वार्षिक प्रतिवेदन

ANNUAL REPORT

1995–96

ICAR

INDIAN INSTITUTE OF SPICES RESEARCH
(Indian Council of Agricultural Research)
CALICUT, KERALA

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भारतीय मसाले फसल अनुसंधान संस्थान
(भारतीय कृषि अनुसंधान परिषद)
कालिकट - ६७३ ०१२, केरल, भारत

INDIAN INSTITUTE OF SPICES RESEARCH
(Indian Council of Agricultural Research)
CALICUT - 673 012, KERALA, INDIA

Published by : Dr. K V Peter
Director
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Front cover : *Vanilla planifolia*

Back cover (Top to bottom) :
- Direct organogenesis from black pepper leaf
- Somatic embryogenesis in *Cinnamomum verum*
- 'B' chromosomes in ginger
- Root knot nematode eggs colonised by *Verticillium chlamydosporium*

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INTRODUCTION

The year 1995-96 witnessed all-round growth and development in Spices Research. The spices export was an all time record in terms of quantity (1.908 lakh tonnes) and value (Rs.743.35 crores), an increase of 23.10% and 19.90%, respectively over 1994-95. The production of spices during 1994-95 also showed increase in black pepper (53110 tonnes) and small cardamom (6330 tonnes). Productivity of small cardamom also rose to 120 kg/ha during the year. A new chapter was created in the history of spices research in the country by the upgradation of the National Research Centre for Spices (NRCS) to a full-fledged institute, "Indian Institute of Spices Research" with effect from July 1, 1995. The new institute is entrusted with more responsibilities and is better equipped to compete nationally and internationally to advance the knowledge and technology in the sphere of spices.

The scientific output during 1995 - 96 was substantial. Plant regeneration protocols are standardised for callus cultures of cinnamon, camphor and several herbal spices. Protoplasts were isolated from *Piper colubrinum* leaves. 'Synseed' technology was developed by encapsulating the embryos/shoot tips in sodium alginate for ginger, turmeric, vanilla, cardamom, camphor, lavender, dill and fennel. There have been strides in the area of biocontrol. *Trichoderma* isolates suppressed damping off and pre and post emergence rotting of cardamom seedlings. *Chilocorus nigrita* (Coleoptera: Coccinellidea) was recorded for the first time to predate on *Lepidosaphes piperis* (scale insect) infesting black pepper. Similarly *Verticillium chlamydosporium*, a known nematode biocontrol agent, was isolated for the first time from the rhizosphere of black pepper.

The scientific projects of the institute make up a portfolio of fundmental, strategic and applied research, complimentary to the needs of farming community and trade people. The research projects under mini missions were reallocated to Divisions viz. Crop Improvement and Biotechnology (13 projects), Crop Production and Post Harvest Technology (11 projects), Crop Protection (7 projects) and Social Sciences Section (5 projects). In addition, five ICAR (A.P. Cess Fund) projects and four DBT funded projects were also in operation. Network programmes on *"Phytophthora* Diseases of Horticultural Crops" and "Drip Irrigation in Horticultural Crops" are on the anvil.

The Staff Research Council met twice, during 21 - 23 April and 9 - 10 November 1995. New research projects on vanilla, drought management and transfer of technology were

initiated during the year. Three specific recommendations were made for use of extension agencies. The recommendations are 1) an environment friendly package for production of disease free planting material in black pepper; 2) a new technology for homestead cultivation of cardamom; and 3) three new high yielding varieties of spices (one ginger and two turmeric selections).The institute organised a Group Meeting on "Virus Diseases of Black Pepper and Cardamom" from 13- 14 June, 1995. A network project on "Viral Diseases of Black Pepper and Cardamom" is envisaged from the deliberations. The XIII National Group Meeting of the AICRP on Spices was organised at Jaipur during 23 - 24 August 1995. One ginger variety (IISR Varada), two varieties each of cinnamon (IISR Navasree and IISR Nithyasree) and turmeric (IISR Prabha and IISR Prathibha) were recommended for release. The institute also organised "Biotechnology Popular Lecture Series" on 28, 29 September and 7 October 1995. The first Research Advisory Committee meeting was convened during 12-13 January, 1996. Perspective Plan for the institute was debated and approved .

Study circle of the Institute met 23 times during the year and approved 22 research papers for publication. Laboratory facilities were further improved during the year by the addition of sophisticated instruments like Freeze Drier, 'Perkin Elmer' autosystem gas chromatograph, 'Hoefer' electrophoretic system for different types of electrophoresis and DNA sequencing and BIORAD gene cycler. During the year, the possessions in the library are 3278 books, 2354 bound volumes of journals and 1931 reprints. The budget of the Institute was Rs. 109 lakhs under Plan and Rs. 113.5 lakhs under Non Plan. Other plan schemes including Krishi Vigyan Kendra brought Rs.47.99 lakhs during the year. The All India Coordinated Research Project on Spices (AICRPS) with 20 centres conducted nation wide research on various spices with special emphasis on research on seed spices. The Krishi Vigyan Kendra, Peruvannamuzhi imparted short term trainings and also took part in many exhibitions.

1995-96 was an year for introspection on IISR's accomplishments as a national research centre and for looking ahead to the role that IISR will play in the coming years of patenting and intellectual property rights. On the 20th anniversary of its establishment and in the first year of its new status, IISR stood ready to meet the future challenges.

1.10.1996
Calicut

(K.V. Peter)
Director

अनुसंधान उपलब्धियॉ

फसल सुधार

काली मिर्च जर्मप्लासम (Germplasm)के 75, इलायची के 60, 9 हल्दी, 22 अदरक, 13 दालचीनी, 29 जायफल, 4 लौंग , 7 वैनिला, 5 मिर्च और 7 ओसिमम मसालों के । जर्मप्लासम में जोड दिये गया है । पेस्वन्नामुषि में काली मिर्च के संकरज तथा चुने गये ओ. पि. लाइनों की उत्पादन क्षमता संबन्धी प्रयोग का शुभारंभ हूआ । इलायची में 3 वयनाड किस्म, एक प्रकंद विगलन प्रतिरोधी क्लोन और 5 मोजेक वाईरस प्रतिरोधी क्लोनों उपज और गुण के आधार पर बहुक्षेत्रीय जांच के लिए चुने गये । मसालों पर जयपुर में आयोजित आखिल भारतीय समेकित अनुसंधान परियोजना की 13 वी राष्ट्रीय गूप बैठक में उच्च उत्पादन क्षमता के अदरक की एक किस्म, हल्दी और दालचीनी उच्च गुणावाली दे किस्मों की वितरण के लिए सिफारिश की गयी । राइसोम युक्त अदरक की दो किस्मों का मूल्याँकन कर रहे है ।

जैव प्रैयोगिकी

मसाले वृक्ष जैसे दालचीनी, कर्पूर और कई शाकीय मसालों की सूक्ष प्रजनन प्रोटोकोल (protocol) का द्रुत क्लोनल (clonal) गुणन के लिए मानकीकृत किया गया । अदरक, इलायची, हल्दी, दालचीनी, कर्पूर, वैनिला, सोंफ, लवन्डर और सेज में "सिनसीड"(synseed) को विकसित किया गया । वैनिला के कालस (Callus) कर्षण से पहली बार पादप पुनर्जनन संयत हुआ । दालचीनी के बीज कर्षण, अदरक के केसर युक्त कालस कर्षण और शाकीय मसाले जैसे लवन्डर, बडी सोंफ, सोंफ और सेज के कालस कर्षण से सोमाटिक एम्ब्रयोजनसिस (somatic embryogenesis) और पादप पुनर्जनन प्राप्त हुए । वैनिला की बीज संतति में एस्टरेस (esterase) और SOD केलिए PAGE के प्रयोग करने से उच्च असमानता दिखायी पडी । सामान्य काली मिर्च और लम्बी काली मिर्च में RAPD बाह्य रूप का अंकन किया गया ।

फसल उत्पादन

शुभकरा और श्रीकरा जैसी विकसित काली मिर्च किस्मों केलिए NPK के साथ पोषक जैसे Zn, B और M o की ज़रूरत है । NPK की टिकियाँ एक ही मात्रा में देने की तुलना में NPK का प्रयोग त्रैमासिक करने से बुश काली मिर्च की पैदावर में वृद्धि दिखायी पडी । काली मिर्च के लिए पोटासियम सलफाइट K का एक अच्छा स्त्रोतस है । 2 x 2 मीटर अन्तराल में लगे हुए बुश काली मिर्च को जनवरी, मई, सितन्बर महीने में 10 : 5 : 20 ग्राम NPK देने से ज्यादा आर्थिक लाभ दिखाया गया । अभी तक वियुक्त किस्मों और नयी विमोचित करनेवाली किस्मों P 24 से तुलना करने पर पन्नियूर - 1 और पन्नियूर - 3 में उत्पादन की दृष्टि से उच्चतम निष्पादन पाये गये।

काली मिर्च को अक्तूबर से मार्च तक सिंचाई @ 7 लिटर/दिन/वाइन देने पर उसकी उत्पादन क्षमता 2.34/ किलो ग्राम/वाइन नियंत्रित पौधों की तुलना में अधिक दिखायी पडी । असोस्पिरिल्लम (*Azospirillum*) नर्सरी

मिट्टी में डालने से उसको प्रारंभिक धूमन न करने पर भी काली मिर्च की वानस्पतिक वृद्धि दिखायी पड़ी । वेर्मिकम्पोस्ट (vermicompost) से उगे हुए एक सालवाली लौंग पौधों की वानस्पतिक वृद्धि तथा ताकत दो सालवाली परम्परानुसृत पालित पौधों के बराबर पाया गया । आफ्रिकन एर्तवर्म (African earthworms) ने सूखे और सड़े हुए पत्ते, सुपारी के छिलके, कयर के कण, कॉफी छिलके , गोबर आदि कूडे करकटों को तीन महीने में 90% तक जेविक खांद के रूप में परिवर्तित किया । इसके अलावा वेर्म की संख्या में दुगुनी वृद्धि भी दिखायी पड़ी ।

पर्ण हरित या क्लोरोफिल की मात्रा पन्नियूर 5 और श्रकरी में जनवरी के बाद वृद्धि हुई । बल्कि दूसरी आठ उत्पादन क्षमतावाली किस्मों में उनकी वृद्धि काल में स्थिरता दिखायी गयी । पन्नियूर 3 या पंचमी की तुलना में P 24, पन्नियूर । और पन्नियूर 2 में पर्ण हरित की मात्रा ज्यादा दिखायी पड़ी । सुखापन सह्यता के बारे में काली मिर्च के 50 जर्मप्लासम में प्रारंभिक जॉच करने पर स्थापित किये गये कि Acc. 891, 908, 1079, 1092 और 1114 पर ज्यादा मेम्बरेन स्थिरता और पानी घटक का अपेक्षाकृत उच्च तत्व कायम रहा ।

इसी साल में विभिन्न एजेंसियों को काली मिर्च के 95000 रूटेड कलम, 1250 रूटेड लेटरल, 23 टन हल्दी, 800 कलमी जायफल, 5150 दालचीनी के पौधे आदि की पूर्ति की गयी ।

फसलोत्तर प्रौद्योगिकी

इलायची में केट्टे रोग से नैसर्गिक तौर वचे हुए NKE - 3 में बाष्पशील तेल (7.5%) और RR 1 तथा NKE 73 में अल्फा टरपिनिल असिटैट मसाहित पाया गया । सात MLT - 1 लाइन्स में, Ml - 1 और Ml - 5 में 8 % से अधिक तेल तथा Ml- 3, Ml - 2 और Ml - 6 में अल्फा टरपिनिल असिटैट भी समाहित है । इलयाची के वयनाड् सलेकशन में APG 221 लगातार 7.8 % अनिवार्य तेल दिया, जिसमें 19%, 1,8 सिनोल और 33% अलफा दरीपनिल असिटैट आदि मौजूद है । फैबर घटक के लिए मूल्यांकित अदरक की उपागम में Acc. 18, 13, 35, 51, 151, 215, 179 और 249 में 3.5% कम कडे रेशे थे । Acc. 360, 361, सुगुणा, सुदर्शना आदि हल्दी किस्मों में कुरकुमिन की मात्रा कलिकट और मुवाटुपुषा की अपेक्षा कोयम्बतूर, जगतियल और धारवाड में 40% कम थे । सिनमोन कासिया छाल और पत्ते का विश्लेषण सूचिन करता है कि Acc. D - 1, D - 3 और D - 5 को 4% से अधिक छाल तेल के साथ उच्च सिनामलडिहैड घटक और A - 6 में लगभग 72% सिनामलडिहैड के साथ उच्च पर्ण तेल भी थे ।

फसल संरक्षण

केरल, कर्नाटक तमिलनाडु आदि राज्यों के 162 प्रमुख काली मिर्च प्रदेशों में आयोजित सर्वेक्षण से यही साबित हुआ कि इन प्रदेशों में 18 जाति/वर्ग शल्क कीटों और मीली बगों की बाधां दिखायी पडी जिसमें 14 नये रूप के थे । लेपिडोसफस पायपरिस और अस्पिडियोटस डिस्ट्रक्टर आदि फसल के लिए सबसे हानिकारक है ।

पि. सुगन्धि, पि. आरगिरोफाइलम और पि. हाइमेनोफाइलम भी काली मिर्च के CMV बाधित पाये गये । इलायची के कोक्के कन्तु रोग में वाइरस - वेक्टर संबन्धों पर होनगादहल्ला वियुक्त तथा कीट वेक्टर पेन्टोलोनिया नाइगेनेरोसा f. कालाडी द्वारा कियो गये अध्ययनों ने वाइरस की अर्ध उपस्थित प्रकृति दिखायी । विविध मसालों से संग्रहीत छ : मूल कान्डे निमाटोड (*Meloidogyne incognita*) से उनकी अनाशक रीतियों में विविधतायें दिखायी पडी । एम. इनकोग्निटा में Pi ≤ 2/100 cc मिट्टी के एक घट कर्षण अध्ययन में अदरक के तथा फसल की मात्रा में सर्वाधिक कटौती दिखायी गयी । टि. पायपरिस अंडों का हेचिंग आसवित जल में ठीक से हुआ आर इस प्रक्रिया में रूट एक्स्यूडेट्स (root exudates) की कोई भूमिका नहीं दिखायी गयी ।

काली मिर्च के फायटोफ्थोरा फूट रोट बाधित प्रदेशों में तीन साल के परीक्षण से यह दिखाया गया कि जब P 24 किस्म में रोग प्रसंग सिर्फ 20% हुआ तब अन्य किस्मों में ये 50% तक थे । पाइपर नाइग्रम के दो वन्य और एक उत्पादजनक किस्म पोल्लु बीटल (*Longitarsus nigripennis*) से हुई हानी से मुक्त पाया गया । सिरसि में कोक्के कन्तु रोग बाधित प्रदेशों में दो साल के परीक्षण में इलायची के क्लोन 893, स्वाभाविक संक्रमण के प्रतिरोधक दिखाये गये । प्राथमिक छान बीन से अदरक की 10 और हल्दी की 17 किस्मों में रूट नोट नेमटोड की प्रतिरोध शाक्ति/ सहनशालिता विभिन्न स्तरों में पायी गयी ।

पाइपर कोलुब्रिनम में कालस के प्रोटोप्लास्टों की सफल वियुक्ति और पुनर्जीवन की सिद्धि हुई है । इसके अलावा पि. काप्सिसि से काली मिर्च के सोमाक्लोन की प्रतिक्रिया की छान-बीन करने पर विचारणीय विभिन्नतायें दिखायी पडीं। पाँच साल के खेत परीक्षण में VAM निवेशन से संबद्ध फायटोफ्थोरा खूर गलन के नियन्त्रण के लिए एग्रोकेमिकल से युक्त और रहित VAM उपचारित प्रदेशों में नियन्त्रण की मात्रा न्यूनतम(11%) रही जबकि नियन्त्रण में यह 50% रही । काली मिर्च की जडों पर VAM कोलनाइसेशन के ऊपर कोपर ओक्सिक्लाराइड छिड़कने पर उल्टा प्रभाव दिखाया दिया जबकि सिस्टमिक फंगीसाइड मेटालाक्सील मेन्कोसेब (Ridomil MZ 72 WP) तथा पोटाशियम फोस्फोनेट (अकोमिन) के छिड़कने पर एसा प्रभाव नहीं हुआ । सोरगम के रूट बयोमास के उत्पादन के लिए एक ही अनुपात में सोलारईट, मिट्टी, रेत और FYM का लगाना पर्याप्त था । उसके द्वारा बडी मात्रा में VAMउत्पादन का सफल उपयोग भी कर सकते है ।

काफी भूसा के माध्यम से तैयार किये ट्रइकोडरमा हरसियानम को इलायची खेत में प्रयोग करने पर यह दिखाया गया कि जब उपचारित प्लोटों में 6.4% राइसोम सड़न रोग का दमन हुआ तब अनुपचारित प्लोटों में यह 19.8% थे । अदरक और हल्दी के प्ररोह बेधक (*Conogethes punctiferalis*) के खिलाफ बासिलस तुरिनजनसिस के दो व्यावसायिक रूपों का मूल्यांकन यही सूचित करता है कि रोग बाधा के नियन्त्रण के लिए 0.3% डिपल के चार बार (जूलाई, अगस्त, सितम्बर, अकतूबर) छिडंकने से कीटबाधा के नियन्त्रण में ज्यादा प्रभावी फल प्राप्त होगा।

तमिलनाडु के अन्ना जिले के डिन्डीगुल, जो काली मिर्च का प्रमुख क्षेत्र है, में आयोजित सर्वेक्षण सूचित करता है कि प्स्यूडोसैमनस एस पि., सैबोसिफालस एस पि. (कोलियोप्टेरा), मल्लडा बोनिनेनसिस (न्यूरोप्टेरा) और

एनकार्सिया लाँनसबरी (हैमनोप्टेरा) आदि काली मिर्च पर बाधित शल्क कीटों के सामान्य प्रकृतिक शत्रु है । केरल के कोषिकोड़ जिले में पहली बार काली मिर्च पर बाधित शल्क कीटों के परभक्षी के रूप में कैलोकोरस निग्रिटा को आभिलेखित किया गया । प्रयोगशाला में सि. नाईग्रिटा के विपुल पालन की रीतियों का भी मानकीकरण किया गया ।

कोषिकोड़ जिले के कूताली से टि. पायपेरिस के प्रकरण से पहली बार वर्टिसिलियम क्लामिडोस्पोरियम को वियुक्त किया । 24 घंटे के अन्दर एम. इनकोग्रिटा अंडों को निकालने की मात्रा 56.3% सीमित हुई साथ ही वि. क्लामिडेस्पोरियम के द्वारा रूट नोट नेमटोड के परजीवन का भी प्रेक्षण किया गया रूट नोट नेमटोड के प्रबन्धन में फ्लोरसन्ट स्युडोमोनाड्स की 10 वियुक्तियाँ भी आशाजनक दिखायी गयी ।

पोल्लु बीटल के नाश के विरोध नीम संबन्धी दवाईयाँ और एन्डोसल्फान का मूल्यांकन करने पर यह साबित हुआ कि एन्डोसल्फान 0.05% को तीन बार (जून, जुलाई और सितन्बर के समय) या एक बार एन्डोसल्फान 0.05% (जूलाई में) करने की अपेक्षा तीन बार (अगस्त, सितम्बर और अक्तूबर में) 0.3% नीमगोल्ड या चार बार (जूलाई, अगस्त, सितम्बर और अक्तूबर में) नीमासल F 0.05 % छिड़कने से ज्यादा प्रभावशील दिखायी पड़ा । उपलब्ध नीम उपज के इन विट्रो मूल्यांकनों से 2 मि. लिटर / लिटर और उससे अधिक इकोनीम रूट नोट नेमटोडं के प्रति सबसे जहरीला साबित हुआ ।

काली मिर्च पर पोटैशियम फोसपेनेट के साथ ट्राइकोडरमा और ग्लियोक्लाडियम जैसे जैवनियन्त्रक एजेंट को मिट्टी में छिड़कने या डालने पर फैटोफतोरा खुर गलन का नियन्त्रण प्रभावित रूप में दिखाया गया । नियन्त्रण स्तर (72%) पर कोक्के कन्तु रोग प्रसंग के लिए अवांछित पौधा निष्कासन और-कीटनाशी का छिड़काव प्रभावी बन गये थे ।

पौधोगिकी हस्तांतरण

काली मिर्च के फैटोफतोरा फुट रोट, इलायची के क्लंप रोट/ रूट रोट और अदरक के राईसोम रोट आदि के जैवनियन्त्रण क्षमता पर परीक्षण डमोन्स्ट्रेशन 1074 हेक्टर खेत में किया गया ।

सत्र 1995-96 में इलायची को अरबिका काँफीवाली खेत में एकमात्र फसल के रूप में प्रस्तुत करने पर 1945 किलो ग्राम/(शुष्क)/हेक्टर की उत्पादन क्षमता पायी गयी । पुनरोपण क्रमानुगत तौर पर करने पर इलायची की उत्पादन क्षमता 1775 किलो ग्राम/ (शुष्क)/ हेक्टर थी । मृदा संरक्षण माप के आश्रय पर खडी ढाल भूमि में इलायची उत्पादित करने पर औसत उत्पादन क्षमता 982 किलो ग्राम/शुष्क/इलायची/हेक्टर आभिलेखित किया । उक्त साल इलायची का रोपण दलदल भूमि में संपरिवर्तित करने पर प्रति हेक्टर से 648 किलो ग्राम शुष्क इलायची पाये । कृषि वानिकी पर आधारित इलायची सस्य क्रम योजना में 0.22 एकड़ उच्चतल धान प्रदेश में वृद्धि और सिल्वर ओक में अभ्यस्त काली मिर्च पादप 90 किलो ग्राम शुष्क तक उत्पादन क्षमता प्रदान करते वक्त इलायची की उत्पादन क्षमता 110 किलो

ग्राम शुष्क होती थी ।

''मसालों में पौधाघर प्रबन्धन'', ''मसालों के उत्पादन प्रौघोगिकी'', ''मसालों के कृषि संसाधन'' आदि पर आधारित चार प्रशिक्षण कार्यक्रमों के आयोजन किये गये जिनमें विभिन्न राज्यों के 59 आधिकारियों ने भाग लिया था । मद्रास वाणिज्य मेला, कोचिन के राष्ट्रीय रबड सम्मेलन, आकाशवाणी - कालिकट के कृषि और घर यूनिट के वर्षगांठ, कालिकट के कोटुवल्ली की कार्षिक मेला आदि द्वारा आयोजित प्रदर्शनियों में इस संस्थान ने भाग लिया।

मसालों पर आखिल भारतीय समन्वित अनुसंधान परियोजना

इसी साल में देपोली (KKV, महाराष्ट्रा) कुमारगंज (NDUAT, उत्तर प्रदेश) रायपूर (IGKVV, मध्यप्रेदेश) और पुंटिबारी (BCKVV, पश्चिम बंगाल) आदि अखिल भारतीय समन्वित परियोजना में शामिल हुए।

फसल सुधार

पालघाट के निकट कांचिरपुषा से ''मुंडा'' नामक एक कृषियोग्य काली मिर्च किस्म, कुमकुमुडी और वंगसरा से 4 जंगली किस्में और षेवराय पहाडी से 20 विशिष्ट किस्मों को पहचान लिया । मसाल वृक्षों में परंपरागत क्षेत्र से 13 विशिष्ट लौंग जाति, आनमलइ पहाड से 10 दालचीनी की उपागम और कोल्ली पहाड से पीली जावित्री के जायफल आदि का अभिनिधार्रण किया । ओरीसा से अदरक और हल्दी की 4 किस्मों को संचित किया । जगतियाल केन्द्र ने अदिलाबाद, रायलसीमा और आन्ध्रप्रदेश के तटवर्ती प्रदेशों से हल्दी की जर्मप्लासम और भी जोड़ दिया। बीज मसालों के अन्दर जगुदान केंद्र ने गुजरात से 27 धनिया, 53 जीरा, 9 बडी सोंफ और 7 मेथी आदि सुस्पष्ट भेदों का अभिनिर्धारण किया । NBPGR के सहयोग से गुंडूर केन्द्र ने धनिया के 110 उपसाधन का समवेत किया ।

उत्पादन क्षमता का मूल्यांकन

पन्नियूर केन्द्र ने काली मिर्च के तीन और संकर संतति को अभिलखित किया गया । काली मिर्च की उदीयमान उपजों के मूल्यांकन में कुतिरवल्ली के साथ नीलमुंडी और आरकुलम मुंडा उच्चतम उत्पादन क्षमतावाले दिखाये गये। पांपाडुमपारा में PS - 31 और PS - 1 नामक इलायची क्लोन द्वारा अधिकतम उत्पादन प्राप्त हुए। P - 17, P - 8, CL - 728, CL 692, CL - 661, P - 12, CL - 730, CL - 757, P - 20 EB - 1277-7 क्षमतावाले क्लोनों को पांपाडुम्पारा और मुडिगेरी में इलयाची के उच्चतम उत्पादन क्षमतावाले क्लोनों को अच्छे रोपण वस्तुओं के तौर पर निर्धारित किया गया । मुडिगेरी के 8 इलायची के ऊतक संवर्धक कर्षण के मूल्यांकन से TC - 5 के ऊतक संवर्धक वरण सबसे अधिक आशाजनक रहे थे । वुड उपरोप और पाँप प्रिक्युवर्ड औरतोट्रोपिक के उपयोग और मूल कांड के दो पत्तेवाली दशा के जायफल में उच्चतम सफलता दिखायी गयी । पोटांगी के PTS - 19 के बाद PTS - 43(दीर्घकालिक और PTS - 59 (हस्व कालिक) को हल्दी की खेती में आशाजनक रूप में

अभिनिर्धारित किया गया । अदरक में SG - 666 और VIE - 8 आदि उच्चतम उत्पादन क्षमता दिखायी। जयपूर में संपन्न मसालों की आखिल भारतीय समन्वित अनुसंधान परियोजना के 13-वी राष्ट्रीय ग्रूप मीटिंग ने अदरक में SG 666 और ACC - 64, इलायची में मुडिगेरी 2, काली मिर्च में PLD - 2, हल्दी में ACC - 360, 361, धनिया में UD - 20, दालचीनी में Sel - 63 और In. 189 आदि मसालों की 9 किस्में विमाचित करने की सिफारिश की ।

फसल संरक्षण

चिंतापल्ली में काली मिर्च कर्षण प्रक्रिया के साथ साथ 1 किलो ग्राम नीम की खली + 3 ग्राम फोरैट + 1% बोर्डो मिश्रण पहले, और दूसरी बार अकोमिन (4%) छिडंकने पर फैटोफतोरा शुर गलन और नेमटोड के प्रभाव को कम किया गया। पन्नियूर में काली मिर्च सें नर्सरी रोग नियंन्त्रण के लिए 1% बोर्डो मिश्रण छिडंकने और 0.2% अकोमिन से ड्रेंचिंग करना प्रभावी रहा । चिंतापल्ली के अनुपचारित नियीन्त्रत प्रदेशों के 33.3% की तुलना में ट्राइकोडरमा हरसियानम और टि. विरीडी के उपचार से फैटोफतोरा खुर गलन का प्रसंग 8.3% रखा गया। मुडिगेरी केन्द्र में इलायची त्रिप्स के प्रबन्धन के लिए तीन छिड़कोव एक मार्च में (मानोक्रोटोफोस 0.05%) उसके पीछे दो बार, मई अगस्त में (फोसालोन 0.05%) अधिकतम प्रभावी सिद्ध हुए । एकीकृत विशलेषणे ने दिकाया कि फरवरी /अप्रैल/मई/आगस्त/अक्तूबर में पाँच कीटनाशी प्रयोग का उपचार पांपाडुम्पारा की इलायची के थ्रिप्स तथा प्ररोह बेधक के नियन्त्रण में प्रभावी है। जगतियल केन्द्र द्वारा हल्दी के टैफरिना पर्णदाग रोग नियन्त्रण के लिए डाइथेन एम 45(0.25%) छिड़कने की सिफारिश की गयी। जगतियाल में 77 हल्दी किस्मों द्वारा कोलोटोट्रिकम पर्णदाग के प्रति फील्ड रसिस्टन्स दिखायी गयी तथा 44 किस्मों द्वारा टैफरिना पर्ण दाग के प्रति जगुदान के फुसेरियम म्लानी के लिए विदेशी जीरा भेद जैरो EC - 232684, EC - 243373, EC - 243375 आदि प्रतिरोधक बन रहे ।

फसल उत्पादन

मुडिगेरी में स्वाभाविक छाया के अन्दर 150 : 150 : 225 NPK उर्वरकों की उच्च मात्रायें लगाने से इलायची की उत्पादन क्षमता की वृद्धि हुई हे। पोटांगी में अदरक (सुरुचि) के ऊपर N 125, P 100, K 100 लगाने से उच्चतम उत्पादन क्षमता (53000 रूपये/हेक्टर) का अधिकतम लाभ हासिल किया गया । पन्नियूर में cv. करिमुंडा के काली मिर्च पौधे 0.25 IW/CPE अनुपात में सिंचाई करने पर अधिकतम खूटी की प्राप्ति के लिए अत्युत्तम सिद्ध हुई । पोटांगी में हल्दी में मिश्रफसल के रूप में सोयाबीन उगाने से अधिकतम राईसोम उत्पादन क्षमता (17 टण/हेक्टर) पायी गयी । इसके द्वारा खेती की लगत कम हुई और इससे हल्दी खेती में दूसरी और तीसरी मल्चिंग की जंरूरत नही पडी।

कृषि विज्ञान केन्द्र

सन् 1995 जूलाई में पादप और पशु स्वास्थय केन्द्र की स्थापना हुई और इस केन्द्र में एक कृत्रिम इनसेमिनेशन यूनिट आंरभ करने का प्रबन्ध पूरा किया गया । वर्मिकल्चर, खुम्भी, मधुमक्खी पालन, राबिटरी, कुक्कुट पालन, नर्सरी प्रबन्धन आदि के लिए प्रदर्शन यूनिट की स्थापना हुई। कृषि, बागवानी और गुह विज्ञान आदि की 45 प्रशिक्षण पद्धतियों का आयोजन किया गया। जिनमें 3,500 प्रतिभागियों (किसान, कर्षक स्त्रियाँ,स्कूल से छुटे हुए और गुहवालियाँ)ने भाग लिया। खेती के क्षेत्र में नारियल के साथ मसालों के मिश्र फसल के रूप में उगाने के दस राष्ट्रीय प्रदशानियों के आयोजन किये गय। काली मिर्च के फायटोफथोरा खुर गलन और सुपारी के महाली रोग के नियन्त्रण के संबन्ध में समस्योन्मुख अनुसंधान का कार्य किया गया। कोचिन के राष्ट्रीय रबड सम्मेलन और प्रदर्शनी के (1995 नवेंबर 3-6) समय आयेजित कृषि और वैज्ञानिक प्रदर्शनी, आकाशवाणी कालिकट द्वारा चुंकत्तरा में संचालित कृषि और घर कार्यक्रम का वषगिांठ (1995 दिसंबर 27-30), कालिकट के कोडुवल्ली की कार्षिक मेला (1996 जनवरी 6-7) और वालुश्शेरी पंचायत प्रदर्शनी आदि में इस केन्द्र ने भाग लिया। इस केन्द्र पनिकोटूर गांव को गोद लिया जहाँ आश्रितोन्मुख (Client oriented) कार्यक्रम के अनुसार अनुसूचित जाति वर्ग के 25 परिवारों को रोपण सामग्रियाँ, कुक्कुट पालन और कृषि प्रोत्साहन सामग्रियाँ जो उनकी परिवारिक आय की वृद्धि के लिए उपयुक्त हो दी गयीं ।

1

Crop Improvement and Biotechnology

Spices germplasm was enriched by addition of new accessions - 75 black pepper, 60 cardamom, 9 turmeric, 22 ginger, 13 cinnamon, 29 nutmeg, 4 clove, 7 vanilla, 5 *Capsicum* and 7 *Ocimum*. A new yield trial of hybrids and selected OP lines of black pepper was initiated. In cardamom, 3 Wynad collections, a rhizome rot resistant clone and five mosaic virus resistant clones were short listed for multilocation trials based on their high yield and quality. One high yielding ginger variety, high quality varieties two each in turmeric and cinnamon were recommended for release at the XIII National Group Meeting of the AICRP on Spices held at Jaipur. Two ginger lines with bold rhizomes are in advanced stage of evaluation.

Micropropagation protocols for rapid clonal multiplication were standardized for tree spices like cinnamon and camphor and several herbal spices. 'Synseeds' were developed in ginger, cardamom, turmeric, cinnamon,

camphor, vanilla, anise, lavender and sage. Plant regeneration from callus cultures of vanilla was achieved for the first time. Somatic embryogenesis and plant regeneration were obtained from seed cultures of cinnamon, anther derived callus cultures of ginger and callus cultures of some herbal spices. Isozyme profiles for esterases and SOD using PAGE showed high variability in seed progenies of vanilla. RAPD profiles were recorded in black pepper and long pepper.

Gen. I (813)
Collection, conservation, cataloguing and evaluation of black pepper germplasm
K Johnson George, P N Ravindran, B Sasikumar and V S Korikanthimath

During the year, the collection included high elevation *Piper* species from Nilgiris and species indigenous to Andaman and Nicobar Islands. *P.cubeba*, a species of medicinal importance, was gathered from Witzenhausen, Germany. A survey in Idukki and Wynad districts helped to collect 48 cultivated black pepper types from farmers' gardens that escaped *Phytophthora* foot rot disease. Five collections of black pepper were also assembled from Trivandrum district (Table 1.1). Sixty accessions of black pepper were planted in the field and a block of laterals were established in the germplasm nursery.

Table 1.1 Piper *germplasm collections during 1995-96*

Place	Number	Details
Nilgiri Hills	18	High elevation *Piper* types including *P. silentvalleyensis*
North, Middle and and South Andamans	26	Species indigenous to Andamans & Nicobar islands including *P. longum*
Idukki District	33	Cultivated black pepper types including Neelamundi, Jeerakamundi and Narayakodi (*Phytophthora* foot rot disease escapes)
Wynad District	15	Cultivated black pepper types including Balankotta, Arakkulamunda and Wynadankodi (*Phythophthora* foot rot disease escapes)
Others	8	*P. cubeba* from Germany and five cultivated and two wild types from Brymoor, Trivandrum

Gen. IX (813)
Collection, conservation, cataloguing and evaluation of cardamom germplasm
Ravindra Mulge and M N Venugopal

A total of 288 accessions of cardamom and related genera were maintained at the centre. This includes sixty accessions collected in the








last season comprising of different types of panicles namely; compound panicle (multi branch), long panicle, compact panicle, and sterile. Among the bearing accessions assessed in the current season in germplasm blocks, 200 accessions were characterized as Malabar type, 51 as Mysore type and 27 as Vazhukka type. Action on shifting and assembling of entire germplasm in one block was initiated.

Evaluation of Wynad collections for growth and yield parameters showed significant difference among the entries for plant height, number of leaves, number of bearing and total tillers, number of panicles and wet capsule yield per plant. Superior clones viz., Vazhukka suckers, APG 223, APG 230, APG 228, APG 215 were selected and the trial is closed (Table 1.2). The entries APG 221 and APG 223 possess good quality capsules with high oil and α-terpinyl acetate and low 1-8 cineole.

Table 1.2 *Cumulative yield (four years) of selected entries of Wynad trial*

Entry	Cumulative yield (g/plant)
Vazhukka suckers	2734
APG 223	2364
APG 230	2247
APG 228	2153
APG 215	2063
Vazhukka seedlings	2059
APG 221	2034
Malabar seedlings	1996
SE m±	**195.0**
CD at 5%	**540**

Gen. II (813)

Collection, conservation, cataloguing and evaluation of ginger and turmeric germplasm

P N Ravindran, B Sasikumar, Johnson K George and K P M Dhamayanthi

Genetic Resources : Ginger and turmeric accessions collected during the year are given in Table 1.3. Four hundred and forty seven accessions of ginger, 697 accessions of turmeric and 9 accessions of *Kaempferia* were maintained in the field gene bank in cement tubs. Twenty seven accessions of 'Alleppey turmeric' were multiplied for further evaluation. Dry recovery of these accessions ranged from 14 (acc. 695) to 22% (acc. 697).

Yield evaluation of ginger : Fourteen accessions (bold rhizome type) of ginger were evaluated in replicated trials at Peruvannamuzhi for the second consecutive year. Mean yield and dry recovery of these accessions are presented in Table 1.4. Acc. 415 ranked first with respect to fresh yield.

Table 1.3 *Genetic resources of ginger and turmeric collected during 1995-96*

Crop	Place	Number	Remarks
Zingiber sp.	Queensland (Australia)	6	Cultivated types on exchange
,,	Bihar	2	Cultivated types (smooth rhizome)
,,	Andaman & Nicobar Islands	11	Cultivated and wild types
,,	Idukki	3	'Ellakallan' type, high oil type, cultivated
Curcuma sp.	Andaman & Nicobar Islands	7	Wild and cultivated
,,	Almora (UP)	2	Cultivated types

Table 1.4 *Mean yield and dry recovery of ginger accessions*

Accession	Mean yield/bed ($3m^2$)kg.	Dry recovery (%)
15	6.86	22.0
27	2.83	21.0
36	6.40	25.0
49	5.30	20.0
71	5.63	21.5
142	6.63	22.0
116	6.00	22.0
117	6.80	25.0
179	7.10	22.5
204	6.43	20.5
244	5.83	18.0
294	6.47	21.5
415	8.43	22.5
3573	7.58	22.0
CD	**0.60**	–
CV%	**11.60**	–















Quality analysis : The new ginger variety, IISR Varada and turmeric varieties, IISR Prabha and IISR Prathibha, proposed for release were multiplied. The quality attributes of these new varieties were verified at the Quality Evaluation and Upgradation Laboratory, Spices Board, Cochin (Table 1.5).

Table 1.5 *Quality attributes of ginger and turmeric varieties*

Spice	Variety	Quality parameter
Ginger whole	IISR Varada	Crude fibre (% by wt.) - 3.29
Turmeric	IISR Prabha (Finger)	Curcumin (% by wt) - 7.51 Oleoresin (EDC Extractable) (% by wt.)- 14.60 Volatile oil (% v/w) - 5.67
	IISR Prabha (Mother)	Curcumin (% by wt.) - 5.38 Oleoresin (EDC extractable) (% by wt.)- 14.05 Volatile oil (%v/w) - 6.67
	IISR Prathibha (Finger)	Curcumin (% by wt.) - 7.64 Oleoresin (EDC extractable) (% by wt.) - 15.46 Volatile oil (% v/w) - 5.67
	IISR Prathibha (Mother)	Curcumin (% by wt.) - 7.49 Oleoresin (EDC extractable) (% by wt.) 17.7- Volatile oil (% v/w) - 6.7

Source: Quality Evaluation and Upgradation Lab., Spices Board, Cochin

O.P. progenies in turmeric : The OP progenies of turmeric (25 accessions) raised during 94-95 were multiplied. Seeds from 3 more accessions were sown during the current year.

Evaluation of turmeric accessions with high curcumin : Ten accessions of turmeric possessing 7 per cent or above curcumin were evaluated in a replicated trial at Peruvannamuzhi for yield. The accessions differed significantly among themselves and acc. 295 ranked first (Fig 1.1).

Cataloguing of ginger : Morphological characteristics such as general appearance of the rhizome (Plumpy grades), length, breadth and internodal length of rhizomes, inner core colour (creamy, creamy blue, yellow, yellowish blue, etc.), presence or absence of rhizome scales, odour (strong, mild) etc., were recorded in 73 accessions. Dry recovery of another 50 accessions was also recorded for cataloguing. The dry

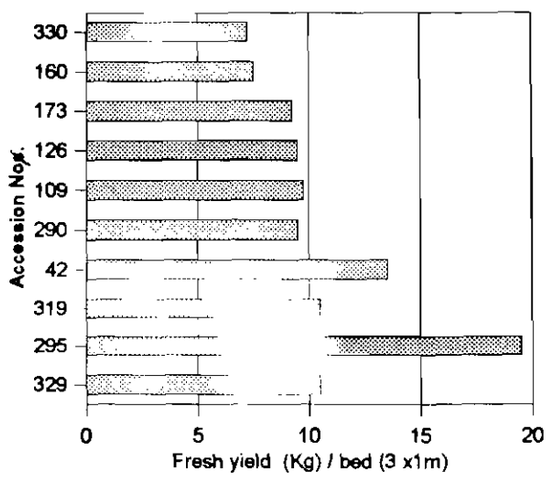


Fig. 1.1 *Mean yield of turmeric accessions with high curcumin*

recovery of these accessions varied from 18.3% (acc. 108) to 26.6% (acc. 206).

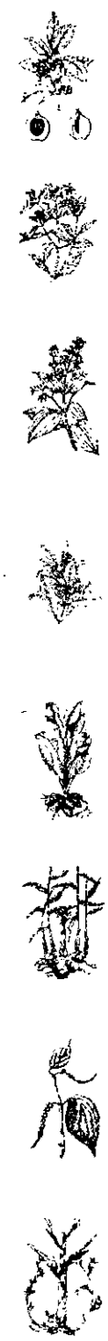
Reproductive biology of ginger : 'Pin' and 'thrum' types of incompatibility are reported to be one of the reasons for zero seed set in ginger. Analysis of flower features of 14 accessions of ginger did not reveal any 'thrum' type incompatibility feature. Pollen fertility in ginger (estimated through staining) varied from 14 to 27.9%.

Cytological studies in ginger : Chromosomal indexing of 21 accessions of ginger confirmed the somatic chromosome number 2n=22. 'B' chromosome was also observed in 2 accessions of ginger for the first time.

Gen. VI (813)
Collection, conservation, cataloguing and evaluation of tree spices germplasm

B Krishnamoorthy, J Rema, P A Mathew and V S Korikanthimath

Collection and conservation : Germplasm collection surveys were made in Andaman Islands, South Kanara and Coorg districts (Karnataka), Ponmudi (Kerala) and the Nilgiris (Tamil Nadu) and identified three elite nutmeg trees and twelve elite clove trees. Five cultivated cinnamon accessions, 8 wild cinnamon types, 13 cultivated nutmeg types, 16 wild nutmeg types and 4 clove types were collected and added to the germplasm. The collections include important species like *Cinnamomum macrocarpum* Hook. f.c. wightii, Meisson, *Myristica andamanica* Hook f.c.



and *Knema andamanica*, leaf variant type, clustered fruit type, cricket ball type and pink mace type (nutmeg).The present status of genetic resources of tree spices is given in Table 1.6. Nutmeg accession A9/4, a clone of Mannoor elite accession, yielded 800 fruits in the 7th year after planting. Progeny evaluation trials of clove at Calicut, Appangala and Peruvannamuzhi were maintained. Studies on dwarf clove seedlings are initiated.

Quality evaluation of cassia cinnamon : Out of 19 cassia cinnamon plants (4 years old) two lines having very high bark oil (5%) and cinnamaldehyde (95%) were selected (Table 1.7). Both bark oil and leaf oil have more

Table 1.6 *Genetic resources of tree spices (Figures in parenthesis denote 95 - 96 collections)*

Crop	Number of accessions			
	Exotic	**Cultivated**	**Wild and related**	**Total**
Cinnamon and Cassia	14	192(5)	56(8)	275
Nutmeg	Nil	405(13)	18(16)	452
Clove	2	210(4)	1	217
Allspice	Nil	137	-	137
Total	**16**	**944(22)**	**75(24)**	**1081**

cinnamaldehyde than eugenol in cassia cinnamon, as against more cinnamaldehyde in bark oil and more eugenol in leaf oil of *Cinnamomum verum*.

New cinnamon varieties : Based on quality and yield evaluation of elite cinnamon lines and clonal progenies, two high yielding and high quality

Table 1.7 *Quality analysis of 19 cassia cinnamon lines*

Quality parameter	Range (%)	Mean (%)
Bark oil		
Quantity	1.3 - 5.0	3.3
Cinnamaldehyde	53.6 - 96.0	79.5
Eugenol	12.0 - 38.2	15.3
Oleoresin	7.1 - 10.1	8.9
Leaf oil		
Quantity	0.8 - 1.8	1.4
Cinnamaldehyde	33.6 - 79.0	65.0
Eugenol	7.0 - 28.0	17.0

cinnamon varieties viz. "Navashree" (SL 63) and "Nithyashree" (In 189) were recommended for release during the All India Coordinated Research Project on Spices Group Meeting held at Jaipur (Table 1.8 and 1.9).

Navashree is a selection from open pollinated seedling progenies of a Sri Lankan introduction. It has high and stable regeneration capacity (6 to 7 shoots per year), high bark recovery (40.6%), high yield (average

Table 1.8 *Yield evaluation of clonal progenies of elite lines of cinnamon (pooled)*

Accession	Regeneration (Shoots/plot of 4 plants)	Fresh weight of bark (g)/plot of 4 plants	Dry wt. of bark (g)/plot of 4 plants	Yield of bark (kg/ha)	Recovery of bark (%)
SL 53	15.65	256.25	100.1	27.775	32.9
SL 63	25.45	488.95	201. 1	55.555	40.6
SL 65	23.00	468.80	187.4	52.217	36.6
In 189	18.90	511.15	194.6	54.161	30.7
In 203	18.20	314.45	123.1	34.163	32.7
CD at 5%	**4.01**	**138.10**	**54.41**	–	**5.32**

Table 1.9 *Yield evaluation of seedling progenies of elite lines of cinnamon (pooled)*

Accession	Regeneration (Shoots/plot of 4 plants)	Fresh weight of bark (g)/plot of 4 plants	Dry wt. of bark (g)/plot of 4 plants	Yield of bark (kg/ha)	Recovery of bark (%)
SL 5	33.15	379.80	160.40	44.580	32.122
SL 44	36.20	415.90	146.95	40.815	31.487
SL 53	36.95	501.85	213.00	59.160	32.895
SL 63	40.60	579.55	238.75	66.313	33.885
SL 65	38.70	489.20	204.30	56.744	39.620
In 189	36.80	528.25	216.65	60.175	35.735
In 203	38.90	419.40	170.20	47.273	33.460
In 310	29.70	367.05	141.55	39.316	32.545
In 312	34.78	373.90	152.85	42.454	31 050
CD at 5%	**NS**	**134.20**	**63.23**	–	**NS**








yield 56 kg/ha in the first harvest) in addition to excellent quality attributes (bark oil 2.7% with a very good cinnamaldehyde content 73%, bark oleoresin 8%, leaf oil 2.8%). Its important distinguishing morphological character is that the very young flushes are purple in colour and they turn green in 7- 10 days. It is recommended for all cinnamon growing places, both in plains and in high altitudes (open condition).

Nithyashree is another cinnamon selection from germplasm. This variety also has good and stable regeneration capacity (4 to 5 shoots per year), high yield (average 54 kg/ha in first four harvests) coupled with excellent quality attributes (bark oil 2.7%, bark oleoresin 10% and leaf oil 3%, with a very good eugenol content 78%). Its important distinguishing morphological character is that the very young flushes are purple in colour and they turn green in just 2 days. It is recommended for all the cinnamon growing places, both in plains and high altitudes (open condition).

Floral biology in wild nutmeg : One *Knema andamanica* flowered in the third year after planting. The inflorescence is cauliflorus type and the tree is male. Six *Myristica andamanica* trees flowered in the 7th year after planting, three of which are males and the other three are females.

Flowering and fruit setting in allspice: A preliminary trial was undertaken to study the effect of spraying Indole Acetic Acid (IAA) and Benzyl Amino Purine (BAP) in various combinations for increasing fruit set in allspice. In one of the trees which was sprayed with IAA 50 ppm + BAP 5ppm, ten unusually large sized berries that developed to full maturity could be harvested. Table 1.10 give the morphological characters of the berries of sprayed and unsprayed panicles. The number of seeds per berry varied from 4 to 20 in the sprayed panicles, as against 2 in control. The viability of seeds of the large sized berries was 78%. The seeds germinated in 20 to 30 days and the seedlings were healthy and vigorous.

Table 1.10 *Salient features of allspice berries developed from hormone sprayed and unsprayed panicles*

Character	Sprayed	Unsprayed
1. Fruit diameter (cm)	1.5 - 2.0	0.5 - 0.7
2. Mean fresh berry weight (g)	0.500	0.025
3. Mean no. of seeds per fruit	10.8	2.0
4. Seed size	Bold	Very small

Gen. XIII (813)
Collection, conservation and improvement of vanilla
P N Ravindran, B Krishnamoorthy, K Nirmal Babu and K Kandiannan

A germplasm collection of 15 accessions consisting of seven *Vanilla planifolia* collections and eight collections of related taxa, including one collection of *V.aphylla* and seven collections of *V.andamanica* was established. Ovule culturing of vanilla was standardised. About 150 lines in the lab and 60 lines in the nursery are now available.

Gen. VII.1 (813)
Breeding black pepper for high yield, quality and drought
B Sasikumar, P N Ravindran, T John Zachariah and K S Krishnamurthy

The existing yield evaluation trials were maintained and a new trial comprising of selected hybrids and cultivars was laid out at Peruvannamuzhi (Total entries - 40, Design - RBD, Replications - 3, Standard - *Erythrina indica*).

Interspecific hybridization of P. colubrinum *with* P. nigrum: A total of 19 cross combinations involving *P.colubrinum* with *P.nigrum* were attempted. The popular black pepper cultivars such as Panniyur- 1, Karimunda, Narayakodi, Perumkodi, Kottanadan, Aimpiriyan, Kalluvally, Kuthiravally, etc. were used as female parents. A triploid cultivar 'Vadakkan' was also used as a female parent in one of the crosses. Berry set was observed in all crosses except in the crosses with 'Vadakkan'. Preliminary observations on the hybrid seedlings indicate lack of hybrid nature.

Establishment of P. sugandhi *laterals:* Laterals of *P.sugandhi* (collected from Wynad) were established.

Yield trial on P. chaba: In a clove-arecanut intercropping plot, hundred *P.chaba* were planted on arecanut standards.

Gen. VII.2 (813)
Breeding black pepper for resistance to *Phytophthora*, pests and nematodes
P N Ravindran, B Sasikumar, Johnson K George, M Anandaraj, S Devasahayam and Santhosh J Eapen

Four pollu beetle tolerant lines viz. Acc. 816, 841, 1084 and 1114 were multiplied for further evaluation.








Gen. X (813)

Breeding cardamom for high yield and resistance to Katte disease

Ravindra Mulge and M N Venugopal

Evaluation of selections in MLTs: In MLT-1, five Mysore type selections along with local checks (CCS-1 and CL.37) are being evaluated for growth and yield parameters. Entries differed significantly among themselves for number of bearing and total tillers and number of panicles per plant but not for plant height, number of leaves and wet and dry yield per plant (Table 1.11).

Table 1.11 *Growth and yield of cardamom entries in MLT-1*

Entry	Plant height (cm)	No. of leaves	No. of tillers	No. of bearing tillers	No. of panicles	Wet yield (g/plant)	Dry yield (g/plant)
SKP 52	231	229	33.1	24.5	28.7	496	113
MCC 12	224	227	28.1	22.5	26.0	521	105
MCC 21	188	181	24.2	17.8	20.7	345	75
MCC 61	220	224	32.0	23.3	27.5	287	61
MCC 85	214	192	24.2	18.4	22.0	547	118
CCS 1	208	220	31.2	24.1	28.0	455	90
CL.37 (Bulk)	213	207	28.1	21.4	25.5	527	115
S.E. m±	**21.36**	**20.15**	**1.78**	**1.35**	**1.63**	**88.05**	**18.99**
CD at 5%	**NS**	**NS**	**5.3**	**4.1**	**4.9**	**NS**	**NS**

In MLT-2, Malabar type entries are being assessed along with local checks for growth and yield parameters. Entries differed significantly among themselves for plant height, number of leaves and number of tillers per plant and wet and dry yield per plant. Among the entries, number of bearing tillers and number of panicles per plant did not differ significantly. None of the entries yielded more than local checks (Table1.12).

Evaluation of hybrids: Six hybrids (including reciprocal crosses) along with four parents and one local check are being evaluated for growth and yield. In the current season entries did not differ significantly among themselves for plant height, number of leaves, number of bearing and total tillers, number of panicles and dry and wet yield per plant.

Table 1.12 *Growth and yield of cardamom entries in MLT-2*

Entry	Plant height (cm)	No. of leaves	No. of tillers	No. of bearing tillers	No. of panicles	Wet yield (g/plant)	Dry yield (g/ plant)
872	178	130	17.8	8.8	15.3	247	54
893	160	158	25.3	16.5	20.6	117	22
800	144	146	34.8	20.2	24.0	74	16
CL.679	179	152	22.2	12.7	15.0	197	44
CL.683	177	151	26.0	14.9	19.0	79	17
CL.726	168	210	33.1	18.0	23.6	79	13
MUD P-1	183	115	12.4	6.1	7.6	92	19
PV- 1	226	272	39.3	22.3	29.0	235	55
SKP- 14	199	222	29.2	20.4	26.0	142	28
SKP-72	243	296	29.2	20.9	26.6	167	38
SKP-21	272	266	35.2	21.8	27.3	328	61
SKP-100	155	205	35.2	22.0	27.7	107	23
MCC-34	176	133	19.1	14.6	14.3	83	16
CL.37 (Seedl.)	230	208	27.5	15.4	20.3	402	78
Mal. Bulk	189	255	28.5	26 2	32.7	281	61
S.E. m±	**18.62**	**25.28**	**5.12**	**4.02**	**5.17**	**58.83**	**12.27**
CD at 5%	**54**	**73**	**14.8**	**NS**	**NS**	**170**	**36**

Selfing and hybridization: In order to study the genetics of disease resistance and to develop high yielding and disease resistant clones, selfing and hybridization work was carried out using natural Katte escapes RR-1 and CCS-1 . The entries viz. NKE-12, NKE-19, NKE-26, NKE-27, NKE-34 and RR-1 were selfed and 447 seedlings were obtained from selfed seeds. Above mentioned entries (female parents) were crossed with CCS-1, NKE-19 and NKE-26 (pollen parents) and 1,100 hybrid seedlings were raised. Hybrid seedlings derived in the previous season are being maintained to take up field planting.

Multi branch OP progenies: Observations on plant height, number of tillers, tiller thickness, number of leaves per tiller, leaf length and breadth








and number of panicles per plant were recorded in 228 open pollinated progenies of multi branch plants. Statistical analysis revealed the significant variability among the progenies for number of tillers and number of panicles per plant.

Screening of Katte resistant entries: Performance of 16 natural Katte escape (NKE) entries for field resistance against natural infection of mosaic virus was consistent in all the three hot spot areas. Selfed and OP progenies of NKE were screened twice for mosaic virus resistance. The selfed seedlings of NKE-28 and NKE-5 have taken up infection. Second batch of selfed and OP seedlings were raised for confirming the reaction to virus.

Yield evaluation of Katte resistant entries: In a comparative yield trial, 16 Katte resistant clones are being evaluated along with other selections and local checks. In the second year, entries viz. NKE-3, NKE-12, NKE-19, NKE-32, NKE-34, NKE-72, NKE-78, CCS-1, RR-1, MB-3 and M-1 have significantly yielded high over local check (Malabar cultivar). The highest yield per plant was observed in NKE-12 (932 g/plant) followed by NKE-34 (873 g/plant) and NKE-32 (872 g/plant) and the lowest yield was observed in local check Malabar cultivar (480 g/plant).

Hort. I (813)
Vegetative propagation of tree spices
J Rema, P A Mathew and B Krishnamoorthy

Allspice: Semi hard wood cuttings of allspice were treated with IBA 500, 1000, 2000, 2500 and 5000 ppm for studying their ability in production of adventitious roots. The trial was undertaken in January with 3 replications and with 20 cuttings in each replication. Etiolated and pregirdled hard wood and semi hard wood cuttings of allspice were treated with Seradix or NAA 4000 ppm + IBA 4000 ppm in June and September for rooting. However, no rooting was observed.

Nutmeg: Patch budding, forked budding and chip budding of nutmeg were carried out on two root stocks viz. *Myristica fragrans* and *Gymnocranthera* sp. However, no union was observed in any of the root stocks studied.

Clove: Seedlings of *Eugenia uniflora, Syzygium aquae, S. lanciolatum, S. cuminii, S. jambos* and *S. fruticosum* were raised for using them as root stocks for grafting clove. Grafting of clove was carried out on the root stocks of *E.uniflora.*

Vegetative characters such as height, number of primary and secondary shoots, girth above the graft union and canopy were recorded in the approach grafts of clove planted in the field.

Cassia cinnamon: Rooting of cuttings of 22 accessions of cassia was carried out by treating the cuttings in Seradix B. Cassia could be successfully propagated vegetatively through semi hard wood cuttings with 90% success, in a period of 3 months. However, variability in rooting was observed among the various accessions (0-90%).

Preliminary studies indicate that cassia could be successfully grafted on one year old root stock of *Cinnanmomum* by wedge grafting.

Biochemical basis of root initiation in cinnamon cuttings: Biochemical parameters such as nitrogen, carbohydrate, reducing sugars, non reducing sugars and total phenols were analysed to understand the variation in rooting percentage observed among the 5 Sri Lankan accessions and also the seasonal variation observed in the rooting of cinnamon cuttings.

Biotech. I (813)
Tissue culture for rapid multiplication and evaluation of elite clones of cardamom
Ravindra Mulge and M N Venugopal

Somaclonal plants (230 numbers) produced in the previous season were screened for their reaction to mosaic virus in two cycles. In the first cycle 75% of the plants took up infection and all the remaining plants took up infection in the second cycle. In the current season 200 somaclones were produced and are being maintained to take up field planting.

Biotech. II (813)
***In vitro* selection for resistance to soft rot and bacterial wilt in ginger**
K Nirmal Babu and G N Dake

Production, multiplication and field evaluation of somaclones : Over 200 cultures of ginger plantlets and over 1000 cultures of embryoids were multiplied and maintained in the laboratory for *in vitro* selection as well as for planting. Over 200 somaclones were planted in pots and evaluated for yield this year also.

Multiplication of promising lines and disease escapes: Fifteen lines, identified as disease escapes and promising, were multiplied during the year. Some of the lines continued to be promising.















Isolation and purification of toxin from Pseudomonas solanacearum: The pathogenicity determinant crude toxin (EPS), produced by the pathogenic strains of *P.solanacearum,* was passed through Dowex-1 and 50 columns. The elute was further reduced to 1/10th of its original volume by using freeze drier.

Anther and cell culture: Plant regeneration was noticed in anther derived callus cultures of both diploid and tetraploid ginger. Fifty cell cultures were established and oil cell formation was noticed in them.

Isolation of DNA: DNA was successfully isolated from two accessions of somaclones.

Biotech. III (813)
Micropropagation of black pepper
J Rema and K Nirmal Babu

Field evaluation of Piper *species:* The tissue cultured plantlets of *Piper nigrum, P. colubrinum, P. betle, P. longum* and *P. chaba* are under field evaluation for various vegetative and reproductive characters.

Production of black pepper plantlets: To undertake a field trial on tissue cultured plantlets of black pepper, cv. Karimunda was micro propagated from shoot tip explants. About 370 rooted plantlets of black pepper were hardened and are available for planting in the field for evaluation.

Cost of production of black pepper tissue culture: Cost of a tissue cultured black pepper plantlet was estimated to be Rs.5.73 when the variable cost alone was used for computing the cost of cuttings.

Biotech. IV (813)
Biotechnological approaches for crop improvement in black pepper
K Nirmal Babu, J Rema, B Sasikumar and P N Ravindran

Production of somaclones: Over 100 cultures of somaclones were raised from seeds. They are in various stages of multiplication.

Isolation of protoplasts and DNA: Protoplasts were isolated from black pepper. This technique is to be refined further for better yield and survival of protoplasts. DNA was successfully isolated from three species of *Piper* viz. *P.nigrum, P.longum* and *P.colubrinum.* This DNA was of good quality and was completely digested using Eco R5 restriction enzyme.

RAPD profiles of black pepper: RAPD profiles were recorded in two species of *Piper* viz. *P.nigrum* and *P.longum* using 15 random primers. Of these, most of the primers gave positive differences between these species.

ICAR A.P. Cess fund Project

Developmental morphology of rhizomes of ginger and turmeric

P N Ravindran, A B Remashree and K K Sherlija

(Collaborator: K Unnikrishnan, Department of Botany, University of Calicut)

Internal structure of rhizomes of ginger and turmeric showed an outer and an inner zone, separated by intermediate layers. Collateral vascular bundles were scattered and were more abundant in inner zone. The xylem was with scalariform thickenings and perforation plates. The phloem consisted of sieve tubes and 5-7 companion cells. After the development of primary vascular cylinder, the secondary thickening meristem (STM) produced secondary vascular bundles (amphiphloic and inverted) and parenchyma cells. Once this development was completed and the STM was not distinct, single endodermoid layer occupied its place. In ginger, the shoot apex was with a single layered tunica while in turmeric it is two layered. The axillary buds arose exogenously from the abaxial side of the scale leaves. The roots originated endogenously from the intermediate zone. Numerous starch grains, varying in their shape, size and number were present in both sides of intermediate zone. The resin (oil) canals were abundant in the ground parenchyma. The oil canals were formed lysigenously by the disintegration of entire cells. Presence of cambium was an important feature found in ginger and turmeric rhizomes.

CONCLUDED PROJECTS

DBT Projects

1. *In vitro* conservation of spices germplasm

K V Peter, P N Ravindran, K Nirmal Babu, Sreerenjini Devi Pillai, C Manjula and Geetha S Pillai

Objectives

The main objectives of this project were to standardize ideal protocols for *in vitro* conservation and cryopreservation in spices such as black pepper, cardamom, ginger, turmeric and their related taxa so that a method for safe storage of valuable base collection of these spices with least risk and maximum possible genetic stability can be worked out.

Technical programme

Standardization of an ideal protocol for:

- shoot tip / meristem culture for micropropagation
- minimal growth to increase the subculture interval
- cryopreservation








Studying the effect of minimal growth storage and cryopreservation on tissue viability

Studies on genetic stability in *in vitro* conserved and cryopreserved materials

Micropropagation

a) *Materials and methods*

Explant and surface sterilisation: Shoot tips were used as explant for culture initiation in black pepper and related species whereas rhizome buds were used in cardamom, ginger, turmeric and other related taxa. Explants were collected from the source plants, grown in the nursery, surface sterilized and rinsed thoroughly in distilled water. Explants of about 2-3 cm size were cut under water and inoculated on to the medium.

Culture media and culture conditions: Different basal media were tried to select out the suitable one for optimum results. WPM (Woody Plant Medium) was found to be suitable in black pepper and related taxa. WPM supplemented with 0.5 mgl^{-1} BA and 2% sucrose was used as culture initiation medium. The basal medium supplemented with 1.0 mgl^{-1} kinetin and 3.0 mgl^{-1} BAP and solidified with 0.7% agar was used for multiplication. Shoot tips were harvested and kept for rooting in half strength growth regulator free medium. In cardamom and related taxa, MS (Murashige and Skoog) basal medium was suitable for the induction of favourable results. The cultures were initiated in MS supplemented with 0.5 mgl^{-1} kinetin. Different hormonal combinations were tried to find out the best suitable medium for multiplication. Cytokinins (BA and kinetin) and auxins (NAA and IBA) were tried singly and in combination at 0.5 and 1.0 mgl^{-1}. The pH of the culture medium was adjusted to 5.8 before being autoclaved. The cultures were incubated at 22 ± 2°C under a light intensity of 2500 lux.

Hardening and field establishment: The rooted plantlets were transferred to a mixture of garden soil, sand and vermiculite (1.:1:1) in thermocol cups or polybags and kept in humid chamber for 20-30 days for hardening. Hardened plants were transferred to nursery and after required growth they were transferred to field.

b) Results

Black pepper and related species: Micropropagation protocols were standardised in black pepper (*Piper nigrum*), long pepper (*P. longum*), Java long pepper (*P. chaba*), betle vine (*P.betle*), *P.barberi, P.colubrinum* and *P. hymenophyllum*. Within 30-90 days multiple shoots ranging from

5-15 could be harvested in WPM supplemented with 3.0 mgl^{-1} BA and 1.0 mgl^{-1} kinetin. The excised shoots could be rooted in growth regulator free WPM medium within 30 days. The rooted plantlets could be transferred to soil and established with 80-90% survival.

Cardamom and related taxa: Micropropagation protocols were standardised in cardamom (*Elettaria cardamomum*), ginger (*Zingiber offcinale*), turmeric (*Curcuma longa*) mango ginger (*Curcuma amada*), kasturi turmeric (*Curcuma aromatica*), *Kaempferia galanga, K.rotunda, Alpinia purpurea* and large cardamom (*Amomum subulatum*). Rhizome buds initiated to grow in MS with 0.5 mgl^{-1} kinetin within 10 -20 days. All the zingiberaceous taxa except large cardamom gave optimum rate of multiplication (5-10 shoots) in MS supplemented with 0.5 mgl^{-1} NAA and 1.0 mgl^{-1} BA within 30-90 days after culture initiation. In large cardamom multiple shoots upto 8 and rooting could be achieved in MS medium with 0.5 mgl^{-1} IBA and 1 mgl^{-1} BA. *In vitro* rooting could also be achieved in the same medium. Hence the need for a separate medium for rooting was overcome. The individual plants with good root system could be separated and planted out.








In vitro conservation: Minimal growth storage

a) *Materials and methods*

Shoot tips of about 2 cm size were excised from the *in vitro* grown cultures of black pepper and three of its related species like *P. barberi, P.colubrinum* and *P. longum* and were used for the experiments. Plantlets of about 2cm size were used as explants in cardamom and its related taxa.The following parameters were tried singly and in combination for inducing minimal growth and thereby extending the subculture interval up to a minimum period of one year.

i) basal medium strength**	:	full and half
ii) carbon source (sucrose)	:	30, 25, 20, 15, 10 and 5 gl^{-1}
iii) osmoticum(mannitol)	:	5, 10 and 15 gl^{-1}
iv) vessel closures	:	cotton plug, screw cap, polypropylene cap and aluminium foil
v) temperature*	:	5, 10, 15, 20±2°C
vi) glycerol***	:	10, 15 gl^{-1}

(* Effect of low temperatures (5 and 10 °C) were tried only in cardamom; ** MS basal salts were used for cardamom and related taxa whereas WPM for black pepper and related species; *** Effect of Glycerol was tried only in cardamom cultures)

Each treatment had 10 - 20 replications. The medium (25 ml) was poured in each culture tube and closed using different types of closures. Observations were made on growth rate, general vigour of the cultures, symptoms of drying, yellowing, decay, vitrification, exhaustion of the culture media, minimum, optimum and maximum period of storage, viability after storage and survival after transfer to soil.

b) Results

i. Effect of different vessel closures: When analysing the rate of evaporation in terms of exhaustion of culture medium, it was observed that use of sealed culture tubes (screw cap, polypropylene cap and aluminium foil) minimised the loss of moisture and thereby reduced the rate of media exhaustion to a great extent. Even after 360 days, the exhaustion of medium was very low which resulted in green and healthy cultures due to the availability of nutrients. In sealed culture tubes, only 25% of the medium was lost after 360 days, whereas in the tubes closed with cotton plugs, 75% of the medium evaporated within 120-180 days. Though cotton plugs, allowed better gaseous exchange, it was not suitable for long term storage of *in vitro* cultures.

ii. Effect of temperature: Normal culture room temperature (22±2°C) was suitable for the growth of cultures of all the species. Low temperatures of 5°C and 10°C were deleterious to cardamom cultures. The cultures turned white around the fifteenth day and lost their viability within 20 days. A sort of chilling sensitivity was observed under low temperatures. At 15°C, cardamom cultures could be stored up to a maximum period of one year, but the cultures showed etiolation which may be due to insufficient light.

iii. Effect of media constituents: Generally full strength of the basal medium along with sucrose at higher levels (30 gl^{-1}) resulted in increased rate of growth, rapid exhaustion of media and hence was not suitable for storage more than six months. By reducing the basal medium concentration to half and sucrose to 20 gl^{-1} cultures showed normal growth. Gradual reduction of sucrose and addition of mannitol resulted in induction of minimal growth and the cultures could be stored up to a minimum period of one year with 70- 80% survival in different species. Half strength WPM with 15 gl^{-1} each of sucrose and mannitol was suitable for inducing slow growth in shoot tip cultures of black pepper and the subculture interval could be extended up to a minimum period of one year and a maximum period of two years. In *P. barberi,* full strength WPM with 25 gl^{-1} sucrose and 5 gl^{-1} mannitol and half strength WPM with

30 gl^{-1} sucrose induced minimal growth with 80 and 70% survival, respectively, after one year. In *P.colubrinum* and *P.longum* the cultures could be stored up to one year in full strength WPM with 20 gl^{-1} sucrose and 10 gl^{-1} mannitol with 75% and 70% survival, respectively. Other *Piper* species such as *P. betle, P. hymenophyllum, P. arboreum, P. crocatum, P. hapnium* etc. are also conserved in *in vitro* repository in half strength WPM with 20 gl^{-1} sucrose with yearly subculture. Using this method 40 accessions of 10 species of *Piper* are kept in the *in vitro* repository for short term conservation.

In cardamom, half strength of the basal medium with mannitol and sucrose at 10 mgl^{-1} each or 15 mgl^{-1} each was suitable for inducing slow growth in cultures with more than 80% survival after 360 days of storage. Using this method, 70 accessions of cardamom germplasm could be conserved under slow growth with yearly subculture.

The method of *in vitro* conservation in cardamom was extended to other related taxa namely ginger, turmeric, kasturi turmeric, mango ginger, *Kaempferia* sp. and large cardamom, *Alpinia*. It was found that all the zingiberaceous taxa could be stored up to a maximum period of one year without subculture in $^1/_2$ strength MS with 10 gl^{-1} each or 15 gl^{-1} each of sucrose and mannitol. But the viability of this technique is to be reexamined by further experimentation

Shoot tip cultures of two species of Vanilla i.e., V. planifolia and V. aphylla (an endangered species) could be successfully kept under minimal growth conditions in MS medium supplemented with 10 gl^{-1} each of sucrose and mannitol up to a period of more than two years without subculture.

In vitro conservation being a tool for conserving germplasm, irrespective of the agroclimatic conditions in which they grow, attempts were made to conserve some of the seed and herbal spices like anise, thyme, marjoram, oregano, lavender, peppermint, spearmint, sage, celery etc. under minimal growth conditions. All of them could be conserved up to three to eight months without subculture.

Cryopreservation

A programmable freezer (Planer Cryo- 10 series III) for controlled cooling of the material and liquid nitrogen storage vessels to store the accessions were procured.

i. *Meristem/Embryo culture*: As a preliminary step to initiate cryopreservation work, meristem isolation and culture was attempted in cardamom, ginger















and turmeric. Meristem with three to four leaf primordia could be isolated and cultured in MS medium containing 0.5 mgl^{-1} kinetin. They were regenerated into whole plants within one to two months.

Embryos were isolated from ten cultivars of black pepper and cultured on WPM supplemented with 0.5 mgl^{-1} BA. The embryos germinated into whole plants within one month.

ii. *Experiments for cryopreservation*: Materials such as seeds, shoot buds and meristem of cardamom and embryos of black pepper were subjected to cryopreservation by rapid as well as slow cooling techniques. Cryoprotectants such as dimethyl sulfoxide (DMSO), glycerol and sucrose at 5-15% levels were tried singly and in combination to pretreat the material. A cooling rate of -1 °C min^{-1} up to -40 °C and -5 °C min^{-1} to -100°C and sudden plunge into LN_2 were tried. After pre treatment, the materials were plunged into LN_2 without controlled cooling. Once frozen the materials were thawed in a water bath (+37 -40°C) for 3-5 minutes. Then the materials were plated or inoculated on to the culture medium devoid of cryoprotectants and kept for recovery. Attempts are going on to find the ideal treatments for cryopreservation and the assessment of viability will take some more time.

Tissue viability after *in vitro* storage

a) *Materials and methods*

The cultures were taken out from slow growth medium and transferred to multiplication medium specified for each species. After rooting, the plantlets were transferred to a mixture of soil, sand and vermiculite (1:1:1) in polybags or thermocol cups and kept in humid chamber for 20 - 30 days for hardening. The hardened plants were transferred to nursery for further growth and study.

b) *Results*

The conserved cultures of *Piper* species could be successfully transferred directly from the slow growth medium to soil with about 80% survival. When the cultures were transferred back to the multiplication medium, more than 90% of the cultures multiplied nomally. The excised shoot tips were induced to root and transferred to soil with about 80- 90% survival. The cardamom cultures were multiplied normally and transferred to soil with 90% survival.

Genetic stability analysis after storage

In the present study, organised cultures such as shoot tip and meristem cultures were used for storage. The cultures showed direct organised

regeneration after culture initiation and growth regulators were completely eliminated from the medium. But there is the possibility of tissue culture instability in minimal growth techniques mainly due to imposition of stress and selection pressure on cultures. The genetic stability analysis of the conserved material can be assessed by different methods like morphological, cytological, biochemical and molecular markers. All the species in which the *in vitro* conservation by minimal growth is stardardized, the materials were brought back to normal condition and the cultures multiplied normally without any morphological differences from the stock materials used for conservation. The plantlets were planted out and they resemble the parent material morphologically indicating the apparent genetic stability. Isozyme analysis has been used to a limited extent to detect changes in tissue cultured plantlets. Trials on stability analysis using isozyme patterns were initiated and it requires further studies to standardize the method.

Table 1.13 *Present status of* in vitro *repository at IISR*

Crop species	No. of species	No. of accessions	Storage period (months)	Viability after storage (%)
Piper sp.	10	40	12-24	70-80
Elettaria sp.	1	70	12	80
Zingiber sp.	1	70	12	70-75
Curcuma sp.	3	56	12-18	70-80
Alpinia sp.	1	1	12	70
Amomum sp.	1	1	12	80
Kaempferia sp.	2	2	12-18	70-80
Vanilla	2	65	24	90
Seed & herbal spices	15	15	6-8	80
Tree spices	3	3	3-6	80

2. Rapid clonal propagation of tree spices

P N Ravindran, K Nirmal Babu, J Rema, Minoo D, Anitha A, Mini P M, John C Z and Sajina A

Objectives

- Standardization of viable protocols for rapid clonal multiplication of elite genotypes in tree spices (nutmeg, clove and cinnamon) through tissue culture
- Standardisation of protocols for plant regeneration from callus cultures
- Genetic characterisation studies








Standardization of suitable explant

a) Materials and methods

i. Disinfection of the explants: Spraying the mother plants as well as treating the explants with different fungicide solutions like Fytolan (0.3%), Indofil (0.3%) and Bavistin (0.3%) were tried . Surface sterilisation of the explants was done using different sterilants like 70% ethanol, sodium hypochlorite solution (5-10%) and mercuric chloride (0.05-0.2%) for different time periods and in different combinations. Explants were wiped thoroughly with a weak detergent solution, washed with water and immersed in fungicide solution (0.3% Indofil) with a wetting agent (Tween 20 or Tween 80) for an hour. Later they were washed in water and shifted to the Laminar Air Flow chamber. The explants were rinsed in 70% alcohol, washed with sterile distilled water and then treated with 0.1% mercuric chloride for 5-7 minutes (depending upon the tissue viz.mature or juvenile, used). Treatment with sodium hypochlorite solution (1:15) for 15 minutes before mercuric chloride treatment was done in explants collected from field and was not necessary in seedling explants.

ii. Selection of explant: *In vitro* responses of explants collected from both mature and juvenile plants were studied. Shoot tips and nodal segments from 7-8 year old trees were used as mature tissues whereas explants from six months to one year old seedlings were used as juvenile tissues in cinnamon, nutmeg and clove, particularly for direct regeneration studies (multiple shoot induction and *in vitro* rooting).

Leaf, stem segments and cotyledons were used for studies to induce indirect regeneration. Explants from *in vitro* germinated seedlings in cinnamon, clove and embryos in nutmeg were cultured to study the responses of juvenile tissue. Nutmeg mace (aril) tissue was utilised to induce proliferation of the spice *in vitro*.

iii. Pre-treatment of the explant: Tree spices have known to be slow in response to different culture media in *in vitro* studies, hence several pretreatments to induce faster growth were tried. They are

- removal of the shoot tips one week before collecting the successive nodal segments so that apical dominance no more inhibits the growth of axillary buds and the latter are pre activated to grow before inoculation
- over night incubation in BAP and IBA (0.01%-0.1 %) solutions as a pulse treatment for shoot and root induction, respectively

- incubation in Ascorbic acid solution (0.01-0.1 %) to prevent inhibition due to oxidation of phenolics
- collection of explants into picric acid
- treatment of explants with 8-hydroxy quinolinine sulphate, to reduce contamination, and
- treatment with 5-10% hydrogen peroxide to break dormancy of the buds

b) *Results*

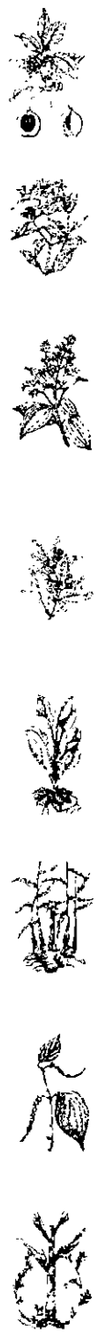
Spraying of the mother plants with any of the fungicides, twice a week reduced contamination of explants. There were no differential effects among the fungicides used. Treating the explant with 70% alcohol followed by mercuric chloride (0.1 %) helped in reducing contamination. In all these crops, excising shoot tips one week prior to collecting the subsequent nodal segments and utilising the pre activated axillary buds as explants was more favourable.

In cinnamon, when explants were collected from field grown trees, fungal contamination was over 90%. Collecting explants from nursery grown plants reduced contamination to 80%. However, fungal contamination arising from the buds (covered with scale leaves), led to loss of cultures even after 30-40 days of establishment and activation of the bud.

Establishment of contamination-free explants was a major problem in clove, coupled with delayed initial response which may be due to inhibitory effects of phenolic exudates. Incubation of explants in ascorbic acid prior to inoculation did not help, but its incorporation in the medium along with activated charcoal showed better bud growth.

The high rate of fungal contamination in nutmeg hindered the establishment of contamination-free cultures. Ninty per cent of the explants collected from field grown trees were infected by fungal growth by the fourth day of culture. Regular spraying of mother plants, surface disinfection procedures, collection of explants into picric acid and 8-hydroxy quinolinine sulphate, based on reports that they prevent fungal growth, did not prove to be very useful. However, explants collected from seedlings grown under nursery conditions established with over 60% success.

Taking into consideration all the above factors, a surface sterilisation procedure for the explants after collection was chalked out. This was










the most suitable to all the tree spices and was used for further experimentation.

In cinnamon, juvenile explants were found to be faster and better in response except in *C.camphora*, where the mature explants were equally good. In clove, though faster response was initially induced, further proliferation was better in mature explants. Orthotropic shoots in nutmeg, collected after detopping one week prior to inoculation, was better.

Standardization of suitable medium

a) Materials and methods

Different basal media viz. (Murashige and Skoog), Woody Plant Medium, Gamborg's B5 and White, supplemented with auxins (IBA, NAA, pCPA, and 2,4-D) and cytokinins (BAP, Kinetin, 2iP and Zeatin) ranging from 0.5 mgl^{-1} to 3 mgl^{-1} were tried singly and in combinations to achieve direct as well as indirect regeneration.

In nutmeg, the above media were insufficient to induce responses and hence a Broad Spectrum Experiment (De Fossard *et al.*, 1974) was done, utilising all the components of the nutrient media as four groups:

Group A	:	Macro nutrients and micro nutrients
Group B	:	Auxins
Group C	:	Cytokinins
Group D	:	Growth factors and amino acids each at three different levels; Low(L), Medium(M) and High(H).

Incorporation of activated charcoal (0.1-0.5%), ascorbic acid and antioxidant mixture (ascorbic acid + citric acid) were tried to overcome inhibition by phenolic exudates in cultures, especially of clove. Compounds like adenine sulfate and phloroglucinol were also incorporated in the media since they are reported to stimulate adventitious shoot formation. To overcome any inadequacy of amino acids in the basal media, substitution with casein hydrolysate (1 gl^{-1}), Hermin (commercially available preparation of a group of amino acids) and coconut milk (100-200 ml^{-1}) was also tried. Initial incubation of cultures in light as well as dark was also tried.

The pH of the culture media was adjusted to 5.8 before autoclaving at 120°C for 20 minutes. The cultures were incubated at 22±2 °C for 14 hrs at 2500 lux.

b) Results

Among the different basal media tried, Woody Plant Medium was favourable in activation and growth of explants in all the three species of cinnamon viz. *Cinnamomum verum*, *C. cassia* and *C. camphora*, *in vitro*. Apical buds from mature as well as juvenile explants could be activated initially by culturing in media supplemented with 0.5 mgl^{-1} kinetin. Multiple shoots up to seven from mature and up to ten from immature could be induced when activated shoot explants from the establishment media were subcultured onto WPM supplemented with cytokinins (BAP 3mgl^{-1} + Kin 1 mgl^{-1}) in *C. verum*. Axillary buds were also induced to produce multiple shoots (2-5) in the same media. In *C. camphora* multiple shoots up to 10 and in *C. cassia* up to six could be induced from actively growing nodal segments of mature tree in the same media.

Shoots separated from the multiplied cultures, developed healthy roots in WPM supplemented with 0.5 mgl^{-1} IBA + 0.5 mgl^{-1} NAA in *C. verum* and *C.cassia*. Rooting was observed in about 60 days in 70% of the established cultures at the rate of 2-5 roots/culture. In *C.camphora*, incorporation of activated charcoal (2 mgl^{-1}) into the multiplication media or in completely growth regulator free media led to the development of a vigorous root system *in vitro*.

In vitro developed plantlets in *C. verum* and *C. camphora* have been successfully transferred to soil. All the three species of cinnamon responded almost similarly *in vitro*, though *C. camphora* showed a higher multiplication rate and faster root induction system.

Woody Plant Medium favoured growth of clove cultures, though bud break was induced in all the media and shoot tips from mature trees as well as seedlings could be activated to grow in media supplemented with IBA (0.5 mgl^{-1}). Incorporation of activated charcoal was essential for the growth of the axillary bud since phenolic exudation from the cut end, inhibited growth of the buds. Multiple shoots up to seven could be induced from mature nodal segments and seedlings when cultured in WPM supplemented with BAP (3) and Kin (1 mgl^{-1}). The rate of multiple shoot production was very low and when produced there was lack of elongation of the shoots. Supplementing the nutrient medium as liquid phase with quartz sand or filter paper bridges as support for the explant, resulted in increased number of multiple shoots with better elongation since the liquid phase allowed better contact with the explant.

In vitro rooting could be induced in shoot tips when cultured in WPM supplemented with IBA (0.5 mgl^{-1}) and activated charcoal (2 gl^{-1}).















However the results were not consistent and the technique requires further refinement.

In nutmeg, orthotropic as well as plagiotropic shoots from mature trees and seedlings were utilised. Single noded cuttings from these were cultured to activate the buds. Axillary buds from orthotropic shoots were activated to grow into an axillary branch with up to 3 leaves/node. Woody tree species have weaker regenerative capacity and compared to clove and cinnamon, induction of rejuvenation in nutmeg was much slower.

Initial attempts with known basal media, pulse treatments with BAP and IBA solutions, removing apical buds one week prior to collection of activated successive nodal segments to overcome apical dominance, treatment with hydrogen peroxide etc. did not yield any favourable response except for initial bud break. After 30-40 days of culture initiation the medium was found to be insufficient to sustain the growing tissue, leading to browning and death of the explant. Phenolic growth inhibition was overcome to some extent by addition of activated charcoal and ascorbic acid in the medium .

Since all these attempts did not give any encouraging results, Broad Spectrum Experiment (De Fossard et al., 1974) was carried out. Among the 81 possible combinations which were tried, it was concluded that low nutrient level coupled with medium level of growth factors and amino acids were favourable for culture initiation and for further maintenance, incorporation of activated charcoal was essential. Further, all possible combinations that included 'low nutrients' and medium growth factors' in combination with auxins and cytokinins at three levels were tried. Among these, activation as well as elongation of axillary shoots were observed in medium with low nutrient concentration and medium level of growth factors and amino acids. Attempts to induce roots led to formation of root like friable structures.

Since juvenile tissue responded faster than mature tissue, embryos isolated from mature as well as immature seeds were cultured *in vitro* in medium supplemented with activated charcoal and coconut milk (200 mgl^{-1}). Mature embryos responded faster in that the radicle and plumule developed in 30 days, the cotyledons opened and developed serrated margins.

Hardening and establishment in soil

a) Materials and methods

Cinnamon (*C. verum* and *C. camphora*) shoots were induced to root *in vitro* and after the development of healthy roots (without intervening

callus) were hardened before transfer to soil. Different planting mixtures viz. coir dust, soilrite or vermiculite, sand were used singly and in combinations. Maintaining initial humidity was tried by methods like covering the transferred plantlet with a polythene bag, transferring the plants to a humid chamber as well as growing them in the incubation room for some more time. After hardening, the plants were transferred to polybags containing garden soil, farmyard manure and sand and maintained under nursery conditions.

b) Results

Plantlets established with over 60% success in *C. verum* and *C. camphora* by the following steps. The agar medium with the plantlet was slowly disrupted to allow easy removal of the plant with minimum damage to the roots. The roots were then thoroughly washed off the agar to avoid infections by fungi and bacterial growth on any remains of the nutrient medium. These plantlets were transferred to sterilised planting medium (soilrite or coir dust) to further avoid microbial contamination, in cups covered with polybags.

In *C. verum* the *in vitro* developed plantlets were transplanted to sterilised soilrite in cups covered with polybags and kept in incubation room (temperature 22 ± 2 °C and relative humidity 60%) for 30- 40 days. They were then transferred to polybags containing a mixture of garden soil, farmyard manure and sand in equal proportions, under nursery conditions.

In *C. camphora* plantlets generated were transferred to cups containing sterilised coir dust for first stage of hardening and kept in incubation room for 40-60 days. Later they were transferred to polybags containing soil: perlite: sand (1:1:3) mixture for second stage of hardening in the nursery.

Standardization of callus induction and regeneration to exploit somaclonal variation

a) Materials and methods

In cinnamon, callus was induced from leaf, stem, petiole and bark explants in MS medium supplemented with 2,4-D and IBA (0.5-2.0 mgl^{-1}). Leaf explants from seedlings of clove, nutmeg and aril tissue (mace) were induced to produce callus.

b) Results

Callus cultures of *C. verum* and *C.camphora* were established from tissues of stem, leaf and petiole in MS supplemented with 2, 4-D(2 mgl^{-1}). Friable








callus from both the species have been utilised for establishing suspension cultures in liquid medium kept in rotary shakers for exploiting possible production of secondary metabolites *in vitro*. Cinnamon bark from juvenile shoots of mature tree (7-8 years) were induced to proliferate by callus induction in WPM medium supplemented with IBA.

Immature seeds (4-5 months old) of cinnamon produced somatic embryos from the embryogenic axis in 3-5 weeks of culture on MS medium supplemented with 0.5 mgl^{-1} kinetin and 2% sucrose in 25% of the cultures.

Leaf segments from clove seedlings were induced to produce callus in MS supplemented with 2,4-D (2 mgl^{-1}). They could be proliferated and maintained in the same medium by frequent subculturing. To broaden the available genetic base in clove, attempts to induce regeneration have been made leading to morphogenetic calli (green) and calli with pink pigmentation (characteristic of juvenile clove shoots). Rhizogenesis was induced from callus when polyethylene glycol was supplemented in the medium to induce stress conditions.

In nutmeg, callus could be induced from internodal regions and cotyledons, in MS supplemented with 2,4-D (2 mgl^{-1}), however the callus did not proliferate. *In vitro* proliferation of nutmeg mace (aril tissue) from immature as well as mature fruits could be induced in WPM supplemented with IBA (0.5 mgl^{-1}). The proliferated mace not only retained the reddish colour of the spice but also had the flavour. The gas chromatographic analysis has indicated that this proliferated tissue is similar to that of natural mace in GC profile.

Conclusions

There is a huge demand for disease free clonal planting material of high yielding varieties in tree spices. Standardisation of protocols for rapid propagation by tissue culture will go a long way in meeting the demands, in addition to solving many of the crop specific problems. This project was envisaged to meet the above demands and expand tree spices cultivation in the country.

Micropropagation protocols have been developed in cinnamon (*C. verum* and *C. camphora*). WPM supplemented with BAP(3 mgl^{-1}) and Kinetin(1 mgl^{-1}) is the optimum medium for multiple shoot induction and supplemented with IBA or activated charcoal induced roots in all the species of cinnamon and clove. In clove, the technique requires refinement before a protocol for large scale multiplication is available. In nutmeg, bud break and elongation of the axillary bud were achieved.

Crop Production and Post Harvest Technology

Application of NPK with micro nutrients Zn, B and Mo is imperative for improved varieties of black pepper viz. Subhakara and Sreekara. NPK application at bimonthly interval increased the nutrient availability in soil and improved yield of pepper compared to slow release NPK tablets. Potassium sulphate was a better source of K for pepper. Bush pepper can be grown in field economically at a spacing of 2 x 2m with a fertilizer dose of NPK @ 10:5:20 g/bush in three equal splits during January, May and September. The growth of Panniyur 1 and Panniyur 3 was superior to other released varieties and a pre release line, P24. Irrigating black pepper @ 7 l/day/vine through drip during October to March resulted in maximum yield. Soil application of *Azospirillum* enhanced the growth of black pepper in nursery. One year old clove seedlings, raised in vermicompost were as good as two year old, conventionally raised seedlings, in terms of growth and vigour. African earthworms (*Eudrillus eugenia*) converted more than 90% of organic waste into usable compost in three months and there was a two fold increase in their population.

Chlorophyll content in Panniyur 5 and Sreekara increased after January while it remained almost constant during the growth period in other eight high yielding black pepper varieties. P24, Panniyur 1 and 2 had higher levels of chlorophyll content while it was low in Panniyur 3 and Panchami. Acc. 891, 908, 1079, 1092 and 1114 maintained greater membrane stability and higher relative water content during stress period.

During the year, 1.02 lakh black pepper rooted cuttings, 23 tonnes of turmeric, 2500 clove seedlings, 800 nutmeg grafts and 5150

cinnamon seedlings were supplied to various agencies. At Appangala, 16,000 cardamom seedlings and 172kg seed capsules were distributed.

In cardamom, NKE 3 contained high volatile oil and RR 1 and NKE 73 contained high alpha terpinly acetate. MI-1 and MI-5 contained more than 8% oil and MI-3, MI-2 and MI-6 contained high alpha terpinyl acetate. The Wynad cardamom selection, APG 221 consistently gave 7.8% essential oil containing 19% 1,8-cineols and 53% alpha terpinyl acetate. Ginger Acc. 18, 13, 35, 51, 151, 215, 179 and 249 had crude fibre less than 3.5%. Curcumin content of turmeric Acc. 360, 361, Suguna and Sudarsana at Coimbatore, Jagtial, Dharwad is about 40% less compared to that at Calicut and Moovattupuzha. *Cinnamomum cassia* accessions D-1, D-3 and D-5 had more than 4% bark oil with high cinnamaldehyde content and A-6 had high leaf oil with about 72% cinnamaldehyde.

Agr. VI (813)

Studies on the impact of input technologies on the yield performance and quality attributes of black pepper

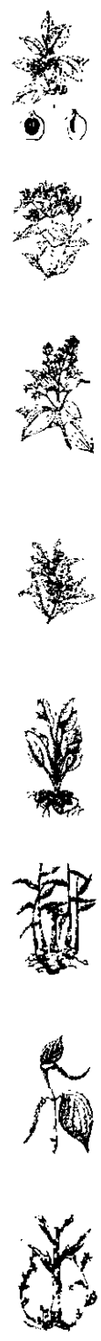
K Sivaraman, A K Sadanandan, C K Thankamani, K Kandiannan and K S Krishnamurthy

Irrigation requirement of black pepper: An experiment on irrigation requirement of black pepper was initiated during 1988. Modified treatments (Table 2.1) were imposed during 1993 as per the suggestion of the staff research council. The results obtained during the year indicated that irrigating black pepper vines @ 7 litres per day per vine through drip during October to March resulted in maximum yield of 3.36 kg dry pepper per vine compared to control (0.96 kg/ha) (Table 2.1).

Table 2.1 *Black pepper yield under different irrigation levels*

Treatment		Yield (kg /vine /year)
1. Irrigation at IW/CPE 0.3	Oct-March	1.075
2. ,, ,,	Oct-April	0.962
3. ,, ,,	Oct-May	1.420
4. Irrigation at IW/CPE 0.6	Oct-March	1.525
5. ,, ,,	Oct-April	1.755
6. ,, ,,	Oct-May	1.503
7. Irrigation at IW/CPE 0.9	Oct-March	2.369
8. ,, ,,	Oct-April	2.448
9. ,, ,,	Oct-May	2.056
10. Drip Irrigation 7l/day	Oct-March	3.306
11. ,, ,,	Oct-April	2.801
12. ,, ,,	Oct-May	2.516
13. Control (No Irrigation)	-	0.962
CD at 5%		**1.600**

Agro-physiological studies: This experiment was initiated to study the agro-physiological characteristics of released varieties of black pepper. *Ailanthus malabaricum* seedlings were used as standards. The data recorded (Table 2.2 & 2.3) on morphological parameters of 10 varieties of black pepper indicated that the performance of black pepper










varieties, Panniyur 1 and Panniyur 3, was superior than the other released varieties including a pre-release line, P 24.

Table 2.2 *Growth increment of black pepper varieties during July - December 1995*

Variety	% increase in height	% increase in dia. at base	% increase in dia. at 1 m height
Sreekara	45.510 (42.420)	31.40 (34.077)	17.51 (24.693)
Subhakara	46.940 (43.236)	37.67 (37.857)	21.89 (27.893)
Panchami	48.022 (44.200)	27.92 (31.900)	14.78 (22.470)
Pournami	46.234 (42.758)	38.43 (38.310)	10.86 (19.153)
P 24	52.470 (46.426)	26.45 (30.943)	9.08 (17.553)
Panniyur 1	52.976 (46.706)	40.93 (39.747)	27.38 (31.550)
Panniyur 2	42.626 (40 354)	25.68 (30.373)	13.06 (21.050)
Panniyur 3	46.602 (43.040)	44.73 (41.957)	23.12 (28.703)
Panniyur 4	33.004 (34.474)	36.57 (37.223)	12.88 (21.003)
Panniyur 5	49.390 (44.660)	27.12 (31.230)	14.17 (22.103)
CD at 5%	**(5.588)**	**(3.589)**	**(2.594)**

Figures in parentheses indicate transformed values

Table 2.3 *Morphological characters and stomatal frequency of 10 black pepper varieties.*

Variety	Internodal length(cm)	Leaf area+ (cm^2)	Petiole length(cm)	Petiole dia. (cm)	Stomatal frequency*
Sreekara	6.418	39.420	3.434	0.289	10.3
Subhakara	7.466	55.213	3.434	0.373	10.1
Panchami	5.828	52.137	3.872	0.348	9.2
Pournami	5.716	63.970	3.752	0.345	9.6
P 24	7.012	61.483	3.428	0.352	11.2
Panniyur 1	6.358	105.410	4.544	0.396	10.7
Panniyur 2	5.744	55.997	3.668	0.361	11.0
Panniyur 3	6.250	68.370	3.436	0.373	10.4
Panniyur 4	5.476	62.397	3.764	0.350	10.3
Panniyur 5	5.092	41.710	2.452	0.273	10.3
CD at 5%	**0.744**	**6.252**	**0.538**	**0.029**	**-**

+ Youngest fully matured leaf **Frequency per 40x microscopic field*

Total soluble sugars in the leaves of black pepper varieties increased gradually from August and reached a peak during October, then showed a declining trend till February and again showed an upward trend in March (Table 2.4). Total chlorophyll content varied significantly among the varieties in all months except December. In general, P 24 maintained higher chlorophyll content during all months. Varieties behaved differently during each month and no specific trend could be seen. The ratio of chlorophyll a to b (Chl.a/Chl.b) was comparatively less during August-December and it increased during Feb-March in all varieties (Table 2.5).

Table 2.4 *Total soluble sugars (mg/g fresh weight) in black pepper varieties*

Variety	Aug	Sept	Oct	Dec	Feb	Mar
Sreekara	62.8	63.5	68.2	50.67	32.07	34.80
Subhakara	64.8	62.1	73.8	52.30	36.13	38.37
Panchami	49.4	55.3	54.2	43.17	42.50	43.85
Pournami	64.7	71.4	59.6	53.23	37.07	48.40
P 24	49.4	51.4	62.7	46.97	29.33	41.10
Panniyur 1	68.3	70.4	74.7	60.98	28.30	38.60
Panniyur 2	67.4	65.3	75.9	46.69	30.33	38.08
Panniyur 3	73.2	78.1	80.2	45.77	26.13	36.10
Panniyur 4	50.7	54.2	46.6	52.23	43.23	43.60
Panniyur 5	54.2	66.4	66.7	49.86	25.63	35.20
CD at 5%	**5.8**	**5.4**	**4.9**	**6.85**	**6.11**	**6.44**

Table.2.5 *Total chlorophyll (mg/g fresh weight) and chl.a/chl.b ratio of black pepper varieties*

Variety	Total chlorophyll				Chl.a/chl. b(Aug-Dec)	Total chlorophyll		Chl.a/chl b(Feb March)
	Aug	Sept	Oct	Dec	(Mean)	Feb	Mar	(Mean)
Sreekara	1.32	1.46	1.35	1.22	2.30	1.75	1.73	2.64
Subhakara	1.08	0.96	0.80	1.26	2.25	1.27	1.42	2.54
Panchami	1.30	1.12	1.01	1.21	2.18	1.04	0.95	2.44
Pournami	1.03	1.08	1.14	1.40	2.20	0.99	1.46	2.45
P 24	2.16	1.98	1.80	1.42	2.22	1.67	1.67	2.50
Panniyur 1	1.61	1.50	1.43	1.30	2.38	1.52	1.37	2.52
Panniyur 2	1.44	1.38	1.66	1.24	2.20	1.69	1.45	2.50
Panniyur 3	1.13	1.04	0.94	1.24	2.13	1.10	0.99	2.45
Panniyur 4	1.44	1.32	1.50	1.43	2.19	1.29	1.15	2.42
Panniyur 5	1.24	1.14	1.20	1.58	2.22	1.60	1.60	2.45
CD at 5%	**0.42**	**0.41**	**0.36**	**NS**	-	**0.34**	**0.20**	-

Agr. XIV (813)

Investigations on spices based cropping systems

V S Korikanthimath, R Hegde, K Sivaraman, M N Venugopal and A K Sadanandan

During the year, cardamom and other component crops started bearing. Yields were recorded in the field experiments on cardamom based cropping system and mixed cropping with coffee. Physiological and micro climatic parameters were recorded in each crop combination by using the LCA-3 instrument.

Growth and yield of component crops: During the year 1995-96, cardamom as a sole crop recorded the highest yield of 592.5 kg(dry)/ha followed by combination of cardamom with clove (520.7 kg/ha) and cardamom + nutmeg (497.8 kg/ha). Lowest cardamom yield of 335.7 kg (dry)/ha was noticed in the cardamom and pepper combinations. Coffee (Cauvery-arabica) as a sole crop recorded the maximum yield (1092 kg dry berry/ha) compared to 346 kg/ha in coffee mix cropped with cardamom. A maiden yield of 78.64 kg dry pepper/ha was recorded during the year 1995-96. Flowering and fruit set was noticed in some allspice plants mix cropped with cardamom. The yield in 1995-96 and the average of three crop seasons (1993-94 to 1995-96) are illustrated in Fig 2.1.

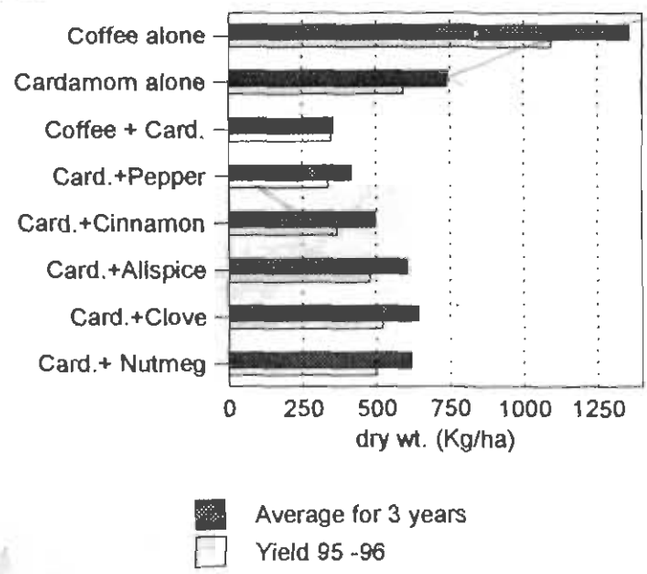


Fig. 2.1. *Yield of cardamom and coffee in mixed cropping*

Physiological parameters: Among the various crop combinations, cinnamon recorded the highest transpiration rate and it was lowest with clove and cardamom sole crop (Table 2.6). Leaf temperature was highest when coffee and cardamom were grown as sole crops. Highest stomatal conductance was recorded in pepper when grown along with cardamom. Allspice showed highest photosynthetic rate. Intercellular CO_2 concentration was highest in coffee as a mixed crop.

Microclimate: In all the crop combinations the humidity inside the leaf chamber was lower than inside the crop canopy. Crop combinations involving cardamom + cinnamon and cardamom + pepper allowed better infiltration to photosynthetically active radiation compared to other combinations (Table 2.7).

Table 2.6 *Physiological parameters in a cardamom based cropping system*

Crop combination	Transpiration (Milli mole H_2O m^{-2})	Leaf temperature (°C)	Stomatal conductance (µmol. $CO_2 m^{-2}$)	Photosynthesis (µmol. CO_2 m^{-2})	Inter cellular CO_2 conc. (µmol. $CO_2 m^{-2}$)
Nutmeg + Cardamom	0.8	31.6	0.03	3.30	88.40
Clove + Cardamom	0.4	33.2	0.01	0.91	179.86
Allspice + Cardamom	1.0	32.4	0.04	6.80	178.00
Cinnamon + Cardamom	2.1	32.6	0.10	4.33	174.30
Pepper + Cardamom	1.4	31.7	1.30	4.58	157.52
Coffee + Cardamom	0.9	31.9	0.04	2.86	216.16
Coffee sole crop	1.8	34.7	0.06	2.70	187.00
Cardamom sole crop	0.4	33.4	0.01	2.05	79.75

Table 2.7 *Microclimatic parameters in a cardamom based cropping system*

Crop combination	Humidity inside (%)	Humidity outside (%)	PAR (mol m^{-2})	
			Above	Below
Nutmeg + Cardamom	36.00	39.20	814.60	61.00
Clove + Cardamom	34.86	37.00	840.66	61.25
Allspice + Cardamom	37.00	37.00	815.20	378.07
Cinnamon + Cardamom	37.00	46.00	815.25	141.38
Pepper + Cardamom	40.00	46.10	904.89	116.71
Coffee + Cardamom	39.30	43.67	961.80	55.83
Coffee sole crop	39.00	46.00	960.00	280.00
Cardamom sole crop	39.87	41.80	968.90	79.30








Agr. XVI (813)

Irrigation requirement of black pepper - clove mixed cropping system

C K Thankamani, K Sivaraman, K Kandiannan, B Krishnamoorthy and K S Krishnamurthy

The soil of the experimental plot was analysed for various parameters. The bulk density of the soil was 1.43 g/ cm^3 and the particle density was 2.22 g/ cm^3. The available nitrogen, P_2O_5, K_2O, Mg and Ca were 133, 14, 269, 48 and 374 ppm, respectively. The root characteristics of six month and one year old clove seedlings were studied and the data is presented in Table 2.8. Tap root lengths of 19.9 cm and 30 cm were recorded in six month and one year old clove seedlings, respectively. The maximum number of roots were concentrated in the upper 5 cm layer in both cases.

Table 2.8 *Root characteristics of clove seedlings*

Age	Tap root length (cm)	Root distribution (No.) at different depths (cm)					
		0-5	6-10	11-15	16-20	21-25	26-30
Six months	19.9	11.5 (6.85)	10.00 (7.67)	4.5 (10.30)	6.0 (9.85)	-	-
One year	30.0	13.0 (7.0)	9.5 (5.0)	10.5 (7.4)	7.0 (6.0)	4.0 (6.3)	5.0 (5.5)

Figures in the parentheses indicate maximum length of root (cm)

Agr. XVII (813)

Vermicompost production using organic wastes available in cardamom

Rajendra Hegde and V S Korikanthimath

Besides local earthworm (Appangala), earthworms were collected from Sirsi (Uttara Kannada) and Sagar (Shimoga) in Karnataka. But local earthworms could not survive in the conditions at which African earthworm (*Eudrillus eugenia*) performed very well. Study on the composting of wastes initiated in 1994 - 95 indicated that coffee husk alone is not a good food for earthworm (Table 2.9). Their population decreased in this medium. When various organic wastes are mixed with leaf litter, the composting rate increased, so also the earthworm population. The composting rate increased substantially when all the wastes are mixed in equal proportion with cowdung slurry.

Table 2.9 *Vermicomposting of organic wastes in three months*

Waste used	Conversion percent	Worms wt. gain (g)*
Coffee husk (Parch ment)	22.62	-31.70
Coir dust	56.20	200.00
Arecanut husk	30.76	135.00
Leaf litter	41.30	211.00
Coir dust + Leaf litter	46.31	100.00
Areca husk + Leaf litter	37.62	300.00
Coffee husk + leaf litter	29.10	25.00
Coir dust + Areca husk + Coffee husk + Leaf litter	80.70	150.00

**Initial worm wt. 100 grams*








Agr. XVIII (813)

Biofertilizer application on growth, yield and quality of black pepper

K Kandiannan, K Sivaraman, C K Thankamani, G N Dake, M Anandaraj and K S Krishnamurthy

An experiment was initiated to evaluate different sources of *Azospirillum* for growth of black pepper with five treatments (four sources of *Azospirillum* - TNAU:Tamil Nadu Agricultural University, Coimbatore; CPCRI:Central Plantation Crops Research Institute, Kasaragod; IOC: Indian Organic Chemicals, Pune; Stanes: Stanes Company Ltd, Coimbatore and a control). Observations were recorded on growth characters at 30 and 90 days after planting (DAP) and the results are given in Table 2.10 and 2.11.

Table 2.10 *Effect of* Azospirillum *on growth of black pepper rooted cuttings*

***Azospirillum* source**	**Fumigated soil**		**Non-Fumigated soil**	
	30 DAP	**90 DAP**	**30 DAP**	**90 DAP**
TNAU	20.40	45.59	14.12	44.80
CPCRI	15.12	49.59	16.06	35.79
IOC	13.56	46.48	16.66	38.93
Stanes	13.20	41.10	15.10	33.60
Control	13.45	29.94	10.87	22.38
CD at 5%	**NS**	**12.01**	**NS**	**12.01**








Effect of *Azospirillum* on plant height and leaf area was not significant at 30 DAP. However, it was significant at 90 DAP. Application of 10 g *Azospirillum* into 5 kg of the growing medium (Potting mixture - soil:sand:FYM in the proportion of 1:1:1) enhanced the growth over uninoculted control both in fumigated and non-fumigated soil at 90 DAP. There was no significant difference among the sources of *Azospirillum*.

Table 2.11. *Effect of* Azospirillum *on total leaf area (cm^2) of black pepper*

Azospirillum	Fumigated soil		Non-Fumigated soil	
source	30 DAP	90 DAP	30 DAP	90 DAP
TNAU	69.09	2796.89	73.47	2643.488
CPCRI	72.00	2584.54	67.92	2680.590
IOC	66.36	2667.95	74.64	2517.670
Stanes	62.98	2534.94	60.33	2584.645
Control	55.94	1519.98	79.63	1503.243
CD at 5%	**NS**	**937.34**	**NS**	**937.34**

Agr. XIX (813)

Management efficacy of whole farm approach in farming - a study on cardamom based farming system

Rajendra Hegde, P Rajeev and V S Korikanthimath

In the whole farm approach, the management attention is equally shared between all the crops and other enterprises without increasing the market purchased inputs to improve the farm. For this, effective recycling of all kinds of organic wastes is essential. To increase the productivity on a long term basis, it is planned to include the unexploited tree spices like *Garcinia* , monkey jack, vanilla, etc. in the project. Accordingly to initiate the project 150 seedlings of each are now being raised. Whole farm plan is also prepared.

Gen. I (443)

Production of parental materials and breeders' stock of spices

K Sivaraman, V S Korikanthimath, K Kandiannan and B Krishnamoorthy

Black pepper: About 1.02 lakh rooted cuttings of released black pepper varieties were produced by rapid multiplication through split bamboo method and distributed to various government development agencies

in Kerala, Karnataka, Tamil Nadu, Goa and North Eastern States. Cuttings were also supplied to the progressive farmers. About 1950 bush pepper were also distributed.

Cardamom: About 16000 cardamom seedlings and 172 kg seed capsules were produced and distributed from Cardamom Research Centre, Appangala.

Turmeric: Twenty three tonnes of turmeric seed rhizomes of four varieties viz. Alleppey, Suguna, Suvarna and Sudarsana were produced and distributed.

Tree spices: Clove seedlings 2500, nutmeg grafts 800 and cinnamon seedlings 5150 were raised and supplied.

S.Sc. II (813)

Nutritional requirement of improved varieties of spices

A K Sadanandan and K Sivaraman

Nutritional requirement of improved varieties of pepper: In the field experiment to work out the optimum response of the improved varieties of black pepper to graded doses of NPK and micronutrients, the NPK treatments during June and the micronutrients during September were given. The experiment is in progress. Yield data showed that vines receiving the treatment NPK @ 150, 60, 270 kg/ha with micronutrients recorded the highest yield during second year of harvest also. Among standards non living gave slightly high yield compared to living standards and the variety Sreekara was superior to other varieties (Fig. 2.2).

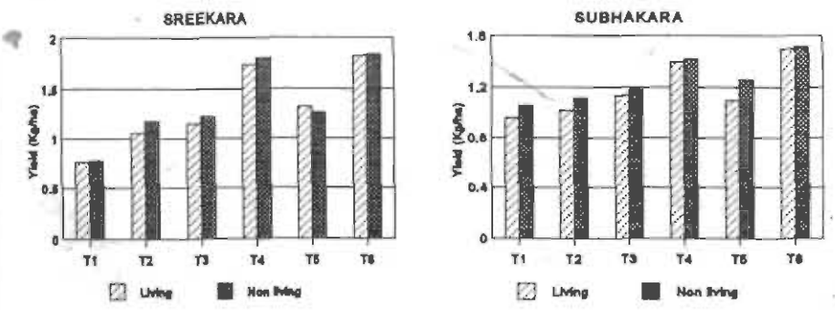


Fig. 2.2. *Yield response of pepper varieties to nutrients grown on different standards during 1995-96. (T1- Control, T2- NPK @ 50, 20, 70 kg/ha, T3 - NPK @ 100, 40, 140 kg/ha, T4 - NPK @ 150, 60, 270 kg/ha, T5-T2 + Zn, B, Mo @ 5, 2, 1 kg/ha and T6 - T4 + Zn, B, Mo @ 5, 2, 1 kg/ha)*








Field experiment with bush pepper of two varieties (Panniyur-1 & Karimunda) and two spacings (1 x 2 m and 2x2 m) was maintained and NPK was applied @ 10, 25, 20 g per plant in January, May and September. Growth and yield were recorded. Among spacings, 2x2 m and among varieties, Karimunda recorded the maximum yield (1149 g / vine) during third year also.

In the pot experiment to compare the effect of slow release NPK tablet (composition NPK 6:3:12) with that of bimonthly application of NPK @ 1, 0.5, 2 g /plot, the latter was found to be superior with regard to nutrient availability as well as yield of bush pepper. The yield was 189 g/ bush on bimonthly application of NPK @ 1, 0.5, 2 g while this was 152 g when equivalent NPK tablets were added annually.

Lime requirement of pepper : Pot experiment to study the effect of application of lime @ 1/4, 1/2, 3/4 and full lime requirement for bush pepper in a laterite soil was maintained and treatments were imposed in May. Analysis of soil samples for pH, nutrients, etc. showed that liming increased pH (5.7 to 7.2) and exchangeable Ca in soil (608 to 1824 mg / kg). With regard to yield, application of lime at 1/2 requirement was found to be optimum.

Sources of potassium for pepper : Experiment to study the effect of potassium (potassium chloride, potassium sulphate, potassium nitrate and wood ash) on bush pepper was maintained and treatments were given during May, July, September, November, January and March. Soil samples, collected and analysed for K, showed that all the sources were on par with regard to the availability of K in soil. But potassium sulphate was found to be a better source with regard to yield, probably because of the additional sulphur contributed by it. The yield of the bush treated with K_2SO_4 was 235 g compared to 192, 162, 128 and 66 in KCl, KNO_3, wood ash and check, respectively. The experiment is in progress. .

Investigations on Magnesium nutrition in black pepper: Field experiment was laid out and planting was done during June 1995 using three varieties viz. Subhakara, Pournami and Panniyur-1. Magnesium will be given @ 0, 50, 75 and 100 kg/ha. There was 76% survival. The experiment is in progress.

Organic farming in black pepper: Bimonthly application of organic manures (poultry manure, goat manure, pig manure and farm yard manure) was done in the green house experiment using bush pepper. Observations recorded showed that poultry manure followed by goat

manure were superior to farm yard manure with regard to yield and nutrient availability.

To study the effect of organics on availability of nutrients, yield and quality of black pepper, a field experiment was laid out in June 1995 using cv. Subhakara. The treatments comprising of different sources of organics will be superimposed. The experiment is in progress.

Nutrient requirement for targetted production of black pepper: Planting of black pepper cv. Subhakara was completed and the treatments will be superimposed during May/June 1996. A plot consisting of 500 vines at Pulpally has been located. Basic data are being collected for superimposing treatments.

Nutrient buffer power of Potassium in different soils: Green house experiment was conducted using 3 types of soils (Peruvannamuzhi-I, II and III), four levels of K viz. 0, 50, 100, 200 ppm and turmeric cv. Alleppey as test crop. Soil samples were analysed for K and plant samples for K uptake and curcumin. Yield, K uptake and curcumin were maximum in Peruvannamuzhi-III soil series as in the previous year.

Evaluation of different sources of rock phosphate for yield and quality of ginger and turmeric: The experiment was laid out for evaluation of three sources of rock phosphate (MRP, RP and GP) with and without farm yard manure and super phosphate (SP) in ginger and turmeric, separately. Soil and plant samples were collected and analysed for P availability and plant content, respectively. It was found that in the case of ginger, soil available P was maximum in the treatment, full recommended NPK, where P was applied as SP in full. Maximum number of tillers were recorded in treatment, recommended NPK, where P was applied 2/3 as RP + 1/3 as SP.

In the case of turmeric, maximum availability of P in soil was observed in treatment, recommended NPK, where P was applied 2/3 as MRP + 1/3 as SP. Maximum yield was recorded in treatment 1/2 recommended NPK + FYM, where P was applied as GP, followed by 1/2 recommended NPK + FYM, where P was applied as MRP.

Phy. III (813)
Quality evaluation in spices
T John Zachariah

Evaluation of cardamom segregants and selections: Quality evaluation of Wynad selections for three years has shown that among the 33 selections APG 221 and 218 consistently gave 7.8 % oil ,19 % 1, 8 cineole








and 53 % alpha terpinyl acetate . On per plant basis APG 221 and 223 yielded highest oil.

Among the 73 segregants evaluated for quality ASH-C -C8, ASH-A-E7 and ASH-D-MB44 are superior in essential oil and terpinyl acetate.

Among the 44 escapes evaluated for quality, NKE 3 contained highest oil (7.5 %) and RR 1 and NKE 73 contained high terpinyl acetate, which is an indication of quality.

Among the seven MLT- 1 samples MI-1 and MI-5 contained more than 8 % oil and MI-2,3,6 contained high alpha terpinyl acetate and linalyl acetate.

Evaluation of ginger at different locations : Fifteen ginger accessions each from Moovattupuzha and Peruvannamuzhi, 16 from Mananthody, 25 from Ambalavayal, 83 germplasm samples and 27 samples from Brahmavar (Karnataka) were analysed for crude fibre and oleoresin. The results are given in Table 2.12.

Table 2.12 *Quality of ginger accessions at different locations*

Location	Crude fibre (range-%)	Oleoresin (range-%)
Germplasm	3.3-7.5 (Acc. 287,288,22, 18,13,35 & 228)	3.5-9.0 (Acc. 164, 7 & 20)
Peruvannamuzhi	2.8-7.0 (Acc. 51 & 151)	3.7-6.3 (Acc.no. 11)
Moovattupuzha	3.0-5.4 (Acc. 51, 63, 64 & 295)	3.7-6.4 (Acc. 11)
Ambalavayal	2.8-5.1 (Acc. 51, 64,151,215,249 & 250)	3.5-6.8 (Acc. 141 & 238)

Twenty seven ginger samples from Brahmavar were evaluated for crude fibre and oleoresin. Crude fibre of some of the popular cultivars were low compared to the reported values (Nybe *et al.*, 1980) (Fig. 2.3).

Effect of location on curcumin content: Curcumin content of Alleppey, Suguna, Sudarsana, Acc. 360 and 361 at different locations viz. Peruvannamuzhi, Moovattupuzha, Coimbatore, Jagtial and Solan were studied. About 35-40 % decrease in curcumin content is observed in

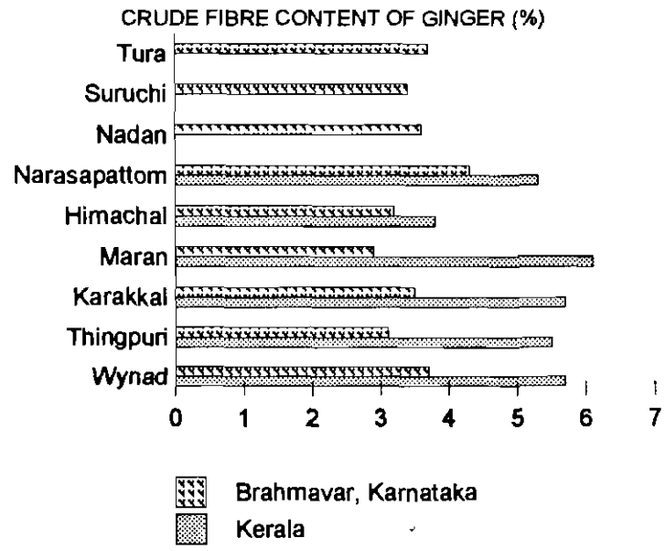


Fig. 2.3 *Crude fibre content of ginger cultivars from two locations*

Coimbatore and Jagtial. Samples obtained from Dharwad also showed similar trend. The reasons attributed are the difference in rainfall pattern, soil conditions and irrigation practice followed at Coimbatore and Jagtial.

Curcumin levels of bulb and fingers: Acc.360 and 361 had same levels of curcumin both in mother and primary rhizomes. Mother rhizomes on varieties Suguna and Sudarsana had more curcumin than primary rhizomes.

Turmeric samples from the coordinating centres viz. Solan, Pottangi, Jagtial, Coimbatore and Bhavanisagar also were analysed.

Evaluation of cinnamon lines: Acc. 53, 63 and 189 were evaluated for the bark oil, bark oleoresin and leaf oil. All the accessions contained 2.7% bark oil. Bark oil of Acc. 53 contained 68% cinnamaldehyde and 6.5% eugenol, Acc. 63 contained 73% cinnamaldehyde and 6% eugenol and Acc. 189 contained 58 % cinnamaldehyde and 5% eugenol. All the three accessions contained 8 - 9 % oleoresin. Acc. 53 and 189 contained 3.2% leaf oil with 75% eugenol and 14% cinnamaldehyde . Acc. 53 and 189 are proposed for release as IISR Navasree and IISR Nithyasree, respectively.

Evaluation of cassia selections: Nineteen cassia selections were evaluated for leaf oil, bark oil and bark oleoresin . Selections D- 1, D-3 and D-5

contained about 5% bark oil with about 90% cinnamaldehyde. A- 1 , A-6 and A-7 had more than 10 % bark oleoresin. Leaf oils of most of the selections contained more than 70% cinnamaldehyde.

Phy. V (813)

Characterization of drought tolerance in black pepper

K S Krishnamurthy, S J Anke Gowda and Johnson K George

Preliminary screening of 77 black pepper germplasm accessions for drought tolerance was carried out in three sets of 27, 24 and 26 accessions each.

Rooted cuttings were subjected to moisture stress till wilting and observations were recorded at six day intervals on cell membrane stability and relative water content (RWC). Accessions differed significantly for both the parameters on all sampling dates (Table 2.13 and 2.14, data are given for only one set). Effect of stress was less severe during initial sampling dates as accessions maintained lesser membrane damage and lesser reductions in RWC during this period. But the effect was more pronounced at later stages which was evident from higher membrane leakage percentages and more reductions in RWC. Acc. 4057, 4072, 891, 995, 1114 and 1113 maintained higher membrane stability and higher RWC throughout the sampling period.

Phy. VI (813)

Characterization of drought tolerance in cardamom

S J Anke Gowda, K S Krishnamurthy and Ravindra Mulge

Identification of parameters for drought tolerance in three types of cardamom has been initiated. Twenty planting units of each type, namely CCS-1 (Malabar type), MCC-21 (Vazhuka type) and MCC-61 (Mysore type) were collected and planted in field for clonal multiplication.

ICAR A.P. Cess Fund Project

1. Water requirement of multiple cropping system with spices

(Collaborative project with CWRDM, Calicut)

K V Satheesan (CWRDM, Calicut) and A K Sadanandan

The weather parameters viz. air temperature, vapour pressure at different heights of pepper canopy, net radiation, wind speed, soil heat flux and soil temperature, soil moisture etc. are continued to get recorded through the Automatic Weather Station, installed in a five hectare plantation of seven year old pepper at Pulpally. During the period of study (January to May), evapotranspiration from the pepper plantation ranged from 2

Table 2.13 *Cell membrane damage (% leakage) of black pepper germplasm accessions with increase in stress intensity*

Accession	Membrane leakage (%) with stress intensity			
	0 days	6 days	12 days	18 days
4025	4.86	6.11	10.96	16.98
4030	6.02	7.29	12.91	24.54
4048	4.85	4.67	7.78	10.10
1636	5.1	5.61	9.52	10.45
4060	5.02	6.29	12.75	26.99
4059	6.21	4.82	15.79	29.39
4073	4.37	4.53	8.54	11.45
4035	5.15	5.52	15.17	22.76
4057	6.18	6.12	6.15	5.46
1642	4.93	4.97	9.44	14.42
4022	5.18	6.23	8.98	15.27
4023	4.59	6.73	11.46	14.86
4045	5.95	8.32	14.59	24.84
4095	5.00	7.71	16.66	32.66
4009	5.20	11.14	20.04	37.71
4037	4.46	6.63	23.22	41.72
4033	4.94	9.95	16.29	31.69
1622	4.05	6.99	7.61	8.41
4072	4.25	6.41	6.59	4.64
4010	6.31	9.76	10.23	18.97
4040	4.24	8.85	13.37	23.53
4081	4.19	8.83	8.63	12.45
1635	5.46	7.7	10.19	17.37
4028	5.44	7.61	14.22	24.94
1641	5.77	5.72	8.35	11.28
4052	4.15	5.43	11.51	17.07
4053	5.78	10.85	16.58	32.27
CD at 5%	1.31	1.50	3.82	5.96

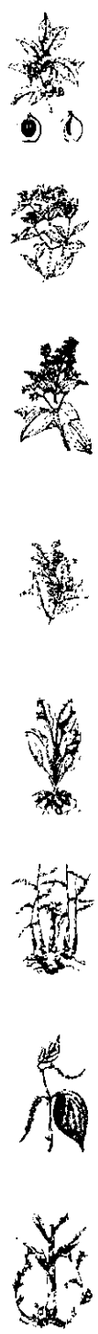









Table 2.14 *Relative water content (%) of black pepper germplasm accessions as affected by moisture stress*

Accession	Relative water content (%) with stress intensity			
	0 days	6 days	12 days	18 days
4025	99.05	72.95	60.37	49.55
4030	89.65	72.80	59.60	44.80
4048	**94.10**	**94.20**	**77.70**	**61.15**
1636	94.30	77.35	64.1	50.60
4060	92.30	74.55	50.20	35.65
4059	89.80	96.30	64.30	48.60
4073	93.65	94.45	60.90	49.60
4035	93.25	92.05	57.20	44.00
4057	**93.05**	**91.10**	**88.35**	**84.55**
1642	90.75	97.65	57.45	44.20
4022	91.45	82.95	77.55	58.60
4023	90.80	80.70	59.75	49.10
4045	91.85	81.35	42.75	35.10
4095	93.25	88.05	48.45	40.60
4009	91.00	79.95	44.50	36.45
4037	97.90	93.05	49.65	40.90
4033	95.65	76.60	41.70	33.75
1622	90.70	90.30	71.90	59.05
4072	**94.10**	**82.30**	**81.60**	**67.80**
4010	93.45	71.80	45.75	37.55
4040	91.85	96.10	43.00	34.30
4081	**93.70**	**92.15**	**68.00**	**55.85**
1635	92.40	79.90	49.20	40.40
4028	93.20	89.45	46.65	38.30
1641	**91.65**	**92.35**	**61.90**	**50.85**
4052	94.35	90.55	52.85	43.60
4053	89.00	76.50	42.20	34.80
CD 5%	**3.13**	**3.77**	**4.44**	**4.26**

to 3 mm/day. It was shown that continuous measurement of evapotranspiration is achieveable using the Bowen ratio energy balance method. The studies are in progress.

2. Biochemical characterization of ginger and turmeric

T John Zachariah and A Shamina

A total of 25 accessions of ginger (cv. Maran, Edapalayam, Sathing, Thingladium, Jorhat, Himachal, Wynadan and Suprabha) and 16 of turmeric (cv. Mananthody, Sugandham, Wynad local, Edapalayam, Kaziranga, Maran, Pulpally, Singhat, Manipur, Daboka and Moovattupuzha) were planted in pots.

Electrophoretic techniques of SDS-PAGE for proteins, isozymes like esterase, superoxide dismutase (SOD), polyphenol oxidase and acid phosphatase have been standardised in the Pharmacia Phast system. Fresh extracts of young leaves in Tris - HCl buffer were best suited for the study.

Quality traits such as crude fibre content, oleoresin, GC profile of essential oil, curcumin and starch were also standardised. A preliminary screening for total phenols, free amino acids and total proteins of the rhizomes of ginger and turmeric accessions was undertaken.








Crop Protection

Lepidosaphes piperis and *Aspidiotus destructor* were the most common among 18 genera/species of scale insects and mealy bugs infesting black pepper in Kerala, Karnataka and Tamil Nadu. In addition to *Piper nigrum, P. longum, P. sugandhi, P. argyrophyllum* and *P. hymenophyllum* were also found infected by CMV. 'Kokke kandu' virus of small cardamom was found to be a semi persistent type.

Six root knot nematode populations from various spices, showed considerable variations in their perineal patterns. *M. incognita* at Pi ≤ 2/100 cc of soil caused maximum reduction in growth and yield of ginger. *Trophotylenchulus piperis* eggs hatched well in distilled water and root exudates had no role in hatching.

P24, a *Phytophthora* tolerant line, showed less disease incidence compared to susceptible variety in a hot spot area for disease. Two wild and one cultivated accessions showed resistance to pollu beetle. Clone-893 showed field resistance against natural infection of 'Kokke kandu' disease. Ten ginger and 17 turmeric accessions showed varying degrees of resistance/tolerance to root knot nematodes.

Successful protoplast isolation and regeneration of callus were achieved in *Piper colubrinum*. Somaclones of black pepper screened for their reaction to *P. capsici* showed considerable variations.

In a five year old field trial, VAM treated plots recorded only 11% *Phytophthora* foot rot disease incidence compared to 50% in control. Copper oxychloride drenching had an adverse effect on VAM colonisation on the black pepper roots whereas metalaxyl mancozeb (Ridomil MZ 72 WP) and potassium phosphonate (Akomin) had no effect. Sorghum raised in a mixture of soilrite, soil, sand and FYM in equal proportion is optimum for large scale VAM production. Application of *Trichoderma harzianum* suppressed rhizome rot of cardamom in the field.

Four sprays (during July-October) of Dipel 3% (a commercial formulation of *Bacillus thuringiensis*) was more effective in controlling shoot borer of ginger and turmeric. Several natural enemies of scale insects infesting black pepper were collected from surveys conducted in Dindigul Anna District, Tamil Nadu. *Chilocorus nigrita* was recorded as a predator of scale insects infesting black pepper for the first time. Methods were also standardised for their mass rearing in the laboratory.

Verticillium chlamydosporium was isolated for the first time from cases of *T. piperis*. It parasitized root knot nematode eggs and suppressed hatching of *M. incognita* eggs. Ten isolates of fluorescent pseudomonads were found promising in the management of root knot nematodes.

Three sprays with endosulfan 0.05% or one spray with endosulfan 0.05% and three sprays with Neemgold 0.3% or four sprays with Neemazal-F 0.05% was more effective in controlling pollu beetle, a major pest of black pepper. 'Econeem' was highly toxic to root knot nematodes in *in vitro* studies.

Spraying and drenching black pepper vines with potassium phosphonate and soil application of biocontrol agents were effective for *Phytophthora* foot rot management. Roguing of infected clumps coupled with spraying insecticides checked 'Kokke kandu' disease incidence in cardamom.

Path. II.1(813)
Epidemiological studies on *Phytophthora* foot rot disease of black pepper
M Anandaraj and Y R Sarma

Variability in Phytophthora *hybrids:* To study the variability in oospore progenies of *Phytophthora* involving two species, *P. capsici* from black pepper was paired with *P. meadii* from cardamom. Oospores were produced by this artificial mating in petri dishes. These oospores did not germinate and are maintained for further studies.

Mass production of Vesicular Arbuscular Mycorrhizae: The efficient strains of VAM, identified in previous studies, are multiplied on graminaceous hosts such as sorghum and both the roots and soil are used as inoculum. This method requires autoclaving the soil mixture before raising the host plant. A study was conducted to see the effect of soil solarization of potting mixture and to use soilrite in place of soil. Growth of sorghum plants was better in the treatment involving forest soil, sand and FYM in the proportion 3:1:1 (Table 3.1). Soilrite alone or in combination with sand did not support good growth of sorghum.

Table 3.1 *Soilrite combination in supporting growth of sorghum.*

Treatment	Shoot (Dry) wt.(g) (Av. of 5 repli.)
1. Soilrite	10.40 d
2. Soilrite + Sand (1:1)	9.20 d
3. Soilrite + Soil (1:1)	23.40 c
4. Soilrite + Sand + Soil (2 : 1 : 1)	18.80 cd
5. Soilrite + Soil + FYM (2 : 1 : 1)	40.60 ab
6. Soilrite + Sand + FYM (2 : 1 : 1)	39.20 ab
7. Soilrite + Sand + Soil + FYM (1 : 1 : 1 : 1)	48.80 a
8. Soil + Sand + FYM (2 : 1 : 1)	36.60 b
CD at 5%	**7.28**

Means followed by common letter are not significantly different under DMRT.

Path. II.3 (813)
Disease management in *Phytophthora* foot rot affected black pepper plantations
Y R Sarma, M Anandaraj and K V Ramana

As a part of the integrated disease management programme on a large scale in farmers' plots, an experiment was conducted at Mepadi, Wynad.

The treatments included two rounds of spraying and drenching with potassium phosphonate as premonsoon and post monsoon treatments followed by soil application of biocontrol inoculum of *Trichoderma harzianum* multiplied in coffee husk. The disease incidence showed a marginal reduction from 25% to 15% during the year. Similar experiment was conducted at IISR Farm, Peruvannamuzhi with 400 vines of 10 cultivars. Foliar yellowing noticed during April showed remission with irrigation and no disease incidence was noticed. The field trials at Valparai and Pulpally are being continued.

Crop Prot. I.1 (813)

Screening germplasm for reaction to diseases

Y R Sarma, M Anandaraj and Johnson K George

Mass screening of 150,000 seedlings of 15 cultivars of black pepper, for their reaction to *P. capsici*, was carried out during the year and six seedlings which did not succumb but showed foliar yellowing were saved for further multiplication and testing. Of the 170 cultivars screened against *P. capsici* by adopting stem inoculation technique, six cultivars showed tolerant reaction based on root rot rating : 1-5% Resistant, 6-24% Tolerant, 25-75% Susceptible and > 75% Hyper susceptible and lesion length : 0 mm Immune, 1-5 mm Resistant, 6-20 mm Tolerant, 21-30 mm Susceptibe and > 30mm Hypersusceptible (Fig. 3.1).

Field evaluation: During the 3rd year of field evaluation at Sirsi with 8 *Phytophthora* tolerant lines and two susceptible cultivars, P24, a

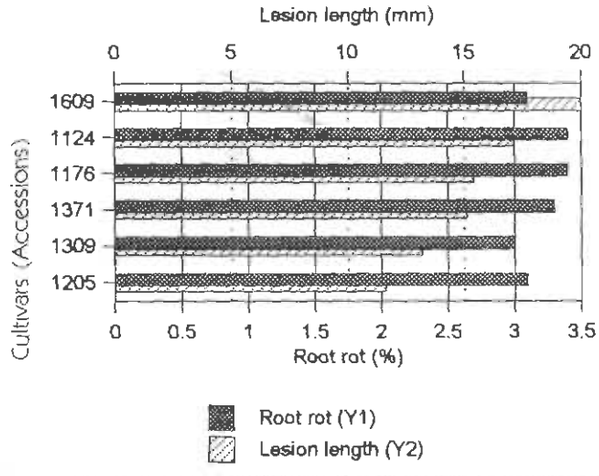


Fig. 3.1 *Reaction of black pepper cultivars to P. capsici*

Phytophthora tolerant line, showed less mortality compared to susceptible checks (Fig 3.2). P24 was supplied to several farmers for field evaluation The field trials at Valparai and Pulpally are being continued.

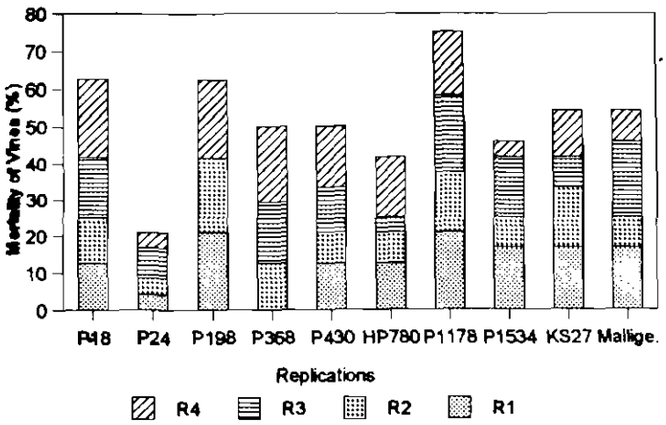


Fig. 3.2 *Mortality of* Phytophthora *tolerant lines and susceptible cultivars of black pepper in the field trial at Sirsi*

Crop Prot. I.2(813)

Screening black pepper germplasm for reaction to insect pests

S Devasahayam and Johnson K George

Twenty six wild *Piper nigrum* accessions available in the germplasm collections of IISR were screened for berry damage by pollu beetle (*Longitarsus nigripennis*) under field conditions at Peruvannamuzhi. Two accessions were free of pest infestation; the incidence of pollu infested berries ranged between 5.1-36.3 per cent in the other accessions.

Thirty five cultivated *Piper nigrum* accessions, available in the germplasm collections of IISR, were screened for berry damage by pollu beetle under field conditions at Peruvannamuzhi. One accession was free of pest infestation; the incidence of pollu infested berries ranged between 21.9-70.5 per cent in the other accessions.

Crop Prot. I.3 (813)

Screening black pepper germplasm for reaction to nematodes

K V Ramana, Santhosh J Eapen and Johnson K George

Thirty black pepper germplasm accessions, received from Genetics and Plant Breeding Section, are being maintained for screening against *Radopholus similis* and *M.incognita* during the coming season.








Path. XII (813)

Investigations on stunted disease of black pepper

Y R Sarma and S Devasahayam

(Collaborator: Prof. P Sreenivasulu, Dept. of Virology, S V University, Tirupati)

Transmission studies: Infected leaf sap in 0.1 M Phosphate buffer produced local lesions on leaves of *Chenopodium amaranticolor* and *Vigna radiata*. Graft transmission to *P. colubrinum* was negative, whereas interveinal chlorosis was noticed on the scions of *P. longum* indicating positive transmission. Studies on insect transmission through aphid *Toxoptera aurantii* are in progress.

Host range: Natural infection was noticed on *Piper argyrophyllum, P. hymenophyllum* and *P. sugandhi* in addition to *P. nigrum* and it was confirmed by ELISA test with CMV antisera.

Symptomatology: Apart from stunting, four distinct types of symptoms are noticed (Table 3.2). The plant sap collected from the plants with these distinct symptoms were subjected to ELISA test with CMV antiserum and were confirmed.

Table 3.2 *Symptoms of CMV infection on* Piper nigrum

Symptom	No. of samples confirmed by ELISA
Stunting – crinkling, cupping & narrowing of leaves	10
Scattered chlorotic flecks on leaves	20
Chlorotic flecks along veins, leading to interveinal chlorosis	30
Vein banding, severe interveinal chlorosis with dark green veins	10
Leathery leaves with mosaic pattern & vein bulging	25

Path. X (813)

Investigations on vein clearing virus of small cardamom

M N Venugopal

Transmission and virus-vector relationship: Studies with different periods of acquisition feeding, transmission feeding, post acquisition starvation and serial transmission clearly revealed that virus is retained in the vector even after 8 hours of acquisition feeding. In the serial transmission also, the persistence was found in III transfer (2 hours after acquisition feeding). Based on these results 'Kokke kandu' virus can be grouped under semi-persistent type.

Disease management: The studies on the efficacy of roguing of infected clumps in reducing secondary spread was continued in different

situations viz. (i) isolated plantations (ii) replanted plantations in infected zone and (iii) replanted plantations lying in contiguous with infected plantation. The cumulative removal of new infections in 1995 varied from 0.28 to 3.28% in different experimental blocks. In three isolated plantations, no fresh incidence was recorded even after two years of roguing the initial infected plants. These results confirmed the previous findings on the usefulness of roguing as a disease management strategy.

Screening for resistant types: Twelve accessions comprising of high yielders and distinct morphotypes are under screening in a severely infected plantation. In the ongoing two year old trial, clone 893 and PV-1 remained free from infection, whereas CCS-1 and popular variety green gold, were found to be highly susceptible.

Six disease escapes were subcloned and planted in the sick plots for multiplication cum screening. In one year period all the six accessions remained free from 'Kokke kandu' infection but three accessions were found to be susceptible to natural infection of 'Katte'.

Path. XI (813)
Studies on bacterial wilt of ginger
G N Dake and T G N Rao

A field trial for management of bacterial wilt of ginger, consisting of five treatments viz. application of avirulent strains of *Pseudomonas solanacearum* to ginger plants, soil amendment with lime, soil application of streptopenicillin and untreated control (water) with challenge inoculation of virulent strain of *P. solanacearum*, was laid out at Peruvannamuzhi farm in a randomised block design with five replications.

The bacterial cell suspension (10^8 cfu/ml) of avirulent strains (1 and 2) of *P. solanacearum*, antibiotic solution of streptopenicillin (200 ppm) and water were poured at the base of ginger plants @ 2000 ml per bed of size 3 sq. m. The lime (powdered form) was mixed in soil @ 1 kg/ bed. All the treatments were imposed on seventy day old ginger plants of cultivar Maran. Subsequently challenge inoculation with virulent strain of *P. solanacearum* was done after 48 hrs by adding 2000 ml of bacterial cell suspension / bed (10^8 cfu/ml) around the base of ginger plants.

Observations on germination (before imposing treatments), wilting (after challenge inoculation), survival of plants and yield of ginger rhizomes (at harvest) were made. The data were analysed statistically and the results are presented in Table 3.3.








Table 3.3 *Field management of bacterial wilt of ginger caused by* P. solanacearum

Treatment	Germination %	Disease incidence (%)	Yield(kg/ 3 sq.m. bed)
Avirulent strain (AV) of *P. solanacearum* - 1 + Challenge inoculation of virulent strain (V) of *P. solanacearum* (PS)	81.75	30.93 (30.62)	3.770
AV of *P. solanacearum* -2 + V of PS	81.00	41.16 (39.71)	3.540
Lime +V of *P. solanacearum*	81.00	43.92 (41.25)	3.000
Streptopenicillin + V of *P. solanacearum*	88.00	41.29 (39.88)	3.162
Water + *P. solanacearum*	81.25	61.83 (52.05)	1.820
SE m±	**2.974**	**5.332**	**0.472**
CD at 5%	**NS**	**15.577**	**1.379**
CV%	**--**	**20.71**	**24.47**

Values given in parentheses are transformed values

Results indicated that the germination was almost uniform in all the treatments. The minimum disease incidence (30.93%) and highest yield of ginger rhizome (3.770 kg/bed) were recorded in plants inoculated with avirulent strain of *P. solanacearum* and subsequently challenge inoculated with virulent strain of *P. solanacearum* compared to control (water + challenge inoculation), where disease incidence was 61.83% and yield was 1.820 kg/bed. Similar results are also obtained in other treatments compared to those of non treated control plants.

Ent. X (813)

Bionomics of major pests of black pepper and evolving integrated control measures against them

S Devasahayam

Evaluation of commercial neem products Five commercial neem products, namely, Neemark 1%, Neemgold 0.3%, Nimbicidine I %, Neemazal - F 0.05% and Neemazal-T/S 0.05% and endosulfan 0.05% (present recommendation) were evaluated against 'pollu beetle' (*Longitarsus nigripennis*) in the field at Peruvannamuzhi. The treatments included four sprays with neem products (during June, July, August and

September; July, August, September and October); one spray (during July) with endosulfan and three sprays with neem products (during August, September and October); two and three sprays with endosulfan (during July and September; June, July and September). A control without spray was also maintained. The crop was harvested during January and the percentage of berries damaged by pollu beetle was assessed and the data were subjected to statistical analysis.

All the treatments were effective in controlling the pest infestation when compared to control. However, three sprays with endosulfan 0.05% (during June, July and September); one spray with endosulfan 0.05% (during July) and three sprays with Neemgold 0.3% (during August, September and October) and four sprays with Neemazal-F 0.05% (during July, August, September and October) were more effective in controlling the pest infestation.

Nema. III (813)
Investigations on nematodes associated with spices
K V Ramana and Santhosh J Eapen

Screening of germplasm: Fortyseven germplasm accessions each of ginger and turmeric were screened against *Meloidogyne incognita* (Pi = 2000 juveniles/pot). There were five replications and the plants were uprooted after four months after nematode inoculation. The root system was stained with Phloxine B. The number of egg masses and galls per root system were assessed and those lines with more than 20 egg masses or galls per root system were classified as susceptible. Ten accessions in ginger and 15 accessions in turmeric showed resistance to root knot nematodes in the preliminary round of screening (Table 3.4). These will be further screened to confirm the host reaction.

Table 3.4 *Reaction of ginger and turmeric germplasm to root knot nematode,* Meloidogyne incognita

Crop	Accession	
	Resistant*	**Susceptible**
Ginger	4, 6, 22, 28, 36, 51, 59, 63, 87 & 90	1, 2, 3, 5, 9, 13, 14, 15, 17, 18, 21, 24, 25, 29, 30, 33, 34, 37, 39, 42, 49, 58, 61, 64, 65, 72, 76, 81, 82, 84, 89, 95, 116, 128, 137&142
Turmeric	3, 31, 71, 79, 82, 84, 90, 95, 128, 142,178,179,182, 198 & 200	11, 14, 15, 19, 34, 47, 48, 59, 73, 74, 75, 76, 82, 86, 93, 97, 104, 115,117, 123, 124, 127, 145, 153,160, 161,162,168,170, 174, 190&192

*To be confirmed








Twelve cardamom germplasm accessions and 50 each seedlings of CCS-1 and CL37 are being screened against root knot nematodes.

Population variability in root knot nematodes: Three new root knot nematode populations, one from black pepper (Andhra Pradesh) and two from turmeric (Kerala and Tamil Nadu), were collected during the year. Studies on perineal patterns of six populations of root knot nematodes showed the wide variability between these populations. Attempts are being made to differentiate these populations based on the isozyme patterns.

Effect of M.incognita *on growth and yield of ginger:* A pot culture trial with different inoculum levels of *M.incognita* (0 - 200 J_2/100cc soil) was conducted to study the effect of *M.incognita* on growth and yield of ginger. Yield and growth characters were recorded after 9 months and they are presented in table 3.5. The results indicate that *M.incognita* at Pi ≤ 0.2/100cc soil caused significant reduction in yield of ginger under test conditions.

Table 3.5 *Growth and yield of ginger inoculated with* Meloidogyne incognita

Treatment (J_2/100 cc soil)	No .of tillers	Height (cm)	Shoot wt.(kg)	Root wt.(kg)	Rhizo-ome wt.(kg)	Total biomass (kg)	Nematodes /g root (Final)
0.0	60.62	83.62	0 724	0.350	1 .439	2.513	-
0.2	76.50	78.62	0.828	0.361	1 .013	2.202	527.23
2.0	53.87	84.50	0.644	0.323	0.959	1.927	478.63
20.0	51.50	80.00	0.557	0.296	0.998	1.851	504.66
200.0	65.62	75.00	0.612	0.248	1.001	1.862	346.74
CD at 5%	**NS**	**6.58**	**NS**	**0.077**	**0.327**	**0.498**	**NS**

Data are mean of 8 replications

Role of M. incognita *in rhizome rot complex of ginger:* A new pot trial has been initiated using *M.incognita* and *Pythium aphanidermatum*, alone and in various sequences and intervals, to study the precise role of *M. incognita* in the rhizome rot complex of ginger.

Biocontrol I.1 (813)
Biological control of diseases of spice crops
M Anandaraj, M N Venugopal and Y R Sarma

Field trials: Three field trials, two on black pepper and one on cardamom, were continued this year. In the black pepper trial, involving VAM with

chemicals, the mortality was 11% in VAM treated plots compared to 50% in control. In non VAM plots, the mortality ranged from 22-27% in chemical treated plots.

In the other experiment, VAM was inoculated at the time of raising cuttings and *Trichoderma hamatum* and *Gliocladium virens* are added every year. The incidence of disease is less than 5% in the biocontrol plots.

The trial on rhizome rot of cardamom was continued with two applications of *Trichoderma* during early and mid monsoon period. The disease incidence was 6.4 and 19.8 in treated and untreated plots, respectively.

Mass multiplication of biocontrol agents: For large scale multiplication of biocontrol agents, sorghum grains and coffee husk are needed. Initial sterilization is done by autoclaving the carrier media. To overcome the problem of frequent power failure, an alternate method using cardamom drier was studied. Coffee husk in polypropylene bags was moistened, sealed and heated to 45-50°C for 8-10 days in flue heated cardamom driers. This eliminated other fungi and supported good growth and sporulation of *Trichoderma*. Mass multiplication of *Trichoderma* was also tried on neem cake, farm yard manure and coir pith after solarization.

Fluorescent pseudomonads: Twenty isolates of fluorescent pseudomonads were collected from black pepper rhizosphere from Pollibetta and Sakleshpur in Karnataka and Palode in Kerala. These isolates were tested for their suppressive activity *in vitro*. Six isolates showed inhibitory effect on *P. capsici*. All the cultures are being maintained for further studies.

Biocontrol I.2 (813)

Biological control of insect pests of spices

S Devasahayam

Natural occurrence of microbial pathogens: Adults and larvae of 'pollu beetle' (*Longitarsus nigripennis*) were collected at regular intervals from the field at Peruvannamuzhi and screened for the natural occurrence of microbial pathogens. However, no pathogen could be recovered from the samples so far.

Bioassay of microbial pathogens: A commercial formulation of *Bacillus thuringiensis* (Dipel) was evaluated against 'pollu beetle' in laboratory bioassays at 0.05-1.00% concentration. However, significant mortality of beetles was not observed in any of the concentration even after 10 days of treatment.

Cultures of *Beavaria bassiana, B. brongniartii* and *Metarhizium anisopliae* were obtained from many sources and multiplied in the laboratory. Preliminary laboratory bioassays were conducted against pollu beetle by allowing the beetles to crawl over the fungal cultures for 24 h. Observations taken after 7 days indicated that 30 and 20 per cent of beetles took up infection of *B. brongniartii* and *B. bassiana*, respectively, and died.

Field evaluation of Bacillus thuringiensis: Two commercial formulations of *B. thuringiensis* (Bioasp and Dipel) were evaluated against shoot borer (*Conogethes punctiferalis*) of ginger and turmeric in the field at Peruvannamuzhi. The treatments included four sprays (during July, August, September and October) with Bioasp (at 0.25, 0.50 and 0.75% concentrations), Dipel (at 0.1, 0.2 and 0.3% concentrations) and malathion 0.1% (present recommendation). An untreated control was also maintained. The percentage of tillers infested by the pest was recorded during November and the data subjected to statistical analysis. In both ginger and turmeric, all the treatments were effective in controlling the pest infestation when compared to control. However, spraying of Dipel 0.3% was the most effective treatment.

Biocontrol 1.3 (813)
Biological control of nematodes of spices
Santhosh J Eapen, K V Ramana and Y R Sarma

Isolation and identification of nematode antagonists: Verticillium chlamydosporium Goddard, a known biocontrol agent against cyst and root knot nematodes, was isolated for the first time from cases of *Trophotyenchulus piperis* infesting black pepper at the District Agricultural Farm, Koothali, Calicut District. The fungal association with roots of black pepper was also noticed.

Attempts are being made to isolate native biocontrol agents from suppressive soils, collected from various parts of Coorg District, Karnataka.

In vitro *studies: V. chlamydosporium* was tested *in vitro* for nematode parasitization. Egg masses, eggs and juveniles of *M.incognita* were placed separately on agar plates along with the fungus and observed daily for any interaction. The fungus readily colonised root knot nematode egg masses. No mycelial penetration was observed in the case of juveniles.

Another study was conducted by placing surface sterilized root knot nematode egg masses in a mycelial suspension of *V. chlamydosporium* and recording the hatching of eggs at 24 h intervals. The hatching was

inhibited significantly at all intervals (Fig. 3.3). The estimated control (based on the equation (1- T/C) x 100, where T is the mean of juveniles hatching in treatment and C is the mean of juveniles hatching in control) ranged from 28.5 - 56.3 per cent.

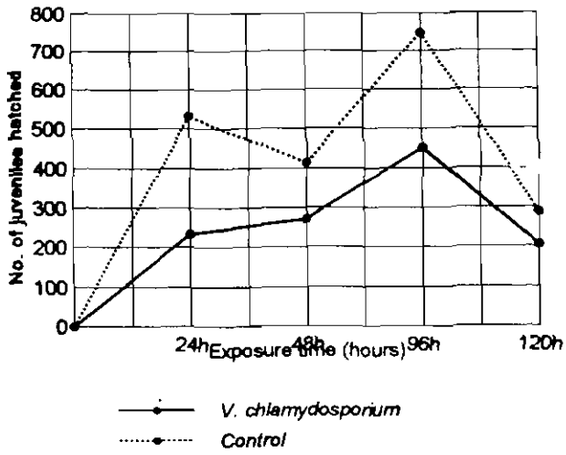


Fig. 3.3 *Suppression of root knot nematode hatching by* Verticillium chlamydosporium

V.chlamydosporium parasitized root knot nematode eggs. Its spores got attached to the nematode eggs and germinated to colonise the inner contents. However, it did not parasitize *M. incognita* juveniles and *Radopholus similis*. Cultures of *Pasteuria penetrans* a bacterial antagonist of nematodes, was obtained from CPCRI, Regional Station, Kayangulam. *P. penetrans* colonised root knot nematode juveniles and adults.

Pot culture studies: Thirty isolates of fluorescent pseudomonads were tested for their interaction with root knot nematodes on black pepper OP seedlings. None of the isolates showed statistically significant improvement in growth of the plant or reduction in nematode multiplication. However, their nature of interaction varied cosiderably between different isolates tested (Table 3.6).

A new pot trial has been laid out to study the effect of *P. penetrans* on *M. incognita* infecting cardamom. There are eight each treatments and replications in a randomised complete block design. The experiment is in progress.








Table 3.6 *Evaluation of different isolates of fluorescent pseudomonads*

Treatment	Nature of interaction & Isolate No.
Fluorescent pseudomonads alone	Improved growth of the plant - Is. No. 27, 29 & 34
Fluorescent pseudomonads +	No effect on nematodes but improved growth of the plant - Is. No. 2, 13, 30, 33, 36 & 43
Root knot nematodes	Suppressed nematodes but no effect on plant growth - Is. No. 12, 23 & 51
	Suppressed nematodes and improved plant gro~kh - Is. No. 7, 10, 14,20,26-28,31,358~49

Evaluation of commercial neem products: Six commercial neem products viz. Neem Gold 0.3%, Neemark 1 %, Econeem, Neemazal - R, Neemazal - T/S 0.05% and Nimbicidin 1% were tested *in vitro* to understand their toxicity to root knot nematodes. The mortality of 100 second stage juveniles was assessed at 24 h intervals in three concentrations of the above products and compared with that in distilled water. Econeem was highly toxic to *M.incognita* larvae at all concentrations.

ICAR A. P. Cess Fund Projects

1. The parasitic nematode, *Trophotylenchulus piperis* and its interaction with black pepper

K V Ramana, Santhosh J Eapen, P Sundararaju and T P Sreeja

The studies on mode of survival of *T. piperis* showed that the second stage juveniles could survive only upto 8 days in host free soil. The cases do not help the nematode to perpetuate in soil. Root exudates did not have any influence on hatching of *T.piperis* eggs. Maximum recovery of juveniles was obtained in distilled water. Hatching takes place inside the cases and the juveniles are retained within the cases till favourable conditions are there.

The nematode feeds about 3-4 cells deep in the root cortex on a single feeding cell. Nematode cases exist as separate entities and there is no connection with the root tissues, indicating that the cases are of nematode origin rather than of plant origin.

T. piperis population starts building up after monsoon and is maximum during April-May. None of the 11 species of weeds that are commonly found in the black pepper garden is a host of *T. piperis*.

Verticillium chlamydosporium, a known nematode biocontrol agent, was identified and recorded for the first time from India in association with *T. piperis* on roots of black pepper. This fungus inhibited the development of the nematode. Further studies are in progress.

2. Biological control of scale insects infesting black pepper

S Devasahayam, S Selvakumaran and Mini Kallil

Distribution of natural enemies: Surveys were conducted at six locations in Dindigul Anna District, a major black pepper area in Tamil Nadu, to record the incidence of natural enemies of scale insects. The natural enemies recorded include *Pseudoscymnus* spp. (Coccinellidae), *Cybocephalus* sp. (Nitidulidae), *Mallada boninensis* (Chrysopidae) and *Encarsia lounsburyi* (Aphelenidae).

At Calicut, *Pharoscymnus horni, Chilocorus nigrita* (Coccinellidae), *Cybocephalus* sp., *E. lounsburyi* and two unidentified species of Coleopterans were recorded as natural enemies in the nursery at IISR. *C. nigrita* is being recorded for the first time as a predator of scale insects infesting black pepper.

Biology of natural enemies: The feeding potential of adults and IV instar larvae of *P. horni* and *C. nigrita* on the scale insects *Lepidosaphes piperis* and *Aspidiotus destructor* was determined (Table 3.7). Studies on life history and other aspects of biology of *P. horni* and *C. nigrita* were completed (Table 3.8). Adult longevity and preoviposition period ranged between 24-35 days and 4-5, respectively, in *P. horni*; in *C. nigrita*, adult longevity and preoviposition period ranged between 44-68 and 4-8 days, respectively.

Table 3.7 *Feeding potential of coccinellid predators*

Species/stage	No. consumed /day	
	A. destructor	*L. piperis*
Pharoscymnus horni		
Adult		3-9
IV instar larva		3-4
Chilocorus nigrita		
Adult	10-35	26-54
IV instar larva	10-20	13-25

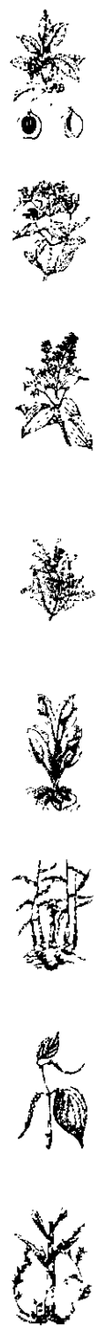









Table 3.8 *Biology of coccinellid predators*

Stage	*P. horni* duration (days)	*C. nigrita* duration (days)
Egg	3-5	3-7
I instar larva	3-4	3-5
II instar larva	3-4	3-5
III instar larva	2-4	3-4
IV instar larva	3-5	4-6
Prepupa	1	1-2
Pupa	4-6	5-6

Mass rearing of natural enemies: Standardization of techniques for mass rearing of *C. nigrita* on *Aonidiella orientalis* (collected from coconut leaf fronds) raised on pumpkins (*Cucurbita maxima*), is in progress. Cultures of *A. orientalis* were established on pumpkins and were placed in wooden insect rearing cages (45 x 30 x 45 cm size) into which field collected *C. nigrita* adults were released. A piece of cotton placed over the pumpkins served as egg-laying sites for the predators. The cotton pieces with eggs were regularly removed and placed on fresh pumpkins infested with *A. orientalis*. The larvae that hatched out were transferred to fresh pumpkins when the food material was exhausted, and reared to adulthood. Standardization of techniques for mass rearing of *C. circumdatus* were initiated.

Field testing of natural enemies: Adults of *C. nigrita* and *C. circumdatus* obtained by adopting the rearing procedures mentioned earlier, were released in the field on black pepper vines infested with *L. piperis*, 750 and 350 adults of these two predators were released at Kuppadi and Kalpetta, respectively. Evaluation of efficacy of the released predators is in progress.

3. Characterization, early detection and management of 'Kokke kandu' disease of cardamom

M N Venugopal, N J Mathew and K A Saju

Disease management: Large scale field trials were initiated on (i) Efficacy of roguing on fresh incidence in a plot adjacent to infected plantation and (ii) efficacy of roguing + insecticide spray (Monocrotophos 0.05%) on new out breaks. Ongoing study indicated that the disease incidence could be minimised effectively to less than 3%.

Monitoring of disease and vector: Monitoring of disease spread and aphid vector (*Pentalonia nigronervosa* f. *caladii*) was initiated in two identified plantations in Hongadahalla. Disease expression was found maximum in early monsoon and post monsoon period whereas vector population started building up during post monsoon period and highest population of alate forms was found after April-March.

Collection of natural disease escapes: A survey was undertaken to collect disease escapes in North Kanara and Hassan districts. After covering 68 plantations distributed in 10 villages, 21 disease escapes have been collected. The accessions are under clonal propagation for further testing.

Screening of germplasm: Clonal accessions (168 numbers), which include popular and specific cultivars, representative ecotypes and distinct morphotypes of Malabar, Mysore and Vazhukka, have been established in microplots. These accessions are being screened for their reaction to 'Kokke kandu' virus.

DBT Projects

1. Development of *Phytophthora* resistance in black pepper (*Piper nigrum* L.) through biotechnological approaches

Y R Sarma, M Anandaraj and Shaji Philip

Protocols to isolate protoplast of *P. nigrum* and *P. colubrinum* and their regeneration into micro calli have been standardized. Callus regeneration is slow in *P. nigrum* compared to *P. colubrinum.*

Out of 500 somaclones screened by adopting leaf inoculation technique, two showed hypersensitive flecks indicating their resistance. However, further multiplication is in progress to test their reaction to root and stem inoculations.

Toxin of *P. capsici* has been isolated and is proteinaceous in nature and showed necrosis on black pepper leaves when applied, thus confirming its biological activity. The same is being used in cell suspension systems of black pepper for *in vitro* screening.

2. Development, production and demonstration of biological control agents under integrated pest management

Y R Sarma, M Anandaraj and M G Prakash

A total of 1022 ha was covered under this programme. As a part of the nursery management in cardamom, biocontrol application, with *Trichoderma harzianum* in coffee husk as a delivery medium, was undertaken in five nurseries in Karanataka. The percentage of recovery of








plantable seedlings varied but was found effective (Fig. 3.4). However, the isolates varied in their efficacy/protection from place to place.

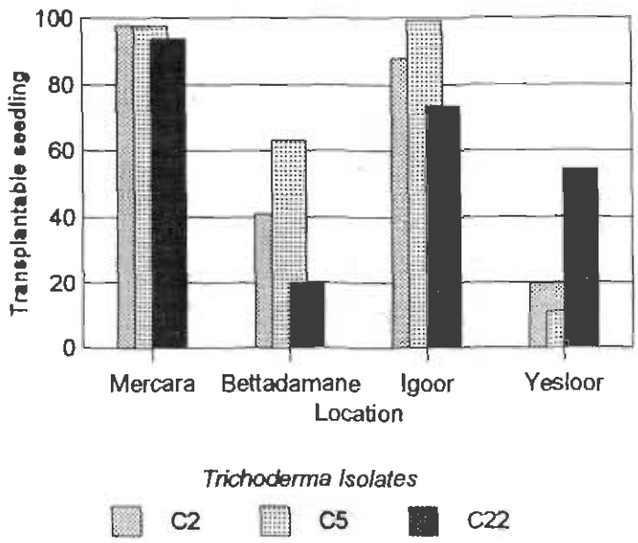
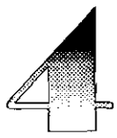


Fig. 3.4 *Nursery management in cardamom through biocontrol (as percentage of transplantable seedlings)*

During 1996, biocontrol treatment has been undertaken in three black pepper nurseries of State Departments. The initial indication was improved sprouting and lush green foliage of the treated cuttings. The field trials undertaken at AP Forest Development Corporation and also at Coorg showed reduced foliar yellowing in black pepper.

As a part of popularization of biocontrol, 8 lectures were given in farmers' meetings in Kerala and Karnataka.



Social Sciences

The average cost of production of black pepper was estimated as Rs.27.55/kg, based on a detailed survey. The benefit cost ratio (BCR) is 2.49.

Demonstration trials on the efficacy of biocontrol against *Phytophthora* foot rot of black pepper, clump rot/root rot of cardamom and rhizome rot of ginger were laid out in 1074 ha. A maiden yield of 1945 kg (dry)/ha was obtained in 1995 - 96 when cardamom was introduced as a sole crop in place of arabica coffee. The cardamom yield was 1775 kg (dry)/ha, where replanting was taken up in a phased manner. Cardamom cultivated in steep slopes by resorting to soil conservation measures, recorded an average yield of 982 kg dry cardamom / ha. Cardamom planted by converting marshy areas gave 648 kg dry cardamom /ha during the year. In a farm forestry based cardamom cropping system (0.22 acres) raised in an open upland paddy area, the pepper plants trained on silver oaks gave an encouraging yield of 90 kg (dry) while the cardamom yield was 110 kg (dry).

Four training programmes on 'Nursery Management in Spices', 'Spices Production Technology' and 'Onfarm Processing of Spices' were conducted wherein 59 officers from different states had participated. The institute participated in four exhibitions organised in connection with Madras Trade Fair, National Rubber Conference at Cochin, Anniversary of Farm & Home unit of AIR, Calicut and Karshika Mela at Koduvally, Calicut.








Stat. V (813)

Economics of black pepper cultivation

Jose Abraham and M V Prasad

Survey was conducted in Calicut and Wynad districts and data on cost of inputs and yield of black pepper were collected. Cost of cultivation at the initial year, pre bearing period and bearing period were worked out and Cost-Benefit analysis was carried out. The information collected from 50 gardens in Calicut and 44 gardens in Wynad District showed that labour is the major component of cost in pepper cultivation. It was found that on an average there was a six fold increase in labour wages raising it to an average of Rs.60/head/day from Rs.10 during 1978-79, as reported in the earlier survey (Balakrishnan & John 1980). The estimated cost of production of black pepper during 1985 under local rainfed condition was only Rs 13.40 per kg (CPCRI, Kasaragod). In the cost of other inputs like standards, rooted cuttings, FYM, fertilizers and plant protection chemicals also there is a similar increase of 6 to 10 times that of 1978-79 period. Based on the data collected the cost benefit analysis is carried out and the tentative estimate is given in Table 4.1

Table 4.1. *Cost of production of black pepper under mono-cropping system*

Item	Cost (Rs/ha)*
Investment during establishment	65,490.00
Interest @ 15% compounded	33,739.00
Total investment	99,229.00
Annuity value @ 15%	16,962.00
Annual maintenance cost	29,340.00
Total cost/year/ha	46,302.00
Average estimated yield/ha	1.68 tonnes
Cost of production/kg of pepper	Rs. 27.55
Benefit Cost Ratio (BCR)	2.49

**Based on the assumption that plant density is 1000 vines/ha, average life of plantation is 15 years, interest rate is 15% and average market rate of pepper is Rs.60/kg.*

For estimating the cost of cultivation of black pepper under inter-cropping system, more data on the various component crops viz. the cost of inputs and the returns obtained from these component crops on a larger sample, representing the different cropping systems are needed.

Ext. I (813)

Increasing productivity of black pepper and cardamom through large scale demonstration of improved technologies in farmers fields

A K Sadanandan, Jose Abraham, V S Korikanthimath, Rajendra Hegde and M N Venugopal

Black pepper: For transfer of HPT, five demonstration plots at Peruvannamuzhi (Coconut + Pepper), one at Thotilpalam (Coconut + Pepper) and two at Pulpally (pepper as monocrop) were selected (Table 4.2). Integrated nutrient management and plant protection technology together with phytosanitation and cultural operations were advocated. Further studies are in progress.

Table 4.2 *Evaluation of impact of high production technology in black pepper*

Name of the farmer	Existing vines (No.)	Yield		Disease incidence (%)
		kg/plot	kg/vine (Mean)	
Peruvannamuzhi				
V M Chako	300	200	0.67	2.0
E T Mathai	350	250	0.71	3.0
T K Mathai	325	350	1.10	3.0
P V Joseph	250	180	0.72	4.8
K I Joseph	150	160	1.10	3.0
Thottilpalam				
Moidu	2000	1000	0.50	4.9
Pulpally				
Raman Pillai	607	1100	1.80	5.4
James	700	1130	1.60	4.6

Cardamom: As performance of cardamom is location specific, need based on-farm trials were conducted in Kodagu district, Karnataka in seven locations to assess the production potential of cardamom by adopting "high production technology" in different situations as follows.

i. Introducing cardamom as a sole (mono) crop in place of arabica coffee: A maiden yield of 1945 kg (dry)/ha was obtained during 1995-96 crop season, within 30 months after planting (cardamom planted in the year 1993 by replacing old arabica coffee).








ii. Replanting cardamom in a phased manner: After taking ten crops, two hectares of area was replanted during the year 1993 by trench method of planting. Besides other packages of HPT, drip irrigation was adopted. A moderate crop of 155 kg (dry)/ha was obtained during the second year of planting (1994-95), followed by a record crop of 1775 kg (dry)/ ha during 1995-96 crop season.

iii a. Comparative performance of cardamom and robusta coffee as sole (mono) crops: Cardamom planted during the year 1993 recorded a moderate yield of 70 kg (dry)/acre in 1994-95 followed by a bumper crop of 680 kg (dry)/acre in 1995-96. Average yield of robusta coffee was 900 kg/acre during 1994-95 and 1995-96.

b. Performance of cardamom and arabica coffee as sole (mono) crop: Cardamom planted during the year 1993, gave a moderate yield of 52 kg (dry)/acre in 1994-95 followed by a bumper crop of 738 kg (dry)/ acre in 1995-96. Average yield of arabica coffee was 546 kg/acre during 1994-95 and 1995-96.

iv. Cultivation of cardamom on steep slopes: Cardamom planted on steep slopes during July 1993 by adopting soil conservation measures, recorded 982 kg(dry) cardamom per hectare during 1995-96.

v. Conversion of marshy area for profitable cultivation of cardamom: Cardamom planted during June 1993, by conversion of low lying marshy area with proper drainage and with sparse shade trees, recorded a moderate yield of 128 kg (dry)/ha in the next year of planting (1993-94) followed by an encouraging yield of 1510 and 648 kg(dry) cardamom per hectare during 1994-95 and 1995-96, respectively.

vi. Farm forestry based pepper and cardamom cropping systems: In a farm forestry based pepper and cardamom cropping system (0.22 acre), raised in an open upland paddy area, the pepper plants trained on silver oaks during 1991 gave an yield of 90 kg (dry) while the cardamom (planted in 1994) yield was 110 kg (dry) during 1995-96.

vii. Rapid clonal multiplication of multibranch types of cardamom in homestead: The high yielding multi branch types of cardamom planted during June 1994, recorded a maiden yield of 128 kg (dry) within 20 months. Multiplication of clonal material is in progress to regenerate adequate number of suckers to demonstrate yield potential in an area of 2 ha during the ensuing planting season.

Ext. II (813)
Effectiveness of "Kurumulaku Samrakshna Samiti" in pepper production in Kerala - A critical analysis
M V Prasad and Jose Abraham

Data from 42 Agricultural Officers on samiti organisational climate, supply and services activities, linkages, constraints faced by them and suggestions to overcome the constraints were collected. Data on perception about samiti, perception on recommended technology on black pepper, extent of their adoption of recommended technology, changes in their yield due to samiti and their constraints in adoption of technology were collected from 44 samiti farmers.

Ext. III (813)
Constraint analysis in cardamom production - A systems approach
P Rajeev and V S Korikanthimath

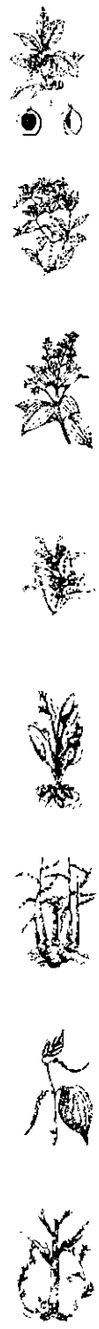
The study is being undertaken in Kodagu district of Karnataka State with the broad objective of identifying and analysing the constraints faced by cardamom growers of the area in viable cardamom cultivaton and for studying the technology transfer gaps. Methodologically the critical incident technique is advocated with the respondents for a brief analysis of critical experiences faced by them. A pilot study was completed to identify some technomanagerial, socio economic and infrastructural constraints faced by the growers.

Based on the broad areas identified, the final data collection instrument has been finalised and refined. It is proposed to cover 50 respondents stratified on the basis of size of holding and the data collection is in progress. An analytical frame work has been prepared to work out the adoption level of HPT, TOT gaps and to quantify some of the important constraints like labour scarcity.

Ext. I (443)
Training of extension and research workers
M V Prasad and P Rajeev

The following training programmes were conducted.

1. Nursery management in spices	2-3 August 1995 (5 participants).
2. Spices production technology	20-25 November 1995 (12 partici pants).
3. Onfarm processing of spices	7-8 February 1996 (20 participants).
4. Nursery management in spices	14-15 February 1996 (22 participants).



All India Coordinated Research Project on Spices

During the year four new centres viz. Dapoli (KKV, Maharashtra) Kumargunj (NDAUT, UP.), Raigarh (IGKVV, M P) and Pundibhari (BCKVV, West Bengal) have been added.

In black pepper, a new cultivated type, 'Munda' from Kanjirapuzha near Palghat, 4 wild types from Kumkumudi and Vangasara and 20 elite lines from Shevroys hills were added. In tree spices, 13 elite clove lines from the traditional areas, 10 accessions of cinnamon from Anamalai hills and a nutmeg having yellow mace from Kolli hills were collected. Four each of ginger and turmeric were collected by the Pottangi centre from Orissa. The Jagtial centre added turmeric germplasm from Adilabad, Rayalaseema and coastal Andhra Pradesh. Under seed spices, several distinct lines have been assembled by Jagudan and Guntur centres.

Three high yielding OP progenies of black pepper were identified at Panniyur. Kuthiravally followed by Neelamundi and Arakkulam Munda were the highest yielders in the evaluation of promising cultivars of black pepper. In cardamom, several high yielding clones were reported at Pampadumpara and Mudigere. Tissue cultured selection, TC-5 was most promising among the 8 tissue cultured cardamom cultures evaluated at Mudigere. Use of non-precured orthotropic and semihard wood scions and the two leaved stage of root stock gave the highest percentage of graft success in nutmeg. Three promising turmeric and two ginger cultivars were identified at Pottangi. The XIII National Group Meeting of the AICRPS held at Jaipur recommended 9 varieties of spices for release. They are SG - 666 and Acc. 64 in ginger, Mudigere - 2 in

cardamom, PLD - 2 in black pepper, Acc.360 and 361 in turmeric, UD - 20 in coriander and Sel.63 and In.189 in cinnamon.

Several management schedules were developed at various centres for tackling the pest and disease problems in various spices. In turmeric seventy seven entries showed field resistance to *Colletotrichum* leaf spot and 44 entries to *Taphrina* leaf spot at Jagtial. Three cumin exotic entries resistant to *Fusarium* wilt were identified at Jagudan.

High levels of fertilizers significantly increased yield of cardamom under natural shade at Mudigere. Application of N_{125}, P_{100} K_{100} gave higher yield in ginger with maximum benefit of Rs.53,000/ha at Pottangi. At Panniyur, irrigation at IW/CPE ratio of 0.25 was the best for maximum spiking in black pepper cv. Karimunda. Intercropping soybean in turmeric gave maximum rhizome yield (17t/ha) at Pottangi. This also reduced the cost of cultivation and substituted the 2nd and 3rd mulching in turmeric.

The All India Coordinated Research Project on Spices (AICRPS) has been an important determinant for strengthening the research capability in Spices Research system in the country. The AICRP on Spices is vested with the mandate to conduct research on 12 spice crops and to develop location specific agrotechniques for sustained spices production. The headquarters of the AICRPS is located at Indian Institute of Spices Research, Calicut and the 20 centres are scattered throughout India in 15 states. In addition to 20 coordinating centres, 8 voluntary/participating centres are also functioning under the purview of this Project.

Genetic Resources

The centres of AICRPS enrich the germplasm accessions of their mandate crops every year by way of germplasm collection by surveys, mutual exchange of germplasm between the centres, etc. The centres of AICRPS hold a sizeable number of germplasm collection of the mandatory crops.

Germplasm survey & collection

Black Pepper : Panniyur centre collected a new cultivated type of black pepper locally known as 'Munda' from the Kanjirapuzha areas of Palakkad, Kerala. Four new wild black pepper germplasm were collected from Kumkumudi and Vengasara areas by the Chintapalli centre making a total of 25 wild collections. Survey work conducted by the Yercaud centre in the various pepper growing tracts of Shevroys hill helped in identifying 20 elite accessions.

Cardamom : Pampadumpara centre added two more cultivated types in cardamom from Vandenmedu and Kanchiyar of Idukki district making the total to 92 accessions which includes 15 wild types.

Ginger & Turmeric : The Pottangi centre collected four new cultivated ginger types and one wild ginger as well as four new turmeric accessions and one each of *C. aromatica* and *C. amada* from Cuttack, Koraput and Malkangiri districts of Orissa. Similarly, Jagtial added new turmeric germplasm from Adilabad, Rayalaseema and coastal Andhra Pradesh; these genotypes were grouped according to the duration of the crop, as short, intermediate and long duration types. The Raigarh centre collected 20 each of ginger and turmeric germplasm for the Pottangi centre. Additional 7 local ginger and 2 turmeric germplasm were also collected by the Centre during 1995-96.

Clove: Thirteen elite clove lines from traditional clove growing areas were collected, identified and maintained at the Yercaud centre. The Pechiparai centre (voluntary centre) collected and maintained 9 clove accessions from IISR viz. Acc. 4, 5, 8, 9, 10, 11, 12, 13 & 14. Another

seven seedlings of high yielding types were also collected during 1994 from local estates at Kanyakumari and maintained at Pechiparai centre.

Nutmeg: A nutmeg accession having yellow mace was collected by the Yercaud Centre from the Kolli hills. The Pechiparai centre collected and maintained 4 elite nutmeg grafts from IISR. In addition, the centre also collected one high yielding nutmeg type from State Horticulture Farm, Courtallam and 7 high yielding types from the estates of Kanyakumari district.

Cinnamon : A total of 10 cinnamon accessions were collected from the Anamalai hills and maintained at Yercaud; one accession was collected from HARS, Thadiyankudisai. The Pechiparai centre has so far collected 12 types viz. Sel. 5, 44, 53, 64, 65, 189, 203, 310, 312 from IISR and 3 types viz., Konkan Tej, Bavani Estate and Zero Point.

Coriander: In collaboration with the NBPGR, Regional Centre at Hyderabad, the Guntur centre collected 110 accessions of coriander during rabi 1995-96. Similarly, the Coimbatore centre surveyed and collected 16 composite germplasm from the principal coriander growing areas of Tiruchi, Kamarajar and Salem Districts. Jobner centre made an extensive survey in the districts of Tonk, Kota, Beran, Jhalawar of the State of Rajasthan and collected 47 coriander accessions.

Cumin : The survey conducted by the Jagudan centre in the state of Gujarat enabled 102 new cumin collections.

Fennel: Extensive survey was conducted in the fennel growing areas of Gujarat by the Jagudan centre; 95 diverse genotypes of fennel were collected with variability for dwarfness and seed character, earliness, etc. Similarly the Jobner centre collected 2 new fennel accessions from Tonk area of Rajasthan.

Fenugreek: The Jobner centre collected 15 fenugreek accessions from Mandore district of Madhya Pradesh and Pratapgarh, Chhotisadri and Nimhaheda areas of Chittorgarh district in Rajasthan.

Germplasm evaluation:

The evaluation of germplasm accessions maintained at the respective centres are progressing well.

Black Pepper : The Chintapalli centre evaluated 16 accessions of pepper and among them, the variety Panniyur 1 gave the highest yield of 9.26 kg green berries/vine. Among the 20 wild accessions, Maredumalli recorded maximum yield of 1.2 kg green berry/vine. In the evaluation

of pepper at Panniyur centre, Karimunda 31 with a mean green berry yield of 4.4 kg/vine stood first during 1995-96. Twenty pepper germplasm collections, planted in the arecanut plantation at Sirsi, are under evaluation.

Cardamom : Out of the 72 cardamom clones evaluated at Pampadumpara, clone PS-31 gave maximum dry yield (835 g/clump) followed by PS-1 (689 g/clump), the other promising clones being PS-27, PS-29, PS-24, PS-22, Veeraputran, MBP, PS-4 & SI. The promising cultures identified at Mudigere on the basis of four years' yield study are P17, P8, CL 728, CL 692, CL 681, P 12, CL 730, CL 757, P 20, and EB 1277-7, all of which produced more than 300 g green capsules/clump.

Ginger: One hundred and forty six germplasm accessions were evaluated at Pottangi. Maximum fresh rhizome yield was recorded in PFLR-1 (10.8 kg/3 sq.m)

Turmeric : Out of the 173 turmeric germplasm accessions evaluated at Pottangi, 153 belong to *C. longa*, 17 to *C. aromatica* and 3 to *C. amada*. Highest fresh rhizome yield was obtained by PTS - 51 (7.7 kg/3 sq.m) among *C. longa*, Uttamgarh (5.75 kg/3 sq.m.) in *C. aromatica* and CAN -2, (6.95 kg/3 sq.m.) in *C. amada*.

Tree Spices: At Thadiyankudisai, 10 promising cinnamon lines were selected based on their yield characters from a population of 250 types.

Coriander : Jobner centre identified coriander entries UD - 164 & UD-68 as most promising in the evaluation of germplasm whereas Jagudan evaluated 168 coriander accessions and identified 27 entries on the basis of variability. The Guntur centre evaluated 50 new coriander accessions and among these, LCC - 138 recorded the highest yield of 817 kg/ha.

Fennel : All the 153 fennel entries were examined at Jagudan and 9 entries were identified as high yielders on the basis of variability.

Cumin : All the 332 cumin accessions were evaluated at Jagudan and 53 entries were identified on the basis of variability for different characters.

Fenugreek: Jobner centre identified UM-288, UM-295 as the most promising germplasm accessions. All the 46 entries were critically examined and 7 entries were identified on the basis of variability at Jagudan. At Guntur, 73 fenugreek accessions were evaluated but the crop failed due to disease incidence.

Crop Improvement

Black Pepper: In the intervarietal hybridization trial with OP/hybrid progenies maintained at Panniyur, Cul. 5489 (Cheriayakaniakadan OP) gave maximum green berry yield (7.14 kg/vine) followed by Cul. 5403 (Karimunda OP) and Cul. 7156 (Perumkodi OP) with 4.6 kg and 3.89 kg per vine, respectively.

In the CYT of pepper genotypes, Karimunda stood first (1.90 kg/vine) followed by Panniyur-5 (1.54 kg) in the study at Panniyur. The Panniyur-3 with mean yield of 4.02 kg green berry/vine ranked first followed by Panniyur-5 (3.91 kg) and Karimunda (2.69 kg) in the MLT with promising cultures at Panniyur.

At Panniyur, in the MLT on the evaluation of promising cultures, Kuthiravally gave the highest yield of 3.39 kg/vine followed by Neelamundi (3.37 kg) and Arakulam munda (3.328 kg). In the MLT-III of pepper, the variety Panniyur-3 is found to be vigorous followed by Panniyur-2 in the evaluation at Sirsi centre.

The MLT of released varieties and promising cultures are in progress at Panniyur, Yercaud and Ambalavayal centres. At Panniyur, Kottanadan (Acc. 2426) and Karimunda seem to be superior in vegetative and yield characters and the variety "Ottaplackal" is performing well at the Ambalavayal centre. In the sixteen pepper types evaluated at Chintapalli, Panniyur - 1 followed by Kottanadan and Balankotta gave higher yields.

Cardamom : The MLT Series - III comprising the trial with Mysore types and another with Malabar types laid out in 1993 are under observation for yield and yield attributes in all the centres.

Studies at Mudigere observed that the yield from clonal crop was 30-40 per cent more than that raised from seedings. Among seedlings, 20 months' old seedling was ideal to get higher yields. Tissue culture selection TC-5 was most promising among the 8 "tissue cultured cultures" evaluated at Mudigere.

Ginger : Among the entries taken under CYT, V_1E_8-2 was the top yielder at Pottangi. In the IET comprising 17 accessions at Solan, SNR, BDJR-1113, BDJR-1054 and SG-687 were comparatively better over check "Himgiri" for yield while in CYT none of the entries performed well over the check. Under ginger MLT, SG-666 gave highest yield at Pottangi while at Solan, the local entries viz. SG-547, SG-646, SG-674 (Rajgarh) and SG-666 (Solan) were better yielders over the check, Maran and collections from Pottangi centre.

Turmeric : PTS-19 has been identified as the most promising turmeric accession at Pottangi under the MLT-III. PTS-43 (long duration) and PTS-59 (short duration) gave the highest yield out of the 12 varieties tested under MLT at Jagtial centre; Duggirala gave higher yield (23.43 t/ha) followed by PTS-10 (16.53 t/ha). Under the CYT, the three years' mean yield data (1993-94 to 1995-96) at the Dholi centre revealed the superiority of Rajendra Sonia and RH-5 out of the 10 varieties tested by giving 40.83% and 23.41 % higher yield giving a mean yield of 410.02 and 359.29 q/ha, respectively.

Tree Spices: The MLT in cinnamon laid out with 5 promising cultures at four centres viz., Yercaud, Ambalavayal, Pechiparai and Thadiyankudisai are progressing well.

Out of the 10 promising cinnamon lines identified at Thadiyankudisai, Acc. 3 recorded the highest yield of quills (0.78 kg dry quills/plant) as well as the highest dryage (39.54%) followed by Acc. 9.

In the standardisation of vegetative propagation techniques of nutmeg using non-precured orthotropic and semihard wood scions on different stages of root stock, "two leaved stage" of root stock gave the highest percentage of (45.5%) success in graft union.

Cumin : The accession UC-209 of cumin was identified by Jobner centre for testing in the farmers' field. The cumin accession UC-223 continued to show superiority with respect to grain yield as well as low incidence of wilt. In the crossing programmes in cumin, the Jagudan centre successfully crossed 'hairy cumin' and 'white flower cumin' with Gujarat Cumin-2.

Coriander : Coriander accessions UD-435, UD-436 were identified for testing in the farmers' field by the Jobner centre. At Dholi 9 varieties were tested under CYT, UD-446 outyielded others by giving 18.45 q/ha.

In the IET at Guntur with 11 entries, ATP- 8 recorded the highest grain yield (556 kg/ha) whereas in the MLT-1993 with 11 entries, the performance of Hisar and Jobner entries were poor and ATP-77 and JCo-64 were identified with an yield increase of 13.9 and 20.7 per cent over Co-3.

Fennel : RF-101 (UF-101) of fennel was identified at Jobner for testing in farmers' field. The fennel exotic culture and "bloomless" fennel were crossed with Gujarat Fennel-1 and the F_1 seeds were obtained at Jagudan for further testing.

Fenugreek : At Guntur in the MLT-1993, accession UM-144 recorded the highest yield of 522 kg/ha and was statistically significant. In the MLT-1995 with 11 entries tested at Guntur, JF-102 recorded significantly highest yield of 544 kg/ha followed by JF-58 with 511 kg/ha.

At Coimbatore, two lines viz. CF-390 and CF-464 were advanced based on the yield under IET & CYT. The percentage of increase in yield was 73.2 in respect of CF-464 over the variety Co-1.

At Jobner, the variety RMt-1, a multipoded, spontaneous mutant (UM-305) characterised by dwarf determinant-habit of growth was identified as a variety as well as for use in crossing programmes.

New Varieties

The XIII National Group Meeting of AICRP on Spices which was held at Jaipur, Rajasthan discussed and recommended 9 varieties in spices for release. The new high yielding varieties in spices, were Mudigere-2 (Acc.683) in cardamom, PLD-2 (Acc. 2559) in black pepper, SG-666 (Himgiri) and IISR Varada (Acc.64) in ginger, IISR Prabha (Acc.360) and IISR Prathibha (Acc. 361) in turmeric, IISR Navashree (SL-63) and IISR Nityasree (Sel. In-189) in cinnamon and the coriander variety RCr-20 (UD-20). The important characteristics of the four varieties recommended from the centres are furnished below:

Black Pepper - PLD-2 (Acc.2559) : A high yielding selection from Kottanadan lines is identified for cultivation in the southern parts of Kerala and was developed by the Central Plantation Crops Research Institute (Regional Station), Palode, near Trivandrum. The variety yields 2.48 t dry pepper/ha and is superior in essential oil (4.8%), oleoresin (15.4%) and piperine (3.0%) with 31.13% dry recovery. The variety performs well in shade and hence suitable for the mixed cropping system.

Cardamom - Mudigere - 2 : Developed by Mudigere (UAS) centre in Karnataka, a clonal selection from Malabar type, yielding 476 kg/ha at a spacing of 1.8 m x 1.8 m. The capsules are bold, has 26% dry recovery, 8% oil, 10.6% oleoresin, 45% 1,8 - Cineole and 38% α - terpenyl acetate. It is an early maturing variety recommended for cultivation in traditional cardamom growing tracts of the hilly zones of Karnataka.

Ginger - SG-666 (Himgiri) : A variety developed by Solan centre (Himachal Pradesh) through clonal selection, suitable for low and mid-hill areas of Himachal Pradesh for both irrigated and rainfed conditions. A high yielding variety with less incidence of rhizome rot and medium in quality viz. 1.63% essential oil, 4.29% oleoresin and 20.62% dryage;

yields 13.0 to 14.0 t/ha at 230 days duration and is suitable for green ginger (salad) purpose.

Coriander - RCr-20 (UD-20) : A coriander variety for unirrigated conditions, recommended for southern parts of Rajasthan, developed by Jobner centre and yields 1100 kg/ha under irrigated and 900 kg/ha under limited moisture conditions. It is a "recurrent selection" based on half-sib progeny testing, matures in 100 to 110 days, a medium tall type and produces an average yield of 11.75 q/ha; specially adopted to heavy soil types of Tonk, Bundi, Kota and Jhalawar districts of Rajasthan.

Disease Resistance

At the Jagtial centre, 77 turmeric entries seemed to have field resistance to *Colletotrichum* leaf spot and 44 entries to *Taphrina* leaf spot/blotch disease.

Cumin exotic entries viz. EC - 239684, EC - 243375 were found to be resistant against *Fusarium* wilt under sick plot conditions at Jagudan. In fenugreek, the Bulgarian collection, EC-257566 and Kasturi Methi are free from powdery mildew at Jagudan.

Crop Production and Management

Black Pepper: The irrigation cum fertilizer trial of black pepper with two different cultures of pepper is progressing at Panniyur and Sirsi centres. At Panniyur centre, irrigation at IW/CPE ratio of 0.25 was the best for maximum spike yield but did not show any significant effect on the variety Panniyur-1. At Sirsi, the study with three levels of irrigation and four levels of fertilizers with two pepper varieties viz. Panniyur-1 and Karimalligessara planted in arecanut standard is progressing.

Cardamom : The average yield of the variety Mudigere-1 ranged from 90-150 kg (dry capsule/ha) under rainfed conditions at Mudigere. Studies on the response of different levels of NPK on the yield of cardamom at Mudigere confirmed that, higher levels of fertilizers viz. 150-150-225 kg NPK/ha resulted in significantly higher capsule yields when grown under natural shade. Studies also revealed that growth regulators had no influence on proliferation of suckers whereas closer spacing significantly increased the sucker production in Mudigere.

Ginger : Studies at Pottangi with ginger variety Suruchi confirmed that application of $N_{125}P_{100}K_{100}$ kg/ha for higher yields and maximum returns (14.65 t/ha) with the maximum benefit of Rs. 53,000/ha.

Ginger seed rhizome size for planting standardised at Dholi (Bihar) revealed that use of larger sizes of 24 g/piece produced the highest yield (213.03 q/ha). The relative profitability of different seed rhizome size also worked out at Dholi and observed that highest net return of Rs. 61,395/ ha was achieved when 18 g size of seed rhizomes were sown. Hence, it is recommended that a minimum of 18 g size of seed rhizomes may be followed for higher net returns per ha in ginger in Bihar.

Turmeric : Intercropping soybean in turmeric is recommended for Pottangi which gave maximum rhizome yield of turmeric (17.0 t/ha) and highest benefit of Rs.34,000/ha; this practice also reduced the cost of cultivation and substituted the 2nd and 3rd mulching operations.

Studies on various spacing/plant population of turmeric were conducted at Dholi using the variety Rejendra Sonia. The maximum yield (484.45 q/ha) was obtained by adopting a spacing of 30 cm x 20 cm (1,66,500 plants/ha) which also generated the highest net return of Rs. 22,615/- per hectare. Studies concluded to adopt a spacing of 30 cm x 20 cm in turmeric in the agroclimatic condition of Dholi, Bihar.

Coriander : Coriander sown on 25th October and on 4th November at 30 cm row spacing produced maximum seed yield with the variety RCr-41. A seed rate of 14 kg/ha using RCr-41 and UD-20 (RCr-20) and a seed rate of 12 kg/ha with the variety RCr-436 (UD-436) produced the maximum seed yield at Jobner. Six coriander varieties evaluated at Dholi for green leaf yield were harvested 55 days after sowing. The variety Pant Dhania -1 and RD-36 produced the highest green leaf yield.

Fennel : Optimum age of fennel seedlings for transplanting was studied at Dholi. It was observed that transplanting of "6-week-old seedlings" of fennel variety RF-17 produced the highest yield of 18.36 q/ha while older seedlings affected the yield.

Crop Protection

Black Pepper: The study on *Phytophthora* foot rot and nematode disease management in black pepper was continued at the three pepper centres. Out of the 8 treatment combinations tried at Chintapalli, combination with the cultural practices + 1 kg neem cake + 3 g a.i. Phorate (soil application) + 1.0% Bordeaux mixture spray first and second round of spray with Akomin (0.04%) spray observed the least disease incidence in terms of foliar yellowing (5.6%) and defoliation (8.4%). In *Phytophthora* disease control studies at Sirsi, minimum disease incidence (10%) was observed in vines receiving the all applications @ 1 kg/vine Phorate 3 G @ 30g/ vine, Bordeaux mixture (1%) spray before onset of monsoon +

application of Akomin (0.04%), Ridomil MZ 72 WP (100 ppm) as spray (@ 3 l/vine) and drench (@ 5 l/vine) separately at 30 days interval from the first spray. At Panniyur, the *Phytophthora* foot rot management studies did not show any significant effect on the disease control.

The preliminary results of biocontrol studies for the management of *Phytophthora* foot rot in black pepper have shown some dividends. Treatment with the biocontrol agents *T. harzianum* and *T. viride* revealed the lowest disease incidence of 8.3% compared to 33.3% in control in Chintapalli; similarly *T. viride* is found to be effective at Sirsi.

Control measures developed for the nursery diseases in black pepper involves the spraying and drenching with Bordeaux mixture (1.0%) and Akomin (0.2%) under low and high shade conditions. At Sirsi, less mortality (26.66%) was observed in pepper cuttings sprayed and drenched with Bordeaux mixture raised under medium light intensity (3.3 lux).

Cardamom: Spraying schedule for the management of cardamom thrips worked out at Mudigere comprising of three insecticidal sprays, one in March (Monocrotophos 0.05%) followed by May and August (Phosalone 0.05%), was the most effectve. The crop protection studies using cultural and chemical control of thrips, shoot borer & capsule borer conducted at the Pampadumpara centre, the pooled analysis of results showed that the treatment of five applications of insecticides during the months Feb/ April/May/August & October appeared to be most effective as well as convenient and economical compared to more number of sprays. Similarly, application of insecticides 5, 6 or 7 times along with or without selective thrashing during Feb/March helped in controlling shoot borer (Pampadumpara).

Tree Spices : The pest incidence studies in cinnamon was initiated at the Pechiparai centre. Incidence of leaf folder was observed throughout the year though the incidence was more from January-April and lesser in May-August. Incidence of the pest *Papillio demoleus* was seen throughout the year except in the month of April and maximum during May-July. The cinnamon selection No.44 recorded the lowest infestation.

Turmeric : *Taphrina* leaf spot disease is of major importance in turmeric. The Jagtial centre recommended spraying of Dithane M-45 (0.25%) to control *Taphrina* leaf spot.

Cumin : Solarisation studies conducted in Jobner during last 2 years observed the least wilt incidence (32.85%) compared to 69.64% in

control. Studies at Jagudan recommended early sowing viz. on the 5th and 15th October which was effective to save the cumin crop from blight diesease.

Coriander : An ecofriendly technique of using 5 per cent onion leaf extract as foliar spray was evolved to control the powdery mildew in coriander (Coimbatore). This practice reduced the powdery mildew incidence from 88.0 to 64.75 per cent. The promising management techniques for coriander wilt developed at Coimbatore centre involves a pre-sowing seed treatment with *Trichoderma harzianum* @ 4 g/kg of seed. The treatment reduced the disease incidence from 22.9% to 3.8%.

Fenugreek: A pre-sowing seed treatment with *T. viride* in combination with the application of 150 kg/ha of neem cake effectively reduced the root rot incidence (from 36.8% to 26.2%).

Evaluation for Quality

The quality studies in coriander using accession UC-964 showed that climate/environment conditions have role in determining the quality. The entry CC-964 has shown maximum volatile oil content (0.5%) when grown in Tamil Nadu compared to 0.4% and 0.3% when grown in Hisar and Jobner centres, respectively.

Krishi Vigyan Kendra

A plant and animal health centre was established in July 1995 and arrangements were completed to start an artificial insemination unit attached to it. Demonstration units were established in the following disciplines viz. Vermiculture, Mushroom cultivation, Bee Keeping, Rabbitory, Poultry and Nursery management. Forty five training programmes were conducted in the disciplines viz. agriculture, horticulture and home science in which 3,500 participants (farmers, farm women, school dropouts and house wives) had attended. Ten National Demonstrations on intercropping of coconut with spices were organised in farmers' fields. Problem oriented research was conducted with regard to management of *Phytophthora* foot rot of black pepper and mahali in arecanut. The Kendra participated in various agriculture and scientific exhibitions. The Kendra adopted Pannikottur village under the client oriented programmes and 25 families belonging to scheduled caste were provided with planting materials, poultry and agricultural implements with a view to improve their family income and thus the living standards.

Plant and animal health centre

A plant and animal health centre, where the farmers could solve their agriculture and animal husbandry problems was established at KVK. Arrangements have been made with the Kerala Live Stock Development Board for starting an artificifal insemenation centre attached to it.

Establishment of demonstration units

Demonstration units have been established in vermiculture, mushroom cultivation, apiculture, rabbitory and nursery management.

Training programmes

One of the major mandates of KVK is to provide need based training to practising farmers, farm women, rural youth and extension workers. In the absense of hostel facilities at the campus , it could organise only a few long term training programmes in 'vegetable production and processing' and 'production and maintenance of high value ornamental plants'. In addition, short term courses of 1-3 days duration on various aspects of agriculture and allied sciences were organised (Table 6.1). In all, more than 3500 participants were trained under this programme.

Table 6.1 *Training Programmes Organized by KVK*

1.	*Phytophthora* foot rot management of black pepper
2.	Pest and diseases of spices
3.	Cultivation of pepper and banana
4.	Pesticides
5.	Mushroom cultivation
6.	Epicotyl grafting in nutmeg and cashew
7.	Spice production technology
8.	Nursery techniques in spices
9.	Training of mitrakisans
10.	Pest and diseases of ginger and turmeric
11.	On farm processing of spices
12.	Cultivation of medicinal plants and spices
13.	Homestead cultivation of spices
14.	Bamboo method of rapid multiplication of black pepper
15.	Mixed cropping in coconut and arecanut garden
16.	Vegetable production and processing
17.	Floriculture

National demonstrations

For the benefit of farmers possessing land and interested in adoption of latest technologies, Rs.40,000 is earmarked for arranging 25 demonstrations. During the year, ten such demonstrations were organised in farmers' fields.

Literature developed /published

KVK has published extension literature on the following aspects. Package of practices of ginger; Package of practices of turmeric and Storage of ginger seed rhizomes.

On farm research

a. Client oriented programme: Twenty five families have been selected in Pannikottur SC/ST colony where agri.implements / planting materials/ poultry have been supplied. Benefits derived to the participants is being monitored.

b. Problem oriented research: For identifying the existing problems in agriculture, horticulture, animal husbandry, home science, agricultural engineering, etc., to provide suitable remedial measures on the research basis, problem oriented research was carried out. Under this, two programmes were selected, one on management of *Phytophthora* foot rot disease of black pepper and another on management of 'mahali' in arecanut. Under this programme, 25 arecanut farmers were selected and critical inputs like plant protection chemicals were made available, in addition to practical training in the preparation as well as application of Bordeaux mixture. Plant protection operations were carried out on a group basis.

c. Watershed management.: KVK organised training of 'mitrakisans' of watershed areas in collaboration with the State Department of Agriculture.

d. First line demonstration (FLD) on pulses: Under this programme, black gram(CO-5 & TMV- I) was introduced at Mukkom in farmers field (5ha). Average yield obtained was 2.5 q/ha. In another programme green gram was introduced in 5ha which gave an average yield of 5 q/ha. In both these programmes, seed material, *Rhizobium* culture and fertilizers were given to the farmers in addition to pump sets on loan for irrigation purpose.

e. Revolving fund scheme: Under the revolving fund scheme, large quantities of planting materials of arecanut and spices were developed and sold. A revolving fund scheme for the production of quality planting materials of fruits, plantation crops and high value ornamental plants, submitted to the council, is expecting clearance.

f. Establishment of progeny orchard, instructional farm and nutrition garden: Progeny orchards of fruit trees and nutrition garden is being developed.

g. Participation in exhibitions: The KVK participated in the scientific / agriculture exhibitions organised by Rubber Growers' Association at Ernakulam, AIR at Nilambur, State Department of Agriculture at Koduvally, Balussery and Regional Engineering College at Calicut.

GENERAL INFORMATION

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MAJOR EVENTS

- **1 April 1995 : IX Foundation Day of NRCS**

The nineth foundation day of NRCS was celebrated on 1 April 1995. Dr. K. V. Peter, Director presided over the meeting. Mr. U.K.S. Chauhan, District Collector, Calicut was the chief guest Rt. Rev. Laurence Mar Ephraem, Arch Bishop, Trivandrum, Dr. E.J. James, Director, CWRDM, Calicut, Mr. E. Velappan, Director, DCASD, Calicut, etc. offered felicitations.

- **21-23 April 1995: VIII Staff Research Council Meeting**

The Eighth Staff Research Council Meeting was held during 21 - 23 April 1995. The progress of work in 33 research projects and three supportive research programmes were presented and discussed. Seven research projects funded by ICAR and DBT were also reviewed. Five new projects were approved. In addition to the scientists of the institute, experts in respective fields and officials from development

organizations also attended the meeting. Dr. P. Rethinam, ADG (PC) was the general chairman of SRC.

- **13- 14 June 1995: Group Meeting on Virus Diseases of Black Pepper and Cardamom**

A group meeting on the virus diseases of black pepper and cardamom was held at NRCS, Calicut from 13 - 14 June 1995. The meeting, convened by Dr. S. Edison, Project Coordinator (Spices), was attended by eminent virologists and molecular biologists from SV University, Tirupati, M K University, Madurai, UAS, Bangalore, CPCRI, RS, Kayangulam and ICRI, Myladumpara, besides the plant protection group from NRCS. Status papers on viral diseases of both crops were presented and discussed in the meeting. The meeting decided to propose an ad-hoc research scheme on stunted disease of black pepper.

- **18 July 1995 : NRCS Upgraded as Indian Institute of Spices Research**

NRCS, Calicut was upgraded as a full fledged research institute, INDIAN INSTITUTE OF SPICES RESEARCH (IISR), with effect from 1 July 1995. This was officially announced in a press conference held at the Press Club, Calicut on 18 July 1995 by Dr. K.L. Chadha, DDG (Hort.), ICAR, New Delhi.

- **23 - 25 August 1995 : National Group Meeting of AICRP on Spices**

The National Group Meeting of All India Coordinated Research Project on Spices was held at the Agricultural Research Station, Durgapura, Jaipur during 23 - 25 August 1995. Dr. Jayant Patil, Member (Agric.), Planning Commission, Govt.of India, inaugurated the workshop, offered felicitations and presided over the inaugural meeting. Dr. S. Edison, Project Coordinator presented the progress report. Dr. K.L. Chadha, DDG (Hort.), ICAR, Mr. M.L. Mehta IAS, Chief Secretary, Govt.of Rajasthan, Dr. R. K. Patel, Vice Chancellor, Rajasthan Agricultural University, Mr. C.S. Rajan, Secretary (Agric.), Govt.of Rajasthan, Dr. P Rethinam, ADG (PC), ICAR, Dr. M S. Manohar, Director of Research, RAU and about 130 delegates from different states including scientists from 20 coordinating/ voluntary centres, Spices Board, DCASD and Agriculture & Horticulture departments of various states attended the meeting. The workshop recommended the release of nine new spices varieties, two each in ginger, turmeric and cinnamon, one each in cardamom, pepper and coriander.

- **28, 29 Sept. and 3 Nov. 1995 : Biotechnology Popular Lecture Series**

A series of popular lectures on Biotechnology were organised by IISR, Calicut at St. Joseph's College, Calicut on 28 and 29 September 1995 and at IISR on 3 November 1995. Dr. (Mrs.) L.U. Suvarnam, Principal, Calicut Medical College inaugurated the programme. Dr. M.R Das, Director, Rajiv Gandhi Centre for Biotechnology, Dr. R.D. Iyer, Head (Retd.) Crop Improvement Division, CPCRI, Kasaragod and Dr. P N. Ravindran, Head, Div.of Crop Improvement & Biotechnology, IISR, Calicut delivered lectures.

- **8 - 10 November 1995 : IX Staff Research Council Meeting**

The nineth Staff Research Council meeting of IISR was held during 8 - 10 Nov. 1995. The mid term progress of work in 32 research projects and nine ad-hoc schemes

was reviewed in the SRC. Dr. P.C.S. Nair, Director of Research (Retd.), KAU attended as an external expert.

- **12 - 13 January 1996 : Research Advisory Council Meeting**

The first meeting of the Research Advisory Council was held on 12 - 13 January 1996. Dr. S.N. Rao, Dr. T.N. Ananthakrishnan, Dr. M.C. Nair, Dr. C.S. Narayanan, Dr. R. N. Pal and Ms. Nirmala Sharma participated in the meeting.

LIBRARY AND INFORMATION SERVICES

During the reporting period, IISR library added 140 books 100 bound volumes of journals and 38 reprints, besides annual reports, technical reports, newsletters, etc. from other institutes and agricultural universities. Four issues of 'Agri Science Tit Bits' and nine issues of 'Content Page Services' were brought out and distributed to research workers at the institute, other institutes, KVK and different centres of AICRP on Spices. 'Spices Bibliography - Part 1 & 2' were also compiled and published in the Journal of Spices and Aromatic Crops. Reprographic services were also provided to the scientists and research workers on request. Apart from the scientists and research scholars in the institute, 155 visitors from other institutes and universities also utilized the library. To accomodate the increasing volume of periodicals, books, etc. the library is being expanded.

BUDGET FOR THE YEAR 1995-96

Particulars	Actual Expenditure (Rs.in lakhs)	
	Plan	Non Plan
Establishment	2.19	88.62
Travelling Allowance	2.00	3.50
Assets	45.71	0.52
Contingency	58.89	19.47
Total	108.79	112.11
Other Sources		
KVK		21.12
A P Cess Fund Schemes		10.54
IPDS		7.04
DBT Schemes		9.29

IMPORTANT COMMITTEES

IISR Management Committee

Dr. K V Peter - *Chairman*
Director, Indian Institute of Spices Research,
Calicut - 673 012

Dr. R N Pal - *Member*
Assistant Director General (PC), ICAR,
New Delhi- 110001

Director - *Member*
Academic & PG Studies, KAU,
Trichur, Kerala - 680 654

Joint Director - *Member*
of Horticulture (PC)
Government of Karnataka, Lal Bagh,
Bangalore - 560 004

Director of Agriculture - *Member*
Government of Kerala, Vikas Bhavan,
Trivandrum - 695 001

Ms. Nirmala Sharma - *Member*
85, Anoop Nagar, Indore,
Madhya Pradesh - 452 008

Mr. V P Joshi - *Member*
12, Baidyanath, Mallick Lane,
Calutta - 700 007

Sr. Finance - *Member*
& Accounts Oflicer
Central Marine Fisheries Research Institute,
Cochin - 682 014

Dr. P N Ravindran - *Member*
Principal Scientist & Head,
Div.of Crop Improvement & Biotechnology,
Indian Institute of Spices Research,
Calicut - 673 012

Dr. M N Venugopal - *Member*
Senior Scientist (Plant Pathology),
IISR, Cardamom Research Centre,
Appangala, Karnataka - 571 201

Mr. M Anandaraj - *Member*
Senior Scientist (Plant Pathology),
Div.of Crop Protection,
Indian Institute of Spices Research,
Calicut - 673 012

Ms. K Usha - *Member Secretary*
Asst. Administrative of Officer
Indian Institute of Spices Research,
Calicut - 673 012

Research Advisory Committee

Dr. S N Rao - *Chairman*
Director of Research (Retd.), APAU,
Hyderabad

Dr. T N Ananthakrishnan - *Member*
Director, Entomology Research Institute,
Loyola College, Madras

Dr. M C Nair - *Member*
Professor & Head (Retd.), Plant Pathology,
KAU, Vellayani

Dr. C S Narayanan - *Member*
Regional Research Laboratory, Trivandrum

Dr. C K George - *Member*
Executive Director, Spices Board, Cochin

Dr. R K Sharma - *Member*
Professor, Plant Breeding & Genetics, RAU,
Jobner

Ms. Nirmala Sharma - *Member*
85, Anoop Nagar, Indore - 452 008

Mr. V P Joshi - *Member*
12, Baidyanath Mallick Lane,
Calcutta - 700 007

Dr. K V Peter, - *Member*
Director, Indian Institute of Spices Research,
Calicut

Dr. R N Pal, - *Member*
Assistant Director General (PC), ICAR,
New Delhi - 110 001

Dr. Y R Sarma - *Member Secretary*
Principal Scientist & Head,
Div. of Crop Protection,
Indian Institute of Spices Research,
Calicut

Staff Research Council

Dr. K V Peter - *Chairman*
Director, Indian Institute of Spices Research,
Calicut

Dr. R N Pal - *Member*
Assistant Director General (PC), ICAR,
New Delhi - 110 001

Dr. P C Sivaraman Nair - *Member*
Director of Research (Retd.), KAU,
Vellanikkara

Dr. V K Gupta - *Member*
Professor & Head, Dept.of Plant Pathology,
Dr. Y S Parmar Univ. of Agriculture &
Forestry, Solan

Dr. C K George - *Member*
Executive Director, Spices Board, Cochin

Dr. M Aravindan - *Member*
Principal Scientist & CTO, KVK, Calicut

Dr. S Edison - *Member*
Project Coordinator (Spices),
IISR, Calicut

All Principal Investigators
of Projects - *Members*

Mr. Santhosh J Eapen - *Member Secretary*
Scientist Sr. Scale (Nematology), IISR,
Calicut

Policy Committee

Dr. K V Peter, Director - *Chairman*
Ms. K Usha, AAO - *Member Secretary*

Members
Dr. S Edison, Dr. Y R Sarma,
Dr. M Aravindan
Dr. P N Ravindran, Dr. A K Sadanandan,
Dr. K V Ramana, Dr. V S Korikanthimath,
Mr. Jose Abraham and
Mr. T. Gopinathan

PG Committee

Dr. K V Peter, Director - *Chairman*
Dr. K V Ramana,
Principal Scientist - *Secretary*

Members
Dr. M Aravindan, Dr. S Edison,
Dr. Y R Sarma,
Dr. P N Ravindran, Dr. A K Sadanandan and
Ms. K Usha

Grievence Cell

Dr. K V Peter, Director - *Chairman*
Ms. K Usha, AAO - *Member Secretary*

Members
Dr. S Edison, Dr. A K Sadanandan,
Mr. T Gopinathan, Mr. N P Padmanabhan,
Mr. S M Chettiar and
Mr. K P Vijayan Nair

Farm Advisory Committee

Dr. K V Peter, Director - *Chairman*
Mr.V K A Koya,
Farm Superintendent - Secretary

Members
Mr. P A Mathew, Scientist in charge (Farm),
Ms. K Usha, AAO, Mr. T Gopinathan, ACO
and all the scientists

Institute Joint Council

Dr. K V Peter - *Chairman*

Official side
Mr. Jose Abraham - *Secretary*
Members
Dr. M Aravindan, Dr. A K Sadanandan, Dr. V S Korikanthimath, Mr. T Gopinathan and Ms. K Usha
Staffside
Mr. P K Janardhanan - *Secretary*
Members
Mr. S Hareendrakumar, Mr. P Bhaskaran, Mr. K Balan Nair, Mr. K K Thimmaiah and Mr. V Balakrishnan

MEMBERSHIP IN COMMITTEES

Devasahayam, S
- Asst. Editor, Journal of Spices and Aromatic Crops

Peter K V
- Member, General Council, Kerala Agricultural University
- Member, Spices Board, Cochin
- Member, Spices & Condiments Sub Committee FADC 9, Bureau of Indian Standards, New Delhi
- President, Indian Society for Spices, Calicut
- Coordinator, Agriculture Research and Development, Malabar Development Board, Calicut

Ramana, K V
- Secretary, Indian Society for Spices

Ravindran, P N
- Editor, Journal of Spices and Aromatic Crops

Sarma, Y R
- Member, Board of Studies - Life Sciences, University of Calicut

PARTICIPATION IN SEMINARS / SYMPOSIA / WORKSHOPS / TRAINING PROGRAMMES

Anandaraj, M
- National Workshop on 'Molecular Biology of the Gene', 11 -30 Nov.1995, Centre for Plant Molecular Genetics, Osmania University, Hyderabad.
- Workshop on 'Online Information Access and Retrieval', 26-27 Mar. 1996, Bioinformatics Centre, School of Biotechnology, Madurai Kamaraj University, Madurai.

Anandaraj, M, Nirmal Babu, K, Minoo, D, Mini P Mathai, Sajina, A, Geetha S Pillai and Shaji Philip
- All India Symposium on 'Recent Advances in Biotechnological Application of Plant Tissue and Cell Culture', 22 - 24 June 1995, CFTRI, Mysore.

Anke Gowda, S
- Workshop on 'Theory and Methodology for Physiological and Molecular Basis of Stress Resistance in Crop Plants', 3-24 April 1995, UAS, Bangalore.

Aravindan, M
- National Workshop on KVKs and TTCs, 9 - 12 Sept.1995, Tirupathi, A.P.

Devasahayam, S
- Workshop on 'Conservation of Invertebrates',19-20 Oct.,1995, Calicut.
- Indo-UK Workshop on Current Approaches to Pheromone Technology, 29 Nov. - 1 Dec. 1995, Madras.

Edison, S

- Pre Season Rabi Workshop for Pulney Hills, 5 Sept.1995, Thadiyankudisai, Tamil Nadu.
- Workshop of AICRP on Palms, 22-23 Dec.1995, CPCRI, Kasaragod.

Edison, S, Sarma, Y R, Sadanandan, A K, Krishnamoorthy B, Sasikumar, B and Johny A K

- National Group Meeting of All India Coordinated Research Project on Spices, 23 - 25 July 1995, Jaipur, Rajasthan.

Edison, S, Sarma, Y R, Ramana, K V, Venugopal, M N, Dake, G N, Anandaraj, M and Devasahayam, S

- Group Meeting on 'Viral Diseases of Black Pepper and Cardamom,' 13-14 June 1995, IISR, Calicut.

Hamza ,

- Short-term Training Course on Analytical Techniques and Instrumentation in Water Quality Management. 6 - 10 Mar. 1995. CWRDM, Calicut.
- South India Regional Symposium on 'Water Treatment for Domestic/Industrial Sector', 14th March 1996, CWRDM, Calicut.

John Zachariah, T

- FAD Meeting organised by Bureau of Indian Standards, 26 - 27 Feb.1996, CFTRI, Mysore.

Jose Abraham

- Training on 'Personal Computer Applications and Information Retrieval', 23-25 Jan.1996, TNAU, Coimbatore.

Korikanthimath, V S

- Expert Committee Meeting on 'Alternative Crops for Cardamom', 4&5 Dec.1995 and 2&3 Jan.1996, Spices Board, Cochin.

Krishnamurthy, K S

- Training in ' Extraction and Quantification of Plant Hormones',15 - 26 May 1995, IIHR, Bangalore.

Manoj, PS

- Zonal Workshop of KVK, 27 - 29 June 1995, KVK, Pondicherry.
- Training on 'Landscape Architecture',27-29 Feb.1996, REC, Calicut.

Mini Kallil

- Training on rearing scale insects and their natural enemies, 14 - 15 June 1995, Project Directorate of Biological Control, Bangalore.

Nirmal Babu, K

- Training in 'Basic Techniques of Molecular Biology', 11 -26 Nov.1995, SPIC Science Foundation, Biotechnology Laboratory, Madras.
- Short Term Course on 'Yeast Genetic Manipulation and Molecular Markers', Nov.27-Dec.11 1995, M.S. Swaminathan Research Foundation, Madras.

Peter, K V, Krishnamurthy, K S and Anke Gowda, S

- National Seminar on Drought Management in Plantation Crops, 7 - 8 Feb. 1996, Kottayam.

Prakash, K M

- Training on 'Mushroom Cultivation', 29-30 July 1995, TBGRI, Trivandrum.
- Training on 'Vermiculture',1-3 Aug.1995, CRC, Appangala.

Prasad, M V

- Seminar on ' Quality Improvement of

Spices' organised at Kalpetta, Pulpally and Iritty, Kerala by Spices Board.
- Training on 'Computer Applications in Agricultural Research', 11 - 22 July 1995, NAARM, Hyderabad.
- Training on ' MS Windows',18 - 22 Mar. 1996, CMC, New Delhi.

Rajeev, P
- National Convention of the Society of Extension Education, 20 - 21 Jan.1996, TNAU, Madurai.

Rajendra Hegde
- State Level Interaction Workshop on 'Agroforestry',13 - 16 Dec.1995, BAIF, Mysore.
- Field Day on 'Hitech Agriculture', 26 Dec. 1995, Bangalore, Karnataka.

Ramana, K V
- Working committee of PLACROSYM XII, 16 Jan.1996, RRII, Kottayam.

Ravindran, P N, Krishnamoorthy, B, Sasikumar, B, Rema, J, Johnson Gorge, K, Dhamayanthi, K P M and Minoo Diwakaran
- Seminar on 'Crop Breeding in Kerala', 25 Jan.1996, Department of Botany, Univ. of Kerala, Trivandrum.

Rema, J
- International Symposium on 'Strategies for Exploiting Biotechnology Potential', 26-30 Nov.1995, CPMB, Osmania University, Hyderabad.

Sadanandan, A K
- National Symposium on 'Use of Rock Phosphates for Sustainable Agriculture', 24 - 25 April 1995, UAS, Bangalore.
- National Seminar on 'Development in Soil Science 1995', 2-5 Nov.1995, ISSS & PAU, Ludhiana.
- Workshop on 'Management of Perennial Crop Loans for Bank Managers from Sri Lanka', 1 Nov.1995, College of Agricultural Banking, Reserve Bank of India, Pune.
- Seminar on Plantation Crops jointly hosted by SBT and Lions Club, Wynad, 25 Nov. 1995 Kalpetta

Sakeer Hussain
- Training on 'Mushroom Production', 26 Feb. - 2 Mar. 1996, KAU, Vellayani.

Sarma, Y R
- Meeting on 'Integrated Pest and Disease Management (IPM/ IDM) of Black Pepper', 10 April 1995, Spices Board, Cochin.
- Annual Conference of UPASI, 11 Sept. 1995, Coonoor, Tamil Nadu.
- Kodagu Planters Association Annual Conference, 22 Nov.1995, Pollibetta, Karnataka.
- Farmers' seminar organised by Lions Club & SBT, 25 Nov.1995, Kalpetta, Kerala.
- Plant Protection Panel of Horticulture Division, 22 December 1995, ICAR, New Delhi
- Working Committee of PLACROSYM XII, 16 Jan. 1996, RRII, Kottayam.
- National Symposium on 'Management of Threatening Plant Diseases of National Importance', 14 - 15 Feb. 1996, PAU, Ludhiana.

Shaji Philip
- National Symposium on 'Biotechnology for Rural Development', 22-24 Dec. 1995, Gulbarga University, Gulbarga, Karnataka.

Shanmughavel, S and Kavitha, C S
- Trainers Training Programme, 5 - 16 Sept. 1995, NAARM, Hyderabad.

Sreejith, N
- Training on 'E-mail', 11 - 15 Mar. 1996, CMC, New Delhi.

DEPUTATIONS ABROAD

Johnson George, K
International Training Course on 'Conservation and Utilization of Plant Genetic Resources',18 Aug. to 12 Sept.1995, DSE, Zschortau, Germany.

GUEST LECTURES

Edison, S
- 'Cultivation of spices', 5 Sept.1995, HRS, Thadiyankudisai, Tamil Nadu.

Devasahayam, S
- 'Insect diversity and human welfare', 23 Nov.1995, St. Joseph's College, Calicut.
- 'Insect pests of spices and their management', 11 Dec.1995, Government Arts College, Madappally.

John Zachariah, T
- 'Value added spices - an overview'- Science and Technology Enterpreneurship Development (STED) Technology Clinic, 25 March 1996, Kalpetta.

Peter, K V
- 'Present status, diversification, value addition and export orientation in spices', Sub group Meeting on ' Diversification, value addition and export orientation', ICAR, New Delhi.

Rajendra Hegde
- 'Problems and prospects of spices cultivation', 13 - 17 Oct.1995, Farmers' meet, Hosamayara, Shimoga, Karnataka.

Ramana, K V
- 'Nematodes associated with spices', 13 - 18 Nov.1995, Training on 'Identification of Burrowing Nematode, *Radopholus similis*', CPCRI, RS, Kayangulam, Kerala.

Rema, J
- Application of 'tissue culture and floriculture' Science and Technology Entrepreneurship Development (STED) Programme, Tanur.
- 'Tissue culture - an introduction', Training on Floriculture, KVK, Calicut.

Sadanandan, A K
- 'Production technology in black pepper development and transfer', 7 Oct.1995, All India Spices Exporters Forum, Cochin.
- 'Techno-economics of pepper cultivation', 1 Nov.1995, College of Agricultural Banking, Reserve Bank of India, Pune.
- 'Pepper production, management and quality improvement', 25 Nov.1995, Seminar on Plantation Crops jointly hosted by SBT and Lions Club, Kalpetta, Wynad.
- 'Water mangement in spices with special reference to nutrition', 21 Dec.1995, Training course on 'Onfarm water management', CWRDM, Calicut.

Sarma, Y R
- Background paper on 'IPM strategies in black pepper - present status and

future strategies', 20 Apr. 1995, Spices Board, Cochin.
- 'Biological control of diseases of spice crops', 11 Sept. 1995, Annual Conference of UPASI, Coonoor.
- 'Latest aspects of biocontrol of *Phytophthora* foot rot of black pepper', 9 Oct.1995, Consolidated Coffee Ltd., Pollibetta, Karnataka.
- 'Biocontrol-an important component of integrated disease management of foot rot of black pepper', 22 Nov.1995, Kodagu Planters Association, Pollibetta, Karnataka.
- 'Integrated disease management of *Phytophthora* root rot of black pepper', 25 Nov.1995, Kalpetta, Wynad.
- 'Tips on foot rot management in black pepper', 4 Mar. 1996, Thirunelly Service Co-op. Society, Thirunelly, Wynad.
- 'Phytophthoras of plantation crops - an overview', 'Biotechnological approaches on disease management of the spice crops' and 'Management of soil borne plant diseases - a holistic approach', 28 Mar. 1996, Faculty of Agriculture, Annamalai University.

Santhosh J Eapen
- 'Management of nematodes of black pepper', 4 Mar. 1996, Thirunelly Service Co-op. Society, Thirunelly, Wynad.

Sasikumar, B
- 'Spices varieties', 'Karshakamela', 6-7 Jan. 1996, Koduvally, Calicut.

Venugopal, M N
- 'Management of pepper with special reference to biocontrol', 1 Dec.1995, Growers' Meet, RARS, Mudigere, Karnataka.

RADIO TALKS

Johny, A K
'Manuring of tree spices' - 7 June 1995, AIR, Calicut

Kavitha, C S
'Planning nutritive diet using seasonally available foods'- Nov.1995, AIR, Calicut

Korikanthimath, V S
'Location specific cardamom cultivation' - June 1995, AIR, Madikeri

Mini P Mathai
'Advanced propagation method in black pepper' -21 June 1995, AIR, Calicut

Peter, K V
'Quality maintenance in spices' - Aug. 1995, AIR, Calicut
'Agricultural research in India: Achievements' - Feb.1996, AIR, Calicut

Rajendra Hegde
'Pest management in cardamom' - 18 Apr. 1995, AIR, Madikeri
'Scope for organic farming in Kodagu district' Sept. 1995, AIR, Madikeri
'One straw revolution: A book review' - Dec. 1995, AIR, Madikeri

Ravindra Mulge
'Nutrition of cardamom' - Aug. 1995, AIR, Madikeri
'Post harvest technology in cardamom' Oct. 1995, AIR, Madikeri

Santhosh J Eapen
'Disease management in black pepper: New approaches' - Aug. 1995, AIR, Calicut

Thankamani, C K
'Care of spices during summer' - Oct. 1995, AIR, Calicut

Venugopal, M N
'Rhizome rot in cardamom' - July 1995, AIR, Madikeri

'Varietal mixture of pepper for better productivity' - Nov.1995, AIR, Madikeri

T.V. PROGRAMME

A group discussion on 'Management of *Phytophthora* Foot Rot of Black Pepper' was telecasted by Trivandrum Doordarshan on 20 July 1995. Dr. Y.R. Sarma, Mr. M. Anandaraj and Mr. Santhosh J. Eapen participated in the programme.

AWARDS AND RECOGNITIONS

- University of Agricultural Sciences, Bangalore awarded Ph.D. to **Mr. K S Krishnamurthy**, Scientist (Plant Physiology) for his research on 'Physiological basis of seed abortion in *Syzygium cuminii* (L.) Skeels and the role of self-organized flow of resources to sinks in differential development of seeds in plants' under the guidance of Dr. R Uma Shanker, Asst. Professor of Crop Physiology, UAS, GKVK,Bangalore.
- **Mr. P Rajeev,** Scientist(Agri.Extension), CRC, Appangala has been awarded Ph.D. degree in Agricultural Extension by IARI, New Delhi.
- University of Calicut granted recognition to **Dr. T John Zachariah** as research guide in Biochemistry / Physiology.

VISITORS

At Calicut

Dr. K L Chadha, Deputy Director General (Hort.), ICAR, New Delhi.

Mr. Harshvardhan Patil, Hon. Minister for Agriculture, Water & Soil Conservation, Maharashtra

Mr. C T Mein, Hon. Minister for Horticulture, Arunachal Pradesh

Mr. D B Maji, Director of Horticulture, Govt.of Arunachal Pradesh

Dr. M V Rao, Vice Chancellor, APAU, Andhra Pradesh

Dr. V N Rajasekharan Pillai, Professor & Director, School of Chemical Science, M.G.University, Kottayam

Dr. S R Sreerangaswamy, Director, Centre for Advanced Studies, Hosur, Tamil Nadu

Dr. M K Nair, Director, CPCRI, Kasaragod.

Dr. R N Pal, Assistant Director General (PC), ICAR, New Delhi

Dr. P Rethinam, Director, NRC for Oil Palm, Eluru, Andhra Pradesh

Dr. D Devaraj, Director, CMFRI, Cochin

Dr. U B Pandey, Director, NHRDF, Nasik, Maharashtra

Mr. K Ahmed Ismail, Vice President, NHRDF, Nasik, Maharashtra

Dr. M R Sethuraj, Director, Rubber Research Institute of India, Kottayam

Dr. A Abdul Kareem, Director, UPASI Tea Research Institute, Valparai, Tamil Nadu

Mr. Ranga Rao, Chairman, Fresh Cooperative Marketing Federation, Hyderabad

Dr. M R Das, Director, Rajiv Gandhi Centre for Biotechnology, Trivandrum

Mr. B S V Murthy, Deputy Collector, Customs & Central Excise

Dr. A Rajan, Dean, College of Veterinary & Animal Sciences, KAU, Trichur

Mr. S S Rana, Director (P), ICAR, New Delhi

At Appangala

Dr. K L Chadha, Deputy Director General (Hort.), ICAR, New Delhi

Justice N S Rao, Cauvery Water Dispute Tribunal
Mr. S C Modgal, Vice Chancellor, G. B. Pant University of Agriculture & Technology, Pantnagar
Justice Nanavathy, Chief Justice, Karnataka High Court
Dr. S Rangarajan, Director(Retd.), Metereological Department, Pune
Dr. S Krishnamoorthy, I.G.P (Training), Bangalore

NEW APPOINTMENTS

IISR Calicut

Mr. N Sreejith, Tech. Asst. (T-II-3), Compute Programmer cum Operator
Mr. V C Sunil, Jr. Clerk (Hindi Typist)
Ms. N Prasannakumari, Hindi Translator
Dr. (Ms) A B Remashree, Research Fellow, ICAR ad-hoc scheme
Dr.(Ms) K K Sherlija, Research Fellow, ICAR ad-hoc scheme
Ms. A Shamina, Research Associate, ICAR ad-hoc scheme
Ms. S M Lakshmi, Sr. Research Fellow, DBT Scheme
Ms. Minoo Diwakaran, Research Associate, ICAR ad-hoc scheme
Ms. Geetha S Pillai, Research Associate, ICAR ad-hoc scheme
Ms. A Sajina, Senior Research Fellow, ICAR ad-hoc scheme,
Mr. M G Prakash, Jr. Research Fellow, DBT scheme

IISR Farm, Peruvannamuzhi

Mr. E V Ravindran, JTA (T I)
Mr. T R Sadasivan, Pump Operator
Mr. P K Balan, Tractor Driver (A)

IISR CRC, Appangala

Mr. T P Jyodhi, Mali (Gr. I), IPDS
Dr. C Dileep, Research Associate, ICAR ad-hoc scheme
Mr. V Prabhakar, Research Associate, ICAR ad-hoc scheme
Mr. K A Saju, Research Associate, ICAR ad-hoc scheme
Mr. N J Mathew, Research Associate, ICAR ad-hoc scheme

K V K, Peruvannamuzhi

Dr. S Ravi, Trg. Asst.- cum - Tech. Asst. (T-II-3), Animal Husbandry
Dr. S Shanmughavelu, Tech. Officer(T6), Animal Husbandry
Mr. A Sakeer Hussain, Tech. Officer (T6), Agri. Extension
Ms. C S Kavitha, Trg. Asst.- cum - Tech. Asst. (T-II-3), Home Science
Mr. P Sundaran, Jr. Clerk (Calicut)
Ms. S Sunitha, Jr. Stenographer (Calicut)
Mr. M S Sivadasan, SS Gr. I (Village Work Attendant)

PROMOTIONS

Mr. Johnson K George, Scientist (Gen. & Cytogenetics) as Scientist Sr. Scale
Mr. Santhosh J Eapen, Scientist (Nematology) as Scientist Sr. Scale
Ms. N K Leela, Scientist (Org. Chemistry) as Scientist Sr. Scale
Ms. K P M. Dhamayanthi, Scientist(Gen.& Cytogenetics) as Scientist Sr. Scale
Dr. A K Johny, Tech. Offcer as Sr. Tech. Information Officer
Mr. M M Augusthy, Tech. Asst. (T4) as Tech. Officer (T5),
Mr. K Kumaran, JTA(T2) as Tech. Asst. (T- I-3)

Mr. N P Padmanabhan, JTA(T2) as Tech. Asst. (T- I -3)

Mr. K Ananda, JTA(T2) as Jr. Tech Asst. (T-I-3)

Mr. V Sivaraman, JTA (T-I-3) as Tech Asst.(T-II-3)

Mr. K T Mohammed, JTA(T- I -3) as Tech. Asst. (T-II-3)

Mr. N A Madhavan, JTA(T-1-3) as Tech. Asst.(T-II-3)

Mr. K S Sreekumaran, Jr. Steno as Sr.Clerk

Mr. M Vijayaraghavan, Driver (T-I-3) as Driver (T-II-3)

Mr. N Chandrahasan, Driver(T-I-3)as Driver (T-II-3)

Mr. K Balan Nair, Driver (T-I-3) as Driver (T-II-3)

Mr. K P Premachandran, SS Gr.I as JTA (TI)

TRANSFERS

- Dr. T G Nageshwar Rao, Sr. Scientist (Plant Pathology) transferred to Directorate of Oilseeds Research, Hyderabad.
- Mr. S J Anke Gowda, Scientist (Plant Physiology) transferred to CRC, Appangala.
- Ms. K P M Dhamayanthi, Scientist (Gen. & Cytogenetics) joined at IISR, Calicut on transfer from Central Potato Research Institute, RS, Patna.
- Mr. P A Mathew, Sr. Scientist (Hort.) joined at IISR, Peruvannamuzhi on transfer from ICAR Research Complex, Goa.
- Mr. K Krishnadas, Mechanic cum Pump Operator (T2) joined at IISR, Calicut on transfer from IISR, Peruvannamuzhi.

DEPUTATION

- Mr. K S Sreekumaran, Sr. Clerk on deputation as Superintendent (A&A) CMFRI, Cochin.

RESIGNATIONS

- Ms. Reeny Mary Zachariah, Tech. Asst., DBT scheme, IISR Calicut
- Ms. M.R, Bindu, Research Asst., DBT scheme, IISR, Calicut
- Mr. V. Prabhakar, Research Associate, ICAR ad-hoc scheme, CRC, Appangala
- Dr. C. Dileep, Research Associate, ICAR ad hoc scheme, CRC, Appangala
- Dr. P. Sundararaju, Research Associate, ICAR ad-hoc scheme, IISR, Calicut
- Ms. S.M. Lakshmi, Sr. Research Fellow, DBT scheme, IISR, Calicut

STAFF LIST

INDIAN INSTITUTE OF SPICES RESEARCH, CALICUT

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Dr. S Edison Ph.D., Project Co-ordinator (Spices)

Scientific

Division of Crop Improvement and Biotechnology

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Dr. J Rema Ph.D., Scientist Sr.Scale (Horticulture)
Mr. K Nirmal Babu M.Phil., Scientist Sr.Scale (Plant Breeding)
Mr. K Johnson George M.Sc., Scientist Sr.Scale (Gen. & Cytogen.)
Ms. K P M Dhamayanthi M.Sc., Scientist Sr. Scale (Gen. & Cytogen.) - *w.e.f. 16 Oct. 1995*
Mr. R Ramakrishnan Nair M.Sc., Scientist(Gen. &Cytogen.) - *On study leave*

Division of Crop Production and Post Harvest Technology

Dr. A K Sadanandan Ph.D., Principal Scientist (Soil Science) and Head
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Dr. K S Krishnamurthy Ph.D., Scientist (Plant Physiology)
Mr. S J Anke Gowda M.Sc. (Ag.), Scientist(Plant Physiology) - *Upto 12 May 1995*

Division of Crop Protection

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Dr. K V Ramana Ph.D., Principal Scientist (Nematology)
Dr, G N Dake Ph.D., Senior Scientist (Plant Pathology)
Mr. M Anandaraj M.Sc., Senior Scientist (Plant Pathology)
Dr. T G Nageshwar Rao Ph. D., Senior Scientist (Plant Pathology) - *Upto 2 Aug. 1995*
Mr. S Devasahayam M.Sc., Senior Scientist (Entomology)
Mr. K M Abdulla Koya M.Sc.(Ag.), Scientist Sr.Scale (Entomology) - *On deputation*
Mr. Santhosh J Eapen M.Sc., Scientist Sr.Scale (Nematology)

Social Science Section

Mr. Jose Abraham M.A., M.Sc., Senior Scientist (Statistics)
Mr. M V Prasad M.Sc. (Ag.), Scientist (Agri. Extension)

Technical

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Mr. P Azgar Sheriff M.LIS, Technical Officer(T5)(Lib.)
Mr. Hamza Srambikkal M.Sc., Technical Officer (Lab)(T5)
Mr. V Balakrishnan, Technical Assistant (T4)
Mr. K Samsudeen M.Sc., Technical Assistant (T4)
Mr. M M Augusthy, Technical Assistant (T5)
Mr. N. Sreejith, Tech. Asst. (T-II-3), Computer Progr. cum Operator- *w.e.f. 1 June 1995*
Mr. V Sivaraman, Jr. Tech. Assistant (T-I-3)

Ms. P K Chandravally, Jr. Tech. Assistant (T2)
Mr. K Krishnadas, Mechanic cum Pump Operator (T2) *w.e.f. 15 January 1996*

Administration and Accounts

Ms. K Usha, Asst. Administrative Officer
Mr. T Gopinathan, Asst.Finance & Accts. Officer
Mr. M K Sachidanandan M.A., Superintendent(A&A)
Mr. A P Sankaran, Assistant
Mr. C Padmanabhan, Assistant
Mr. V Vijayan, Assistant
Ms. V Radha, Assistant
Ms. C Sunanda M. Com., Senior Clerk
Mr. P K Janardhanan, Senior Clerk
Mr. K S Sreekumaran M. A, Senior Clerk - *On deputation from 16 Oct. 1995*
Mr. C Venugopalan, Senior Clerk
Mr. S Hareendrakumar, Junior Clerk
Mr. R N Subramanian, Junior Clerk
Ms. K Padminikutty, Junior Clerk
Mr. V C Sunil, Jr. Clerk (Hindi Typist)- *w.e.f 1 Nov. 1995*
Ms. N Prasannakumari, Hindi Translator - *w.e.f. 23 Dec. 1995*
Mr. S M Chettiar, Senior Stenographer
Ms. P V Sali, Stenographer
Ms. Alice Thomas, Stenographer
Ms. C K Beena, Junior Stenographer

Administrative (Non ministerial)

Mr. M Vijayaraghavan, Driver (T-II-3)
Mr. N Chandrahasan, Driver (T-II3)
Mr. K Balan Nair Driver (T- II-3)

Supporting

Mr. M Padmanabhan SS Gr.IV (Peon)
Mr. K Keeran SS Gr.III (Lab attender)
Mr. N Ayyappan SS Gr.III (Mazdoor)
Mr. N Ravindran SS Gr.II (Mazdoor)
Mr. K P Vijayan Nair SS Gr.II (Mazdoor)
Mr. K Chandran SS Gr.II (Mazdoor)
Mr. K Kunhikanaran SS Gr.I (Peon)
Mr. I Unni Nair SS Gr.I (Lab attender)
Mr. T Ammed Koya SS Gr.I (Watchman)
Mr M Koru SS Gr.I (Watchman)
Mr. V Balakrishnan SS Gr.I(Mazdoor)

Mr. T Balakrishnan SS Gr.I (Mazdoor)
Mr. K Balakrishnan Nair SS Gr.I (Mazdoor)
Mr. P Prabhakaran Nair SS Gr.I (Mazdoor)
Mr. V P Vijayan Nair SS Gr.I (Mazdoor)
Mr. V P Ramachandran SS Gr I (Mazdoor)
Ms. K P Devaki SS Gr. I (Mazdoor)
Ms. C M Kamalam SS Gr.I (Safaiwala)
Mr. T T Soman SS Gr.I (Mazdoor)
Mr. P Soman SS Gr.I (Mazdoor)
Mr. P T Madhavan SS Gr.I (Mazdoor)
Mr. K Bhaskaran, Tea Maker
Mr. M K Purushu, Wash Boy

Ad hoc schemes

Dr. P Sundararaju, Research Associate, ICAR ad-hoc scheme - *Upto 27Jan. 1996*
Mr. Shaji Philip, Research Associate, DBT scheme
Dr. S Selvakumaran, Research Associate, ICAR ad-hoc scheme
Ms. Minoo Diwakaran, Research Associate, DBT scheme
Ms. Geetha S Pillai, Research Associate, DBT scheme
Ms. A.Shamina,Research Associate, ICAR ad-hoc scheme-*w.e.f 19 July 1995*
Ms. Mini P. Mathai, Research Associate, DBT scheme - *Upto 31 Mar. 1996*
Ms. C Manjula, Research Associate, DBTscherne - *Upto 31 Mar.1996*
Mr. John C. Zachariah, Research Associate, DBT scheme - *Upto 31 Mar. 1996*
Dr. (Ms.) A B Remashree, Research Fellow, ICAR ad-hoc scheme- *w.e. f. 7 July 1995*
Dr. (Ms.) K K Sherlija, Research Fellow, ICAR ad-hoc scheme- *w.e.f. 7July 1995*
Ms. S M. Lakshmi, Sr. Research Fellow, DBT Scheme - *From 27 April 1995 to 31 Jan. 1996*
Ms. T P Sreeja, Sr. Research Fellow, ICAR ad-hoc scheme
Ms.A Sajina, Sr. Research Fellow, DBT scheme
Ms. Mini Kallil, Senior Research Fellow, ICAR ad-hoc scheme
Mr. M G Prakash, Jr. Research Fellow, DBT scheme - *w.e.f 7 Aug. 1995*
Ms. Reeny Mary Zachariah, Tech. Asst.., DBT scheme - *Upto 17 July 1995*
Ms. M R Bindu, Research Asst., DBT scheme- *Upto 4 Dec. 1995*
Mr. P Prakash, Driver, DBT scheme
Mr. K K Santhosh, Lab. Attender, DBT scheme

IISR EXPERIMENTAL FARM, PERUVANNAMUZHI

Scientific

Mr. P A Mathew M.Sc. (Ag.), Senior Scientist (Horticulture) and Scientist in charge *w.e.f 30 Sept.1995*

Technical

Mr. V K Abubacker Koya, Farm Superintendent(T6)
Mr. K A Somanna, Farm Assistant(T4)
Mr. K T Muhammed, Jr. Technical Assistant(T-II-3)
Mr. V P Sankaran, Jr. Technical Assistant (T-I-3)
Mr. N A Madhavan, Technical Asistant (T-I-3)
Mr. N P Padmanabhan, Jr. Technical Assisstant (T-I-3)
Mr. K Kumaran, Jr. Technical Assistant (T2)
Mr. K Chandran, Jr. Technical Assistant (T I)
Mr. K Krishnadas, Mechanic cum Pump Operator(T2) – *Upto 14 Jan.1996*
Mr. P Bhaskaran, Jr. Technical Assistant (T I)
Mr. D K Eswara, Jr. Technical Assistant (T I)
Mr. A K Balan, Jr. Technical Assistant (T I)
Mr. K P Premachandran, Jr. Technical Assistant (T I)
Mr. K K Sasidharan, Jr. Technical Assistant (T2)
Mr. E V Ravindran, Jr. Technical Assistant (TI)- *w.e.f 7July1995*

Administrative (Non ministerial)

Mr. T R Sadasivan, Pump Operator - *w.e.f 22 May 1995*
Mr. P K Balan, Tractor Driver- *w.e.f. 16 Jan 1996*

Supporting

Mr. E Kunhayyappan, SS.Gr.IV (Watchman)
Mr. E K Nanu, SS.Gr.III (Watchman)
Mr. B T Velayudhan, SS.Gr.II (Watchman)
Mr. C Bhaskaran, SS.Gr.II (Mazdoor)
Mr. P K Balan, SS.Gr.II (Mazdoor)-*upto 15 Jan. 1996*
Mr. P Damodaran SS.Gr.II (Mazdoor)
Mr. K Raghavan, SS.Gr.II (Mazdoor)
Ms. N K Girija, SS.Gr.II (Mazdoor)
Mr. P Sadanandan, SS Gr.I (Watchman)
Mr. M Balakrishnan, SS.Gr.I (Mazdoor)
Mr. M Choyikutty, SS.Gr.I (Mazdoor)
Mr. K Gangadharan Nair, SS Gr.I (Mazdoor)
Mr. N K Raghavan, SS.Gr.I (Mazdoor)
Mr. V K Sankaran, SS.Gr.I (Mazdoor)
Mr. P Sreedharan, SS.Gr.I (Mazdoor)
Ms. V P Sarada, SS.Gr.I (Mazdoor)
Mr. K K Ravindran, Tea Maker
Ms. P N Kausalaya, Wash woman

IPDS Scheme

Mr. K Rajan, Field Assistant

IISR CARDAMOM RESEARCH CENTRE, APPANGALA

Scientific

Mr. V S Korikanthimath M.Sc.(Ag.), Senior Scientist (Agronomy) and Scientist in charge
Dr. M N Venugopal Ph.D., Senior Scientist (Plant Pathology)
Dr. Rajendra Hegde Ph.D., Scientist (Agronomy)
Dr. P Rajeev Ph.D., Scientist(Agrl. Extn.)
Dr. Ravindra Mulge Ph.D., Scientist(Hort.)
Mr. S J Anke Gowda M.Sc. (Ag.), Scientist (Plant physiology)- *w.e.f. 15 May 1995*

Administration

Ms. Enid Savitha, Superintendent
Mr. K Vasudevan, Assistant

Technical

Mr. M K Appaiah, Sr. Farm Assistant (T4)
Mr. K Ananda Jr. Technical Assistant (T-I-3)
Mr. G Arumugham, Jr. Technical Assistant (T I)
Mr. L Balakrishna, Jr. Technical Assistant (T2)
Mr. K B Prasanna Kumar, Jr. Technical Assistant (T I)

Administrative (Non ministerial)

Mr. H G Nanamaiah, Driver (T-I-3)

Supporting

Mr. B J Lakkaiah, SS Gr. IV (Mali)
Mr. H Y Erappa, SS Gr.IV (Watchman)
Mr. K M Madashetty, SS.Gr.III (Mazdoor)
Ms. B L Seethu, SS.Gr.III (Mazdoor)
Ms. H B Gangu, SS.Gr.III (Mazdoor)
Ms. B Lakshmi, SS.Gr.III (Mazdoor)
Mr. P K Belliappa, SS.Gr.II (Watchman)
Ms. B R Janaki, SS.Gr.II (Mazdoor)
Ms. B G Marinanjamma, SS.Gr.II (Mazdoor)
Mr. Gowdegere Shetty, SS.Gr.II (Mazdoor)
Mr. B M Sheshappa, SS.Gr.II (Mazdoor)
Ms. P K Manikka, SS.Gr.II (Mazdoor)
Ms. K M Chikkasakamma, SS.Gr.II (Mazdoor)
Mr. B M Chenniappa, SS.Gr.I (Mazdoor)
Mr. B K Poovappa, SS.Gr.I (Mazdoor)
Mr. S Mahadeva, SS.Gr.I (Mazdoor)
Mr. K M Puttasiddamma, SS.Gr.I (Mazdoor)
Ms. B M Lalitha, SS.Gr.I (Mazdoor)
Ms. B K Chennamma, SS.Gr.I (Mazdoor)

Ms. H B Nagamma, SS.Gr.I (Mazdoor)
Mr. N Cholurappa, SS.Gr.I (Lab. Attender)
Mr. K K Thimmaiah, SS.Gr.I (Watchman)
Mr. Mari Gowda, Tea Maker

Ad hoc schemes

Dr. C Dileep, Research Associate, ICAR ad-hoc scheme - *From 24 to 26 July 1995*
Mr. U Prabhahar, Research Associate, ICAR ad-hoc scheme-*From 3 Aug. to 11 Dec. 1995*
Mr. K A Saju, Research Associate, ICAR ad-hoc scheme- *w.e.f. 6 Nov. 1995*
Mr. N J Mathew, Research Associate, ICAR ad-hoc scheme- *w.e.f. 22 Jan. 1996*
Mr. T P Jyodhi ,Mali (Gr.I), IPDS scheme *w.e.f. 1 Jan. 1996*

KRISHI VIGYAN KENDRA, PERUVANNAMUZHI

Dr. M Aravindan M.V.Sc., Principal Scientist and Chief Training Organizer

Technical

Mr. P S Manoj M.Sc. (Ag.), Technical Officer (T6), Horticulture
Mr. K D Prathapan M.Sc.(Ag.), Technical Officer (T6), Plant Protection
Mr. K M Prakash, Training Asst. cum Tech Assistant (T4), Agronomy - *on study leave*
Dr. S Ravi B.V. Sc., Trg. Asst.- cum Tech. Asst. (T-II-3), Animal Hushndry - *w.e.f 17July 1995*
Dr. S Shanmughavel B.V.Sc., Tech. officer (T6), Animal Husbandry - *w.e.f. 3 Aug. 1995*
Mr. A Sakeer Hussain M.Sc. (Ag.), Tech. officer (T6), Agri. Extension - *w.e.f. Sept .1995*
Ms. C S Kavitha M.Sc., Trg. Asst.-cum-Tech. Asst.(T-II-3), Home Science-*w.e.f. 26 July 1995*

Administration

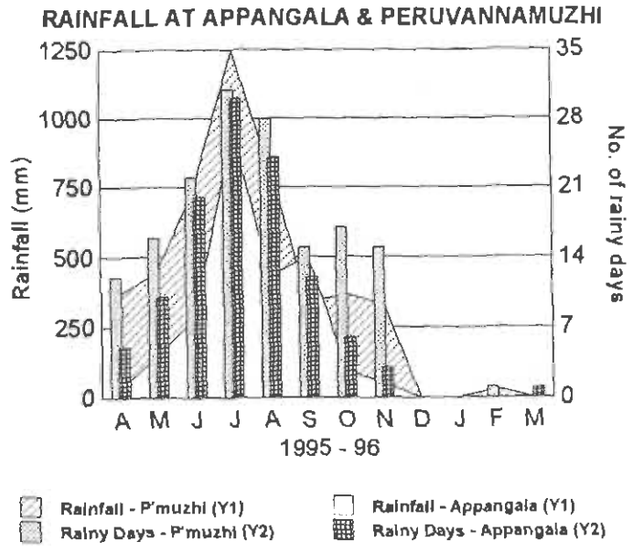
Mr. V L Jacob, Superintendent (A & A)
Mr. P Sundaran, Junior Clerk - *w.e.f. 19 May 1995*
Ms. S Sunitha, Jr. Stenographer - *w.e.f. 28 Aug. 1995*

Administrative (Non ministerial)

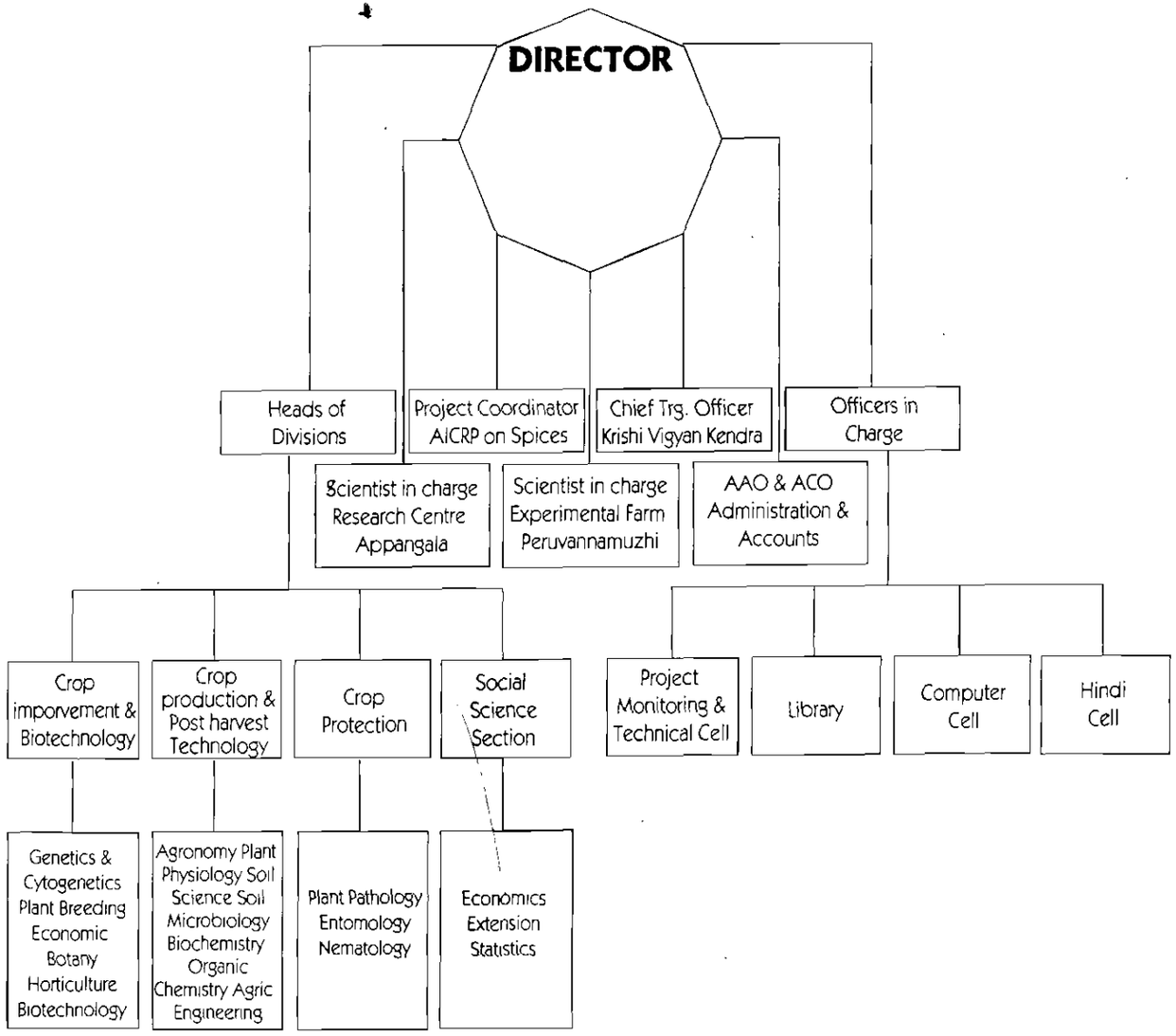
Mr. T C Prasad, Driver cum mechanic
Mr. Ramanna Gowda, Driver

Supporting

Mr. K P Gangadharan, SS. Gr.I (Peon)
Mr. C V Ravindran, SS.Gr.I (Mazdoor)
Mr. C Ravindran, SS.Gr.I (Farm Attendant)
Mr. P D Jose, SS.Gr.I (Animal Attendant)
Mr. B Satheesan, SS.Gr.I (Hort. Attendant)
Mr. M S Sivadasan, SS Gr. I (Village Work Attendant) - *w.e.f. 4 May 1995*



Month	Rainfall (mm)		No. of rainy days	
	Peruvanna-muzhi	Appangala	Peruvanna-mushi	Appangala
Apr 95	368	34.8	12	5
May	448	149.6	16	10
Jun	760	289.6	22	20
Jul	1247	951.0	31	30
Aug	814	431.0	28	24
Sep	337	502.4	15	12
Oct	368	96.0	17	6
Nov	332	52.2	15	3
Dec	-	-	-	-
Jan 96	-	-	-	-
Feb	30	-	1	-
Mar	-	3.0	-	1
Total	**4704**	**2509**	**157**	**111**


DIRECTOR
Heads of Divisions
Project Coordinator AICRP on Spices
Chief Trg. Officer Krishi Vigyan Kendra
Officers in Charge
Scientist in charge Research Centre Appangala
Scientist in charge Experimental Farm Peruvannamuzhi
AAO & ACO Administration & Accounts
Crop imporvement & Biotechnology
Crop production & Post harvest Technology
Crop Protection
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Library
Computer Cell
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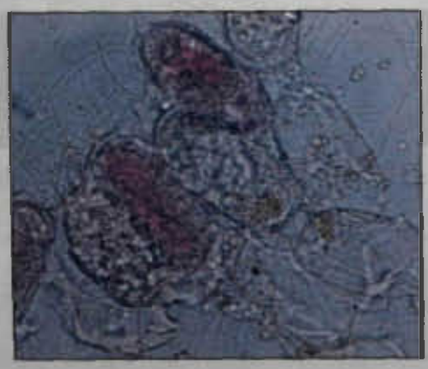
Genetics & Cytogenetics Plant Breeding Economic Botany Horticulture Biotechnology
Agronomy Plant Physiology Soil Science Soil Microbiology Biochemistry Organic Chemistry Agric Engineering
Plant Pathology Entomology Nematology
Economics Extension Statistics



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