C. Murthy, Assistant
Sri G.V.V.S. Rambabu, Assistant
Sri P. Prabhakara Murthy, Assistant
Smt. P. Mariyamma, Assistant
Sri M. Rambabu, Assistant
Sri A. Sridhar, Assistant
Sri P.V. Satyanarayana, Assistant
Sri N. Suryanarayana, Assistant
Sri D. Sreeramamurthy, Assistant
Sri S.V. Ramana, Assistant
Smt. K. Savithri, Assistant
Sri P. Devanagaraju, Assistant
Sri N. Veerabhadra Rao, Assistant
Sri V. Narasimha Rao, UDC
Sri Ch. Jayaram, UDC
Sri P.J.F. Moses, UDC
Sri M.S.S.R. Sastry, UDC
Sri S. Pradeep Kumar, UDC
Smt. P. Suchitra, UDC
Smt. G.M.B. Sujatha, UDC
Smt. J. Suseela Devi, UDC (Dep. to CRIDA, HYD.)
Smt. Y. Subba Lakshmi, LDC
Sri B. Rama Rao, LDC
Sri Pasupuleti Raju, SSS
Sri J. Veerraju, SSS
Sri G. Chinna Rao, SSS
Sri K.A.J. Kennedy, SSS
Sri P.N.M. Swamy, SSS
Smt. R. Sarada, SSS
Sri K. Sankurudu, SSS
Sri Peta Ramana, SSS
Sri P.K.V. Satyanarayana, SSS
Sri N. Nirmala Kumar, SSS
Sri Y.S.V. Subba Rao, SSS
Sri D. Yanadinaidu, SSS
Smt. D. Lakshmamma, SSS
Sri D. Kesavulu, SSS
Smt. P. Rathamma, SSS

Sri M. Mohana Rao, SSS
Sri A. Gangadhara Rao, SSS
Sri S.K. Moulali, SSS
Smt. O. Rathamma, SSS
Sri K. Mallikharjuna, SSS
Smt. M. Subbulu, SSS
Sri G.V. Ramana, SSS
Sri D. Srinivasa Rao, SSS
Sri D. Singaiah, SSS
Sri D. Prabhakara Rao, SSS
Sri D. Koteswara Rao, SSS

BTRC, KALAVACHERLA

Sri B. Raja Rao, Technical Officer T-5
Sri Ch.V.R. Rangacharyulu, SSS
Sri Y.V. Subba Rao, SSS
Sri P. Janakiramayya, SSS
Smt. Ch. Chinnayamma, SSS

CTRI RESEARCH STATION, GUNTUR

Dr. P. Venkateswarlu, Pr. Scientist & Head i/c
Dr.(Mrs.) C. Nanda, Scientist
Sri B. Krishnakumar, Technical Officer T-6
Sri M.V. Jayakrishna, Technician T-4
Sri Shaik Ameer Ali, Technician T-3 (Curer)
Sri K.N. Subbaiah, Technician T-2 (Driver)
Sri A. Suresh Babu, Technician T-2
Smt. T. Nagamani, Technician T-1
Sri B. Yesu, Technician T-1
Sri V. Subba Rao, Technician T-1 (Driver)
Sri E. Veerabhadra Rao, Tech.T-1 (Ele.)
Smt. M.H. Uma, Assistant
Sri V.V.K. Acharyulu, UDC
Sri K. Lakshminaryana, SSS
Sri R. Balaswamy, SSS
Sri A. Seshaiah, SSS
Sri T. Venkatappaiah, SSS
Sri T. Sambrajyam, SSS
Smt. Alla Lakshmi Devi, SSS
Smt. M. Bhagyam, SSS
Sri K. Venkateswarlu, SSS
Sri S. Sambasiva Rao, SSS
Sri P. Purnachandra Rao, SSS
Smt. A. Anasurya, SSS

CTRI RESEARCH STATION, KANDUKUR

Dr. A.R. Panda, Principal Scientist & Head
Dr. K.C. Chenchaiah, Sr. Scientist
Dr. L.K. Prasad, Sr. Scientist
Sri I. Jagadish Chandra, Technical Officer T-6
Sri B.S.N. Reddy, Technical Officer T-6
Sri G. Srinivasa Rao, Technician T-4
Sri T. Venkata Rao, Technician T-3(Curer)
Sri K. Malakondaiah, Technician T-2(Ele)
Sri M. Mathaiah, Technician T-2 (Tr. Driver)
Sri K. Sudhakar, Technician T-1
Sri M. Ramamohana Rao, Asst. Admn. Officer
Sri K. Krishna Murthy, Asst. Admn. Officer
Sri U.R.K. Murthy, UDC
Smt. V. Jayamma, SSS
Sri K. Narasimham, SSS
Sri K. Kondaiah, SSS

CTRI RESEARCH STATION, JEELUGUMILLI

Dr. K. Nageswara Rao, Principal Scientist & Head
Sri J. Sivasai, Technical Officer T-6
Sri T. Sinivasa Rao, Technician T-3
Sri D.V. Prasad, Technician T-3 (Curer)
Sri Y. Venkateswara Rao, Technician T-3 (Ele.)
Sri J. Hanumantha Rao, Technician T-2
Sri A.L. Narasimha Murthy, Technician T-2
Sri B. Durga Rao, Technician T-2
Sri M. Srinivas, Technician T-2 (Computer Operator)
Sri G. Govinda Raju, Techncian T-1 (Tractor Driver)
Sri D. Yesuratnam, Technician T-1
Sri D. Narasimha Rao, Technician T-1
Sri K. Ganesh Babu, Asst. Administrative Officer
Sri Anapakam Prabhu, Assistant
Sri Y. Ramachandra Rao, SSS
Sri P. Kumar, SSS
Sri P.Y. Narasimha Rao, SSS

CTRI RESEARCH STATION, HUNSUR

Dr. Ch. Panduranga Rao, Head
Dr. M. Mahadevaswamy, Senior Scientist
Dr. S. Ramakrishnan, Senior Scientist
Sri S. Ramesh, Technical Officer T-9
Sri C. Mahadeva, Technical Officer T-7/8
Dr. P. Nagesh, Technical Officer T-7/8
Dr. S.S. Srinivas, Technical Officer T-7/8
Sri N.D. Suresh, Technical Officer T-6
Sri T. Venkatesh, Technical Officer T-5
Sri Ramachandra Gowda, Technical Officer T-5
Sri Sambu Gowda, Technician T-3
Sri Chikkanna Setti, Technician T-3
Sri Sanna Swamy, Technician T-3
Sri D.K. Eswara, Technician T-3
Sri B. Suresh Kumar, Technician T-2
Sri C. Puttamallaiah, Technician T-2
Sri Gopala Rao, Technician T-2
Sri J.S. Narahari, Private Secretary
Smt. Rohini, Assistant
Smt. Sherfoon, SSS
Smt. Devamma, SSS
Smt. Chikkabhagya, SSS

Smt. Pankaja, SSS
Smt. Jayamma, SSS
Sri Byre Gowda, SSS

CTRI RESEARCH STATION, VEDASANDUR

Dr. M. Kumaresan, Sr. Scientist & Head i/c
Sri M. Mohan, Technical Officer T-7/8
Sri R. Rajendran, Technical Officer T-6
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Sri V. Annadurai, Technical Officer T-5
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Sri B.K. Champramari, Tech.Officer T-5 (Driver)
Sri J.K. Roy, Technician T-1
Sri S.K. Sarkar, Personal Assistant
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Sri N.R. Barman, SSS
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Sri E. Vijaya Prasad, Technical Officer T-7/8
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Sri K. Suryachandra Rao, Technical Officer T-5
Sri D. Balakrishna, Technician T-4
Sri P. Eswara Rao, Technician T-3 (Driver)
Sri Y. Udaya Kumar, Technician T-2 (Driver)
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