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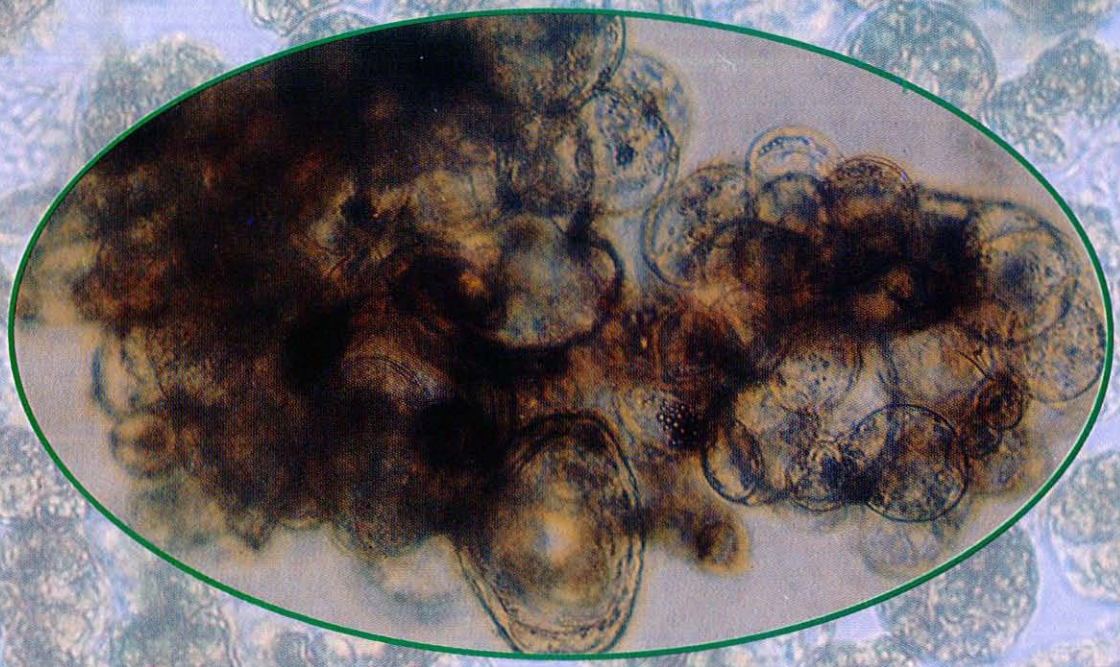

भाकृ अनुप
ICAR

INDIAN INSTITUTE OF SPICES RESEARCH

(Indian Council of Agricultural Research)

CALICUT - 673 012 - KERALA - INDIA

MANDATES OF INDIAN INSTITUTE OF SPICES RESEARCH

I. To serve as a center of excellence for conducting and coordinating research on basic and applied aspects of spices

II. To serve as National Center for storage, retrieval and dissemination of information on spices

III. To serve as a centre for transfer of technology and imparting training on spices

18/12/95

Annual report 1994 - 95

INDIAN INSTITUTE OF SPICES RESEARCH
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Photographs

Front cover : Protoplasts isolated from black pepper leaves
Inset: Microcallus developed from protoplasts of black pepper

Back cover : A clove variant located at Ashamboo hills, Tamil Nadu

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DIRECTOR'S REPORT

The year 1994-95 witnessed all-around growth and development of spices research. Upgrading CPCRI Regional Station to National Research Center for Spices during 1986 and subsequently to Indian Institute of Spices Research with effect from July 1995 is a result of untiring efforts of scientists and staff of the Institute striving for excellence in their endeavors. This institute hosted a group meeting of *Phytophthora* workers in horticultural crops and hosted the first International Symposium on Plantation Crops (PLACROSYM-XI) from November 30 - December 3, 1994. Dr R S Paroda, Director-General and Dr K L Chadha, Deputy Director-General (Hort.), ICAR, visited NRCS on November 29, 1994.

For the first time, Staff Research Council (SRC) was constituted by including three external experts, Dr P C Sivaraman Nair, Director of Research, KAU (Rtd.); Dr C K George, Executive Director, Spices Board, Cochin and Dr. V K Gupta, Professor and Head, Department of Plant Pathology, HPKVV, Palampur. The progress of work in 33 research projects and three supportive research programmes were presented, discussed and finalized technical programmes for 1995-96. Six new research projects were approved. Seven research projects funded through A P Cess Fund and DBT were also reviewed. The Mini Mission I on Spices Crop Protection operated 16 research projects, out of which 3 projects were completed and closed during the year. The viral etiology of stunted disease of black pepper was proved. Natural '*Katte* Escapes' and 'Rhizome Rot Tolerant Lines' in cardamom were identified as sources of possible resistance / tolerance. Use of VAM in nursery of black pepper cuttings against *Phytophthora* foot rot was found effective. Solarization coupled with use of *Trichoderma* has made ginger cultivation possible in rhizome rot prevalent soils. Mini Mission II on spices production operated eight projects including three projects initiated during the year. Cardamom based cropping system is being evaluated for economic returns per unit volume of space and time. Experiments on organic spices are in progress. Organic amendments are assessed for better performance in bush pepper. Water requirements of black pepper and cardamom are worked out. In Mini Mission III on spices improvement, germplasm enrichment continued with vigour in black pepper, ginger, turmeric, cloves and nutmeg. A dwarf clove was identified during the year. Elite lines of cinnamon, clove and nutmeg are further evaluated. Two seedling progenies of turmeric (Acc.360 and Acc.361) having a mean curcumin content of 7.2 and 7.0% and dry recoveries of 19 and 18% respectively and a high yielding ginger cultivar (ARC.64) with low fibre content were recommended for release. Somaclones in ginger resistant to rhizome rot are further evaluated. Protocols have been developed and standardized for micropropagation of *Piper betle*, *Piper chaba*, *Piper colubrinum* and *Ammomum subulatum*. Research on *in vitro* conservation of spices germplasm is in progress. Over 265 accessions of spices, including black pepper, cardamom, ginger, turmeric, vanilla, minor spices and their related species have been conserved in *in vitro* repository. Protoplast isolation in black pepper was successful. Out of 16 ad-hoc research projects submitted for funding, eight projects were approved. The Study Circle of the Research Center met 17 times, 18 research papers were discussed and 17 approved for publication. The Post-graduate Committee met six times, five scientists were

deputed for advanced training during the period. The recently constituted Institute Management Committee (IMC) met on March 16, 1995 and took important decisions. The Institute Joint Council met on April 26, 1994 and November 25, 1994.

The Integrated Programme for Development of Spices (IPDS) made significant strides. Two lakh cuttings of black pepper, 30 tonnes of turmeric seed rhizomes, 23,800 seedlings / grafts of tree spices and 1800 kg of cardamom seed capsules were distributed among State Agricultural Departments of Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Andaman & Nicobar Islands, Maharashtra and Orissa. Four short term trainings were organized on various facets of spices production technology.

During the year, the Library subscribed to 58 foreign journals and 90 Indian journals. An amount of Rs.5.5 lakhs was spent on strengthening Library. Equipments worth Rs.88 lakhs were purchased during the year. Works costing Rs.244 lakhs are in various stages of construction. The budget of the Center was Rs.100 lakhs under Non-Plan and Rs. 160 lakhs under Plan during the year.

The Research Center was honoured by many awards during the year. The Young Scientist Award constituted by Kerala State Committee on Science, Technology and Environment was awarded to the research team in the Biotechnology Facility of the Center. The Research Center continued as a center for Post-graduate Research of Calicut University and Kerala Agricultural University.

The All India Co-ordinated Research Project on Spices also enlarged its network to cover more states. Number of centers was raised from 16 to 20 during the year. Research on seed spices received due attention during the year.

On behalf of the scientists and staff of the institute I place on record my gratitude to Dr P C Sivaraman Nair, Chairman, QRT, Mr A R Antulay, Hon. Member of Parliament and Convener, Spices in the Parliament Committee on Commerce, Dr. R S Paroda, Director-General, Dr. K L Chadha, Deputy Director-General (Hort.), ICAR who together facilitated the dream of Spices Farmers into a reality - the elevation of NRCS into a full-fledged Institute 'Indian Institute of Spices Research' with effect from 01.07.1995.

(K V PETER)
DIRECTOR

अनुसंधान की मुख्यबातें - १९९४ - ९५

आनुवंशिक स्त्रोतें

काली मिर्च

केरल, के कर्नाटक और सुगन्धगिरी जंगली क्षेत्रों के गोरुसाप्पा, अकुम्बे, कुन्द्रीमुख और तलकावेरी से जंगली काली मिर्च के ७६ संग्रह बनाया गया है।

अदरक और हल्दी

हल्दी के ८ नए अधिमिलन (एक रायपुर से, मध्य प्रदेश से, दो हिमाचल प्रदेश से और पाँच दक्षिण कर्नाटक से) और अदरक के १२ अधिमिलन (आठ कर्नाटक से ३ केरल से, जो ब्रसील से एक विदेशी) संग्रह सहित जनित्र द्रव्य में शामिल किया गया है।

वृक्षाकार मसाले

काली मिर्च

अशाम्बू पहाड, कन्याकुमारी और वयनाड जिलों के सर्वेक्षण के बाद आठ सैजाइजियम.अरोमाटिकम जातियाँ, नौ मिरिस्टिका फ्राग्रन्स जातियाँ, एक एम. बेड्डोमी जातियाँ, चार सिन्नोमम वीरम जातियाँ, १२ सी. मलबरिकम जातियाँ और दो पिमेन्टा डायोका जातियाँ का संग्रहण किया गया।

फसल सुधार

वालपराई में काली मिर्च के छः संकर (३४,१०५, ७२८, ७६९, ७७८ और ८१३) अच्छी तरह बढ रहा है।

'वडक्कन' जैसे मोटे बीजवाले कलिटवार के खुले परागणित संन्ततियों ने पौध-सामग्रि में अनन्य आकारकीय विभिन्नता दिखाया है।

अदरक और हल्दी

अदरक के एक नया कलिटार निर्मुक्ति केलिए प्रस्तुत है। यह उन्नत उपजवाले और कम रेशेवाले होता है। २०० दिनों के अंतर्गत यह परिपक्व होता है।

खुले परागणित संतति द्वारा विकसित दो हल्दी किस्में निर्मुक्ति केलिए चुन लिया है।

वृक्षाकार मसाले

अक्तूबर के दौरान सर्वसुगन्धी वृक्षों को एक ग्राम पाक्लोबुट्रासोल (कलटार) छिडकाने से अच्छी तरह फूल लगते है, लेकिन फल न्यूनतम लगता है। सर्वसुगन्धी को एन.ए.ए और ऐ.बी.ए. के मिश्रण से उपचार करने से इनके अस्थानिक मूल रूपीकरण में मदद मिलती है।

जैवतकनीकी

टिसू कलचर के द्वारा मिट्टि में वानिला के २० कतारों को विकसित किया गया है। दालचीनी और कासिया में बहुत प्ररोह का उत्पन्न होता है। लौंग कलचर में जड रूपीकरण होता है। जायफल के भ्रूण कलचर की स्थापना की गई है। अदरक सोमाटिक भ्रूण के एनकापुलेशन के बिना रख सकता है।

काली मिर्च, इलायची, अदरकं, हल्दी, वानिला, सूक्ष्म मसाले और इनके संबद्ध जातियों सहित मसाले के २६५ अधिमिलन अल्पकालीन और मध्यकालीन संरक्षण के लिए सुरक्षित रखा है। अदरक में सूक्ष्म कंद रूपीकरण और हल्दी के कंदिल मूल रूपीकरण सफल ढंग से किया गया है।

१०० दिनों में कालस से पौधों का उत्पादन करने केलिए प्रोटोकॉल का मानकीकरण किया गया है। पी. काप्सिसी के कलचर फिल्ट्रेट से अलग किए क्रूड टोक्सिन फ्राक्षन काली मिर्च के पत्तियों के अति गलन को पहचानने में सहायक है।

पौष्टिक आवश्यकता और फसल प्रबन्ध

काली मिर्च

काली मिर्च में विषयात्मक निदान और सिफारिश के संयोजित प्रणाली को विकसित किया गया। जिसके द्वारा पौष्टिक संतुलन और उपज के निधरिण के लिए विकसित किया। फार्मयाड उर्वरको की अपेक्षा कुकुड उर्वरक बढिया सिद्ध हुआ है।

अदरक और हल्दी

कर्बनिक केक के अवाक्षिज प्रभाव से मिट्टी की सान्द्रता कम होता है जिससे पौष्टिक अगिरण और उपज में वृद्धि होती है।

गुणता के लिए मसाले का मूल्यांकन

हल्दी:- करक्यूमिन के लिए मूल्यांकित किए हल्दी में करीब १४ अधिमिलन में ७ प्रतिशत से अधिक करक्यूमिन प्रदान किया है। २९० और ३५१ अधिमिलन में ८% करक्यूमिन निहित है। मुवाट्टुपुषा और कालिकट में स्थित ३६० और ३६१ अधिमिलन में ७% करक्यूमिन निहित है। दोनों अधिमिलन में करीब १% आलियोरेसिन निहित है।

अदरक

मुवाट्टुपुषा और कालिकट में उत्पादित ६४, २५०, २५६ और १०६ अधिमिलन में रेशे बहुत कम (करीब ३%) निहित है। ७१ अधिमिलन में ११% ओलियोरेसिन और २.९% तेल निहित है।

इलायथी

तेल और गुणता के लिए मूल्यांकित किस्में में ASH-A-MR, ASH-A-V-2 और ASH-B-B-1 में करीब ९%

तेल निहित है। ASH-A, E-7, ASH-C-MR. 39 में तेल और अधिक टेरपिनोल असटेट और कम सिनियोल निहित है।

लौंग:

तेल और यूजिनोल के लिए मूल्यांकित वृक्ष सं. १३५ में २०% और वृक्ष सं. ६९ में ८८%। यूजिनोल सं. ४५ और १८० में १९% तेल निहित है।

फसल संरक्षण

काली मिर्च

जैवनियंत्रण: वयनाड में आयोजित जैवनियंत्रण के 'फील्ड ट्रायल' से देखा गया है कि 'ग्लाइकोक्लेडियम वैरनस' की अपेक्षा ट्रैकोडेरमा और ग्लाइक्लेडियम पाद-गलन से विमुक्त है। नारियल के पानी ट्रैकोडेरमा और ग्लाइक्लोडियम की बढती और बीजाणुरेचन को सहायता देती है। पी. काप्सिसी की बढती और बीजाणुरेचन को कम करने के लिए लहसुन और सरसों के निचोड अधिक प्रभावपूर्ण है। बतेन-कच्चर के किए परीक्षण में यह देखा गया है कि यह निचोड को टी. हर्सियानम के मिश्रण करते हूए प्रयोग करने से पाद गलन को कम करने में प्रभावपूर्ण सिद्ध हुआ है।

मूल-गांठ निमाटोड की दक्षता के लिए ट्राइकोडेरमा और गलाईक्लेडियम के जातियों की जाँच की। उपरोक्त कलचर फिलट्रेट के उपचार से २४ घंटों में मूल-गांठ निमाटोड के द्वितीय हालत के किशोरों के मृत्युदर १००% दिखाई पडा है। टी. हार्सियानम, हीं विरिडे और जी.वैरनस जडगलन निमाटोड के विकास को दबाने में सक्षम सिद्ध हूए है। मूल-गाठ निमाटोड के विरुद्ध स्यूडोमोनास फ्लूरसेन्य के चार पृथक्करण का प्रयोग किया जिनमें से प्रथक्करण सं. ४४ निमाटोड के नियंत्रण करने में सबसे अच्छा सिद्ध हुआ है।

केरल के इडुक्की, वयनाड और कर्नाटक के कूर्ग जिलों में आयोजित सर्वेक्षण से विदित हो गया है कि कालि मिर्च को आक्रमण करने वाले स्केल कीडा लेपिडोसाफस पैपेरिस और अस्पिडियोलस डिस्ट्रक्टर आदि के प्राकृतिक शत्रुओं में कैलोकोरस सरकमड्टेस, फारोसिमनस होर्नी, स्यूडोसिमनस जातियाँ, साइबोसाफसज जातियाँ आदि सबसे प्रमुख है।

प्राकृतिक उत्पन्न

पैपर कोलुब्रिनम के पेट्रोलियम इतर अर्क पी. काप्सिकी के निरोधीकारक है। अर्क के फिर से प्रभाजन से २४२, २५५, २६१ और २७८ की अधिकतम मात्रा में यु.वी. अवशेषण से मिला। समानतः क्रोमोलीना ओडोरेटा के अर्क, पी. काप्सिसी के निरोधीकारक है।

पोल्लु बीटल लोंजिटारसस नैर्गिपेनिस के विरुद्ध प्राकृतिक उत्पन्न के प्रयोगशाला में जैव निधीरण से विदिन हो गया है कि कर्स्टाड अपिल वीज अर्क में महत्वपूर्ण पोषक विरुद्ध प्रक्रिया है। जिसमें उपचार के २४ घंटे बाद ०.०२५%

और ०.२% साद्रता के क्रम में ५०-९०% खाध निवारण है।

पोल्लु के विरुद्ध वणिज्यिक नीम उत्पन्न के मूल्यांकन से विदित हो गया है कि जुलाई में 'नीम गोल्ड (०.३%) के बाद एन्डोसल्फान (०.०५०%) को छिडकाने से कीडा के अक्रमण के लिए अधिक प्रभावपूर्ण सिद्ध हूआ है।

प्रतिरोध / सहिष्णुता

फाइटफथोरा के सहिष्णु पौधों के भा.म अ. केन्द्र में छवीं वर्ष में किए फार्म ट्रायल से देखा गया है कि वलियाकानियकेडन के ओ.पी.प्रो ६०३ अधिक स्वस्थ रहा और इसके उत्पन्न की तीव्रता २५०- १३२० ग्राम प्रति बल है। वैसे ही HP-७८० के उत्पन्न की तीव्रता ५०-४३०० प्रति बेल है। सिरसी क्षेत्र के p-२४ का अच्छी तरह उत्पन्न हो रहा है।

अग्रोकेमिकल

कवकनाशियों के विभिन्न आवृत्तियों में किए गए उपचार से देखा गया है कि पोटासियम फोसफोनेट के प्रयोग से रोग का निगुना नियंत्रण हो गया। अकोमिनं १२०० पी पी एम की साद्रश्य में ट्राइकोडेरमा के निरोधिकारक नहीं, और इसकी पेटेन्शल देकर संयोजित रोग प्रबन्धन में सहायता दे रहा है।

पी. काप्सिसी और निमाटोड के निश्रण

फाइटोफथोरा काप्सिसी, राडोफोलस सिमिलिस और मेलोडोशाईन इनकोगिनटा आदि पर पी. काप्सिसी और निमटोड के मिश्रण के प्रयोग से इनके प्रथम प्रयोग अधिक मृत्युदर बढता हुआ मिलता है। कांलीमिर्च से अलग किए वेसिकुलर आरबसकुलर मयरिए टिशूओं की बढती में बडा उपयोगी सिद्ध हूआ है।

टी. पैपरिस का सर्वेक्षण

केरल के काली मिर्च उत्पन्न होनेवाले जिलों में आयोजित सर्वेक्षण से ४५.८ प्रतिशत बाधा की सूचना मिली। ग्लांइरिसिडिया सेपियम और अरटोकारपस हेटरोफिल्लम इस निमाटोड के नए पोषद के रूप में अभिलेख किया है।

चकमा रोग का हेतुविज्ञान

काली मिर्च को आक्रमण करनेवाले कुकुम्बर मोसाईक के चकमा रोग के हेतुविज्ञान व्यक्त है। अगर जेल द्विगुण विसरण परीक्षणों से विदित है कि सी एम वी केला और सी एम वी काली मिर्च प्रतिजनकता से समान है।

अदरक और हल्दी

पत्तनमतिट्टा, अलपी, कोल्लम और तिरुवनन्तपुरम में आयोजित सर्वेक्षण से अदरक में पितियम अफानिडेरमेटम कंद गलन रोग कारण बन जाता है।

प्रथम अभिलेख

स्यूडोमोनास सोलानासिरम से होनेवाला कीमफेरिया गालंगा के जीवाणु मुरझान और स्यूडोमोनास जातियों से

होनेवाला क्लोव का पहली बार अभिलोख किया गया है। वैसी ही फाइटोफथोरा काप्सिसी से होनेवाला पैपर चाबा के प्राकृतिक बाधा और पैपर लोंगम के कुकुम्बर मोसाइक बाधा का पहलीबार अभिलेख किया गया है।

केन्द्रक पौध सामग्री का उत्पादन

विभिन्न विकास अभिकरणों और बढावा देने वाले किसानों को पुनरुत्पादन एवं कृषण केलिए कालीकर्च के दो लांख जडसहित पौधों यानी श्रीकरा, शुभकरा, पंचमी और पौर्णमी और हल्दी के उन्नत उपजवाले ३० टन सुवर्णा सुगुणा, सुदर्शना और अलपी, इलायंची के २६०० पौध, वृक्ष मसाले के २३,८०० पौध उपरोध का वितरण किया गया।

प्रौधोगिकी का अंतरण

कोको, सुपारी और मसाला विकास निदेशालय और कृषि विभाग मे वयनाड और इडुक्की में आलोचित कालीमिर्च के पादगलन रोग प्रबन्ध के बडे पैमाने के प्रदर्शन का आयोजन किया।

मसाले के अखिल भारतीय समाजित अनुसंधान योजनाः-

मसाले के अ.भा.स.अ. योजना का ४ नये अतिरिक्त केन्द्रों के मंजूरी के साथ- विस्तार किया गया है, जिसमें कुल २० केन्द्र है, महाराष्ट्र में एक, मध्यप्रदेश में एक, उत्तर प्रदेश में एक और पश्चिम बंगाल में एक ये १५ राज्यों के १५ कृषि विश्वविध्यालयों में और एक भा कृ अ प संस्थान में स्थित है। २० अ.भा.स.अ.यो. के २० केन्द्रों के अतिरिक्त इस योजना के अधीन ६ स्वैच्छिक / भाग लेनेवाले केन्द्र भी शामील है।

आनुवंशिक स्रोतें

सभी केन्द्रों में मसाले के मसाले के अधिमिलन के जनित्र द्रव्य का मूल्यांकन बढता रहा है। येरकाड, केन्द्र ने ३ षेवरोय और कोल्ली पहाडों से कालीमिर्च के तीन जंगली तरीकों का संग्रह किया।

बीज मसलों में जोबनर, जगुदान, कोयम्बत्तूर, गुन्टूर और हिसार केन्द्रों में ६० नए मदों का संग्रह किया है। गुन्टुर केन्द्र मे एन बी पी जी आर के संयोग से बनाए संग्रहों में धानिया जनित्र द्रव्य को १२०-२३० के दर में वृद्धी की। कोयम्बत्तूर केन्द्र में २४३ नए संग्रह बनाया और कुल मिलाकर ३७२ संग्रह है। हिसार और जंगूदान केन्द्रों में धनिया के ३० तथा ३७ नए संग्रहों को बनाया। अनुवंशिक मोड के आधार पर धनिया के ५७८ अधिमिलन में १४३, जीरा के २८ अधिमिलन में १०६, सौफ के २८३ अधिमिलन में ९८, मेंथी के १८५ अधिमिलन में ४० की सूची बनाया है और बाकी को जगुदान केन्द्र में छोड दिया गया।

रोग प्रतिरोध

जगुदान केन्द्र में जीरा के ई सी २४३३७३, ई सी - २४३३७५ और ई सी - २३२६८४ आदि फ्यूसेरियम विल्ट रोग के प्रतिरोधी सिद्ध हुआ है। जगूदान केन्द्र में प्राकृतिक स्थितियों में मेंथी के ई सी २५७५६६ (बलगोरिया) चूर्णा फंफूदी के प्रतिरोधी सिद्ध हूआ है। धनिया के जनित्र द्रव्य की समीक्षा में यूडी - २० ः यूडी-२१ आदि मूल-गाँठ निमाटोड के प्रतिरोधी सिद्ध हुआ है।

नए किस्में

काली मिर्च के किस्मे में पन्नियूर-५, इलायची ऐ.सी, ओर ऐ-३, मेंथी एच-एम. ५७ और धनिया डी एच-५ का सिफारिश किया गया है। इसमें से मेंथी (हिसार सोनाली) और धनिया (हिसार आनंद) को भारत सरकार के बागवानी फसलों के फसल मानक अधिसूचना एवं निर्मोचन के केन्द्रीय उपसमिति द्वारा अनुमोदित है।

फसल उत्पादन

पन्नियूर केन्द्र के अध्यायन से सिद्ध हुआ है कि दिसंबर से मार्च चक १ ज़/ड़ सी पी ई के ०.२५ सिंचन फरने से उत्पाद में वृद्धी हुई। अदरक के नत्रजन १२५, फोसफरस १००, पोटासियम १०० कि ग्राम प्रति हेक्टर के प्रयोग से पोट्टागी में इसके उत्पादन में १४.३५ टन प्रति हेक्टर का उत्पादन मिला। २५ कि.ग्र. हेक्टर के बीज के दर में ४० कि.ग्रा. नत्रजन और ४० कि.ग्र P_2O_5 प्रति हेक्टर के प्रयोग से राजस्थान में मेंथी का अधिकतम उत्पादन ११.१२ क्विंटल/हेक्टर होता है। जोबनर केन्द्र में ३ वर्षीय फसल परिभ्रमण यानी क्लस्टर सेम-जीरा-क्लस्टर सेम - गेहूँ क्लस्टर सेम - सरसों का फसल क्रम राजस्थान में कृषण के लिए चुन लिया जा सकता है जिससे विल्ट बीमारी से बच सकता है।

गुणता मुल्यांकन

इलायची के क्लोन यानी सी एल -६८३, सी एल- ६७९ और सीएल-७२६ आदि निर्मोचित किस्म तेल, आल्फा टेरपीनोल असटेट और १,८ सिनियोल की निहिती में मुडिगियर -२से श्रेष्ठ माना गया है। अदरक में एस जी ६७३ अधिकतम सुगधित तेल (२.१%) और एस जी -६७५ में अधिकतम ओलियोरेसिन (८.९%) हल्दी पीसीटी - १४ में ५.६७% करक्यूमिन और ११.५०% ओलियोरेसीन निहित है।

फसल संरक्षण

काली मिची

पन्नियुर केन्द्र में फाईटोफथोरा पादगलन रोग के प्रबन्ध केलिए कार्षिक तकनीकी का मानकीकरण कीया गया है। पोट कलचर के जैवनियंत्रण के अध्यायन से विदित हो गया है कि ट्राइकोडेरमा के प्रयोग से काली मिर्च में पाद गलन टोग को कम कर सकता है। अदरक में बीजारोपण के पहले कंद को इन्डोफिल एम -४५ (०.२५%) अ बाविस्टिन (०.१%) के साथ फोरेट के प्रयोग करने से कंदगलन को नियंमण में रखा जा सकता है। कोयन्बत्तूर केन्द्र में मेंथी का मूल गलन रोग के नियंत्रण केलिए ट्रैकोडेरमा विरिडे. १५० कि. ग्राम नीम केक / हेक्टर के क्रम में प्रयोग प्रभापूर्ण सिद्ध हूआ है। धनिया के दानफंफूदी को रोकने केलिए फूल लंगने के २० दिनों बाद कारबनडासिम (०.१%) का छिडकाव करना चाहिए। राजस्थान में जीरा के विल्ट रोग के नियंत्रण के लिए बीजों को बाविस्टिन (०.१%) का बीजोपचार करना उपयुक्त सिद्ध हुआ है।

MINI MISSION I INCREASING PRODUCTION OF SPICE CROPS THROUGH MANAGEMENT OF DISEASES AND PESTS

EPIDEMIOLOGICAL STUDIES ON *PHYTOPHTHORA* FOOT ROT DISEASE OF BLACK PEPPER

M Anandaraj Y R Sarma and K V Ramana

1 Effect of sequential inoculation of black pepper with *Phytophthora capsici* and plant parasitic nematodes

Previous studies showed that feeder root damage caused by *P capsici* and nematodes either alone or in combination lead to slow decline. In this study, the effect of different sequences of inoculation of these on black pepper causing the disease was studied. One year old black pepper vines(var. Panniyur-1) were inoculated with *P. capsici*, *Radopholus similis* and *Meloidogyne incognita* in various combinations (Table 1 1). High mortality and the high incidence of root rot and yellowing were observed. Inoculation with VAM resulted in reduction in hardening time and enhanced survival and subsequent growth on tissue cultured black pepper seedlings.

Table 1.1 Effect of sequential inoculation of pathogens on mortality, root rot, root lesion, root knot on black pepper

Treatment	Mortality (%)	Root rot*	Root lesion*	Root knot*	Fresh weight(g)	
					Shoot	Root
Phytophthora capsici (PC)	20	4.0	0.0	0.0	188.8	16.8
Radopholus similis (RS)	20	2.6	2.3	0.0	193.8	21.5
Meloidogyne incognita (MI)	0	1.5	0.0	2.3	198.0	26.4
RS + MI	0	2.5	2.5	1.0	156.3	16.2
PC + RS	0	2.6	2.6	0.0	192.0	13.5
PC + MI	0	2.4	0.0	1.6	192.0	20.0
PC + MI + RS	40	2.8	0.6	0.6	146.0	15.0
RS + PC	20	3.8	2.0	0.0	115.0	9.0
MI + PC	40	2.8	0.0	1.2	116.4	12.4
RS + MI + PC	100	4.0	0.0	0.0	8.0	5.4
RS + MI + PC	60	3.4	1.0	1.0	0	11.0
Control	0	0.4	0.2	0.2	228.0	30.0

*Index: (0 - 4); 0= no rot, 1=25%, 2=50%, 3=75%, 4=100%

DISEASE MANAGEMENT IN *PHYTOPHTHORA* FOOT ROT AFFECTED BLACK PEPPER PLANTATIONS

Y R Sarma, M Anandaraj and K V Ramana

A field trial conducted at N R C S experimental farm, Peruvannamuzhi was concluded after three years. Apart from all cultural practices, the treatments with two systemic fungicides viz.., Metalaxyl Mancozeb (Ridomil MZ 72WP) and Potassium phosphonate (Akomin) and Bordeaux mixture both as foliar spray and soil drench were tested at different frequencies of application both as pre-monsoon and post-monsoon treatments. The results indicated the superiority of Potassium phosphonate (Table 1 2).

Table 1 2 Effect of frequency of application of fungicides on foot rot of black pepper -field trial

Treatments	Vine death		Foliar yellowing	Defoliation
	Total	Percentage	(0-4 scale)	(0-4 scale)
Control	9	37.5	1.25	1.66
Neem cake	5	20.5	1.05	1.88
Phorate	7	29.1	1.14	2.30
BM + CoC 2R	3	12.5	1.00	2.16
BM + CoC 3R	3	12.5	1.00	1.41
RMZ 3R	3	12.5	1.00	1.95
Akomin 3R	1	4.1	1.00	1.41
Akomin 4R	0	0.0	0.08	1.29

BM=Bordeaux mixture ; CoC =Copper oxychloride; R=Rounds

Table 1 3 Effect of systemic fungicides on *Phytophthora* foot rot of black pepper

Treatments (ppm)		No. of plants dead	No. of plants showing foliar yellowing	No. of plants healthy
Akomin	400	1	4	4
Akomin	800	1	2	6
Dimethomorph	300	0	2	7
Dimethomorph	400	0	2	7
Aureofungin sol	100	1	1	7
Aureofungin sol	200	1	0	8
Aureofungin sol	300	0	1	8
Control		2	4	3

All treatments except control received neem cake @ 1 kg/vine as a pre-monsoon treatment. Initial pot culture experiments with Aureofungin sol, Akomin and Dimethomorph showed superiority of Aureofungin sol in checking root rot (Table 1 3). A comprehensive field trial has been laid out with *Phytophthora* tolerant lines with Subhakara, a susceptible check with a pre-plant treatment with biocontrol agents.

SCREENING OF GERMPLASM MATERIAL FOR REACTION TO *PHYTOPHTHORA* FOOT ROT DISEASE OF BLACK PEPPER

Y R Sarma and M Anandaraj

1 Screening OP seedlings

Seedling progenies (156000) from 59 cultivars were screened with *P. capsici* and none was found to be tolerant.

2 Screening of cultivars using leaf inoculation techniques

Of the 81 cultivars screened, the lesion size ranged from 12.5-29.5 mm after four days of inoculation in leaves inoculated with pin prick. The lesion range was 2.5-24.5 mm in leaves inoculated with out pin prick. Of these, 13 cultivars did not show lesion development in leaves without pin prick even after 10 days after inoculation indicating epidermal / cuticular resistance (Table 1 4). New field trials with *Phytophthora* tolerant lines were started at Valparai, Kodancherry and Pulpally. A field trial started during 1988 with 80 pepper types was concluded. Of these 11 types showed minimum vine death (Table 1 5).

Table 1 4 Screening of germplasm (leaf inoculation technique)

Cultivar	Lesion diameter pin prick(mm)
C 853	22.40
C 955	23.30
C 1069	24.75
C 1108	24.25
C 1091	12.50
C 1124	23.25
C 1588	24.00
C 1590	24.00
C 1519	23.50
C 1585	28.50
C 1503	23.50
C 1587	27.00
C 1507	25.75

Table 1 5 Field screening of OP cultivars and hybrids

Cultivar/hybrids	Number of plants	
	Healthy	Dead
P 334 (Cholamundi)	5	1
P 339 (Cholamundi)	5	1
P 105 (Mundi)	5	1
P 603 (Valiakaniakadan)	6	0
P 856 (Malamundi)	5	1
HP 3 (Panniyur 1 x Karimunda)	5	1
HP 104 (Narayakodi x Neelamundi)	5	1
HP 780 (Panniyur I x Karimunda)	5	1
C 813	5	1
C 847 (Arakulam)	5	1
Panniyur I	5	1
Karimunda	1	1

INVESTIGATIONS ON STUNTED DISEASE OF BLACK PEPPER

Y R Sarma, S Devasahayam and M Anandaraj
Collaborator: Prof. P Sreenivasulu, Dept of Virology S V University
Tirupati

Studies on transmission and serology

Graft transmission:

Graft transmission from black pepper to black pepper was successful. Healthy *Piper longum* grafted on infected black pepper showed chlorosis and crinkling of leaves.

Sap transmission

Sap transmission from black pepper to black pepper was successful. Local lesions were seen on *Chenopodium amaranticolor* and on black gram with infected black pepper sap.

Insect transmission

Pseudococcids like *Planococcus* sp. *P. minor*, *Psedococcus longispirous*, scale insects *Aspidiotus destructor*, *Lepidosaphes piperis*, aphid, *Toxoptera aurantii*, thrips, *Liothrips karnyii*, *Leptocentrus* sp., hoppers, *Tambinia* sp., *Mandera* sp. and *Colla ceylonica* are the insect fauna associated with black pepper. However, their role in disease transmission is yet to be studied. Studies on disease transmission with *Toxoptera aurantii* are in progress.

Serology

Infected plant samples collected were subjected to ELISA test. The antigen strongly reacted

with cucumber mosaic strains (CMV) of legume, CMV *Arachis* and CMV Banana. Similarly, the antigen of infected *Piper longum* also gave positive reaction with CMV (Table 1 6).

Table 1 6 Reaction of black pepper stunted disease virus with other strains of CMV through ELISA

Antigen	Reaction to antisera*		
	CMV-L**	CMV-A	CMV-B
Piper nigrum (stunted)	0.311	1.17	0.41
P. nigrum (vein clearing)	0.48	1.63	0.62
P. nigrum (mosaic)	0.32	1.50	0.61
P. longum healthy	0.01	0.01	0.01
P. longum (mosaic)	1.25	1.17	0.83
P. longum (healthy)	0.004	0.001	0.002

* Readings at 405 nm 30 mts after reaction; * * CMV L = Cucumber mosaic strain of legume CMV A = Cucumber mosaic strain of *Arachis* ; CMV B = Cucumber mosaic strain of banana

The purified virus resolved in SDS-PAGE into 2 bands, one representing a diamer and the other a monomer. This was confirmed by performing electroblot immunoassay (Western blotting) using CMV-banana antiserum. The virus genomic RNA was resolved into three species like other CMV isolates. The dsRNA isolated from black pepper leaves was also resolved into three species. The agar gel double diffusion test indicates that CMV banana and CMV black pepper are antigenically identical. *Piper longum* mosaic was also found to be a CMV strain.

INVESTIGATIONS ON VEIN CLEARING VIRUS OF CARDAMOM

M.N.Venugopal

Epidemiology of disease:

In the selected experimental plots, the disease progress was monitored periodically. After 3 years of continuous monitoring, the results clearly indicate (I) dual pattern of disease spread with solitary infection in distant blocks/plantation and centrifugal spread around the primary sources of infection, (ii) plotting of disease against distance and duration clearly indicated steep disease gradient followed by shallow gradient in the next 100 meters, (iii) initial disease spread pattern suggests that for raising planting material a minimum of 200 m

distance from infected plantation should be maintained to avoid chances of infection in the nursery stage, (iv) rate of spread (r) in different situations vary from 1-28 to 8-16 per unit/year. The r depended on the distance and level of incidence in the surrounding plots/plantations

Persistence of virus in the vector

Studies were repeated with different periods of acquisition (30 min - 4 days) and transmission feeding (30 min - 4 days). The results confirmed that the virus was retained in the vector for more than 8 hours of post acquisition period.

Yield loss

Growth and yield parameters were recorded from the plants with varying stages of infection. Data clearly suggest the yield reduction to the extent of 68-94%. These studies further confirm the destructive potential of this disease.

Disease management

Effect of selective roguing: Periodical roguing in plantations with different levels of initial incidence and sources of infection clearly indicate that in the representative plots/plantations, the periodical inspection and elimination of virus sources effectively reduced the rate of secondary spread. Even in the plantation with 14% initial incidence the cumulative secondary spread/year can be reduced to less than 3%. Only in two isolated plantations with very initial stage of infection, total elimination of the disease was recorded continuously for two years period. In the rest, with roguing even at monthly intervals, total elimination of the disease was not observed. ii) Feasibility of community approach to contain disease spread: A joint study with ICRI Saklespur was undertaken in one of the contiguous hot spot with high level of disease incidence (48%). After total removal of cardamom crop in areca based mixed crop, replanting was followed in about 12 acre plantation comprising eight contiguous blocks. Periodical inspection and roguing was followed in all the plots. After two years of study, the results indicate that the cumulative fresh incidence for two years in different blocks vary from 0.3 to 5.8 per cent

RHIZOME ROT OF GINGER AND TURMERIC

T G N Rao and G N Dake

Surveyed four southern districts of Kerala viz., Trivandrum, Quilon, Alleppey and Pathanamthitta for assessing the incidence of rhizome rot of turmeric. Surveyed 23 gardens during October 1994(Table 1 7). The frequency of isolation of fungi is given in Table 1 8.

Studies on storage rots of turmeric

Both soft and dry rot symptoms were noticed in storage. The incidence of storage rot varied from 17 to 43 per cent. The effect of infection on germination, plant height and yield was studied by planting healthy, partially rotten and severely rotten rhizomes in beds of 3 x 1 m separately. The result are presented in Table 1 9. The affected rhizomes recorded decreased growth and yield. The fungi developed in storage rots

were isolated and pathogenicity test was proved. *Aspergillus*, *Fusarium* and *M. phoseiolina* were found associated with storage rots of turmeric.

Table 1 7 Survey for incidence of rhizome rot of turmeric in Kerala

District	No.of garden visited	Disease incidence
Quilon	5	1 - 7
Trivandrum	9	1 - 5
Alleppey	6	1 - 3
Pathanamthitta	3	1 - 4

Table 1 8 Frequency of isolation of organisms associated with rhizome rot

Organisum	Frequency
Pythium sp	4
Fusarium sp	22
R bataticola	1

Table 1 9 Effect of storage rot on plant stand and yield

Parameter	Healthy	Partially rotted	Severly rotted
Germination %	97.00	22.50	5.00
Plant height (cm)	19.80	13.90	8.00
No. of leaves	6.57	4.57	3.00
Yield (Kg/Plot)	3.30	0.40	0.35

STUDIES ON BACTERIAL WILT OF GINGER

G N Dake and T G N Rao

The pot culture experiment was conducted in randomised block design with five treatments Viz., (I) plant inoculation with avirulent *P solanacearum*, (ii) Soil amendment with sea shell, (iii) Soil application of Streptopenicillin, (iv) Sterile water and (v) Control. Replicated five times to explore the possibilities of inducing resistance either by prior inoculation with the host by avirulent strain of *Pseudomonas solanacearum*, soil amendments with sea shell or soil drenching with antibiotic and challenge inoculation with virulent strains of *Pseudomonas solanacearum* against bacterial wilt of ginger. Ninty-day old plants of cultivar 'Maran' grown in 30 cms diameter earthenware pots were inoculated with Bacterial suspensions 10^8 cfu/ml

of avirulent strain of *P solanacearum* . Sea shell (powdered form) was mixed in soil by adding (1:50 by w/w) proportion. Strepto-penicillin (Dicrysticin) 100 ppm @ 100 ml per pot was poured at the base of ginger plants. The challenge incoulation of virulent strain of *P solanacearum* was done after 48 hrs by adding 100 ml bacterial suspensions of 10^8 cfu / ml around the plant bases in pots. The observations were recorded for initiation of symptoms daily at 10.00 am and results are presented in Table 1 10. The initiation/expression of symptoms were delayed by 5 days in treatment combinations of application avirulent strains of *P solancearum*, amending the soil with sea shell or drenching with antibiotic (Dicrysticin) and challenge inoculation with virulent isolate of *P solancearum* than pouring water and challenge inoculation of *P. solanacearum.*

Table 1 1 0 Symptom expression in 'Maran' cultivar of ginger after challenge inoculation* with virulent strain of *Pseudomonas solanacearum*** Smith.

Treatment	Number of inoculated plants	No.of plants wilted (Days after challenge inoculation)			
		5	10	15	20
Avirulent strain of *P solanacearum*(AVSPS)	53	0	4	28	21
Sea shell +AVSPS	57	0	5	31	21
Strepto-penicillin +AVSPS	56	0	7	31	18
Sterile water +AVSPS	54	12	42	-	-
Water alone (un-inoculated control)	55	0	0	0	0

*Date of inoculation : Oct 10 1994 **Initiation of symptoms : Oct 15 1994

Table 1 11 Minimum inhibitory concentration (MIC)

Name	Generic name	MIC (ppm)
Aminoglycosides	Kanamycin (km)	5
Tetracyclines	Tetracycline (TC)	10
Polyenes	Chloramphenicol (cm)	10
Aminoglycosides +β-lactum	Streptopenicillin (SP)	2.5
β--lactum	Ampicillin (AP)	-

Bacterial strains used in experiment:

Isolate No.	Hosts
ZoPs - 52	*Zingiber officinale* Rosc.
SaPs - 57	*Syzygium aromaticum* M&P
KgPs - 63	*Kaempferia galanga* L

Curing plasmids

The antibiotics which are water soluble were sterilized by adding few drops of alcohol and then allowed to get evaporated before adding sterile double distilled water to adjust the concentration. The tetracycline was dissolved in small quantity of ethanol by vigorous shaking and made up volume to 100 ml by adding double distilled sterilized water.

Studies were carried out to determine the minimum inhibitory concentration (MIC) of Aminoglycosides (Kanamycin), Polyenes (Chloramphenicol), Tetracyclines (Tetracycline), Strepto-penicillin (Dicrysticin) against *Pseudomonas* sensitive strains keeping β-lactum (Ampicillin) as *Pseudomonas* resistant check (Table 1.11). The growth of *Pseduomonas* strains viz. ZoPs-52, SaPs-57 and KgPs-63 was inhibited at 2.5 ppm in Dicrystin followed by Kanamycin (5 ppm), Tetracycline and Chloramphenicol at (10ppm). The Dicrystin is more effective because of combination of two antibiotics i.e. Streptomycin and penicillin.

The colonies of insensitive (resistant) cells of *Pseudomonas solanacearum* survived from 10^8 cfu/ml) on nutrient Sucrose agar plates supplemented with Kanamycin (10 µg/ml Chloramphenicol at 20 µg/ml) and Tetracycl at (30 µg/ml) were selected (Table 1 12). Further work on curing of plasmids using mitomycin -C1, Acridine orange dye is in progress.

In addition, two more new hosts of *Pseudomonas solanacearum* have been recorded. The occurrence of bacterial (*P. solanacearum*) wilt on *Kaempferia galanga* L. in Calicut district and on *Syzygium aromaticum* L. Merr and Perr caused by *Pseudomonas sp.* in Wynad district of Kerala State are the authentic records of bacterial wilt from India.

Table 1 12 Isolation of drug resistant mutants

Antibiotics	Selection of cfu/ml			
	5 ppm	10 ppm	20 ppm	30 ppm
Kanamycin	1	1	-	-
Chloramphenicol	4	3	1	-
Terarcyclines	17	8	5	2

Bacterial suspension used 10^8 cfu/ml

BIONOMICS OF MAJOR PESTS OF BLACK PEPPER AND EVOLVING INTEGRATED CONTROL MEASURES AGAINST THEM

S Devasahayam

1. Screening of black pepper germplasm against 'pollu' beetle

Twenty-four wild *Piper* accessions maintained in the germplasm of NRCS Peruvannamuzhi were

screened for berry damage by 'pollu' beetle (*Longitarsus nigripennis*) under field conditions. Two accessions were free of pest infestation; the incidence of 'pollu' infested berries ranged between 3.4-26.2 per cent in the other accessions.

2. Bioassay of neem and other natural products against 'pollu' beetle

Four commercial neem formulations (Neemark, Neem Gold, Nimbicidine and Neem Azal), neem seed kernel extract and custard apple seed extract (source: Indian Institute of Chemical Technology, Hyderabad) were evaluated for their antifeedant activity against 'pollu' beetle in laboratory bioassays using 'leaf disc technique' and adopting 'no choice tests'.

All the commercial products were effective resulting in 50 per cent feeding deterrence at 0.2 - 1.0% concentrations and 90 per cent feeding deterrence at 2.0 - 6.0% concentrations, 24 h after treatment. Among the natural products, custard apple seed extract was more promising resulting in 50 and 90 per cent feeding deterrence at 0.025% and 0.2% concentrations, respectively, 24 h after treatment.

3. Evaluation of neem products against 'pollu' beetle in the field

Four commercial neem formulations (Neemark, Neem Gold, Nimbicidine and Neem Azal) and endosulfan (present recommendation) were evaluated against 'pollu' beetle in the field at Peruvannamuzhi. The treatments included four rounds of spraying (July, August, September and October) with neem products; one round of spraying (July) with endosulfan and three rounds (August, September and October) with neem products and two rounds of spraying (July and September) with endosulfan. 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 subjected to statistical analysis.

The trials indicated that all the treatments were effective in reducing the infestation caused by 'pollu' beetle significantly when compared to control. The percentage of berries damaged by the pest was minimum in plots sprayed with one round of endosulfan 0.05% and three rounds of neemgold 0.3%; however, it was on par with other treatments except four rounds of spraying with Neem Gold and Nimbicidine alone.

INVESTIGATIONS ON NEMATODES ASSOCIATED WITH SPICE CROPS

K V Ramana and Santhosh J Eapen

1. Screening spices germplasm against nematodes

Fifty cultivated black pepper germplasm accessions were tested using standard techniques for reaction to the root knot nematode *M. incognita.* All the accessions tested showed susceptible reaction to the nematode with gall index ranging 4.0 to 5.0. Ten accessions of black pepper, 5000 seedling progenies of blackpepper cultivars, 5 cardamom accessions, 50 accessions each of Ginger and turmeric are being tested for their reaction to *M. incognita.*

2. Population variability in rootknot nematodes associated with various spices

Thirty six populations of *M.incognita* from black pepper, ginger and turmeric were collected from different areas in Kerala and Tamil Nadu. Sixteen populations are being maintained on their respective hosts for studying their variability.

3. Effect of *M. incognita* on growth and yield of ginger

A pot culture trial with the following treatments was laid out to study the effect of *M. incognita* on growth and yield of ginger.

Treatments.
1.Control (no nematodes)
2.*M. incognita* @ 0.2 II stage juveniles / 100 cc soil
3.*M. incognita* @ 2 "
4.*M. incognita* @ 20 "
5.*M. incognita* @ 200 "

The experiment was laid in CRD with 8 replications . `Himachal' was used as test material.

4. Role of *M. incognita* in rhizome rot complex of ginger

A pot culture experiment was conducted to study the role of *M. incognita* in rhizome rot complex of ginger in a RBD with 10 treatments replicated 4 times. Cultivar `Himachal' was used for the trial. In treatments T8, T9 & T10, the plants were inoculated with root knot nematodes 20 days prior to inoculating other pathogens and observation on the disease incidence were recorded one day after affecting all the treatments. The results of the study indicate that the plants inoculated with root-knot nematode alone did show any symptoms of the disease. Plants inoculated with *P. solanacearum* alone or in combination with nematode/fungus showed bacterial wilt symptoms (100%) on the 3 rd day after bacterial inoculation except in treatment T10 where the incidence was 95.9%. This indicated the presence of root-knot nematode had no influence on the severity of bacterial wilt caused by *P. solanacearum* in ginger. However, prior inoculation of plants with root knot nematode resulted in increase in the severity of the rhizome rot disease and advanced the expression of disease symptoms. Plants inoculated with nematode and fungus simultaneously, only 16.1% tillers showed disease symptoms while in plants inoculated with the nematodes 20 days prior to fungal inoculation 46.5% tillers expressed disease symptoms 3 rd day after inoculation of the fungus. All the tillers in plants inoculated with nematodes prior to fungal inoculation expressed disease symptoms by 7 th day whereas the plants inoculated with both the pathogens simultaneously all the tillers expressed disease symptoms at 10th day after fungal inoculation. The study shows that root knot nematode predisposed ginger plants to fungal infection resulting in increased severity of the disease (Table 1 13).

Table 1 13 Role of *M. incognita* in rhizome rot and bacterial wilt in ginger

Treatment	Disease incidence (% tillers affected)		
	3 DAI*	7 DAI	10 DAI
T1 Control (No Pathogen)	Nil	Nil	Nil
T2 MI alone	Nil	Nil	Nil
T3 PY alone	Nil	35.4	94.0
T4 PS alone	100.0	-	-
T5 MI + PY(Simultaneously)	16.1	44.6	100.0
T6 MI + PS(Simultaneously)	100.0	-	-
T7 MI + PY +PS(Simultaneously)	100.0	-	-
T8 MI > PY (20 days)	46.5	100.0	-
T9 MI > PS (20 days)	100.0	-	-
T10 MI > PY +PS(20 days)	95.9	100.0	-

*DAI = Days after inoculation
MI = *Meloidogyne incognita;* PY = *Pythium aphanidermatum;*
PS = *Pseudomonas solanacearum*

BIOLOGICAL CONTROL OF DISEASES OF SPICES

M Anandaraj, Y R Sarma and M N Venugopal

Two ongoing trials in the field on the efficacy of VAM in suppressing root rot of black pepper were continued. In the first trial VAM in main plot and 5 sub plot treatments viz., Control application of VAM, copper oxychloride, Ridomil MZ and Akomin. This has 3 replications with a plot size of 6 vines / treatment, planted in a diseased area. The disease incidence was 16.5% in VAM treated plots compared to 28.5% in Non-VAM control plot. In another trial, six isolates of VAM are inoculated first followed by application of biocontrol agents viz., *Trichoderma hamatum*, *Gliocladium virens* and use of *Chromolaena odorata* as mulch. The incidence of disease was less than 5% in this trial. VAM colonization on the roots, soil population of VAM, applied biocontrol agents and pathogen populations were monitored regularly. Biocontrol of foot rot of black pepper was taken up in Wynad district in a farmer's plot with 7 treatments replicated four times with a plot size of 12 vines/treatment. No mortality of vine was not observed in *Gliocladium virens* (Table 1 14) amended plot.

Table 1 14 Effect of biocontrol agents on foot rot of black pepper

Sl. No.	Treatment	Mortality of vines (%)
1	*Gliocladium virens* I	0.0
2	*Trichoderma polysporum*	5.1
3	*Gliocladium virens* II	4.7
4	*T.harzianum*	7.3
5	*T.koningi*	13.2
6	Mixture of 3, 4, 5	2.3
7	Control	11.3

Table 1 15 Growth of biocontrol agents in coconut water amended with nutrients

Composition (for 100 ml) Medium used	Mycelium dry weight (mg) after 30 days growth (mean)	
	T. hamatum	*G. virens*
Coconut water(CW) 100%	530	674
CW 50 + Distilled Water (DW) 50	480	492
CW 25 + DW 75	403	261
CW 10 + DW 90	256	213
CW 50 + DW 50 Micro Nutrients*	515	477
CW 50 + DW 50 Glucose 1g	555	459
CW 50 + DW 50 Yeast Extract 0.1g	556	636
Fungal Medium (Martins Rose Bengal)	501	455

* Micronutrients Fe^{+++} { $FeNH_4(SO_4)_2$ 12 H_2O} = 0.2 mg ; Zn++ ($Zn SO_4$ 7 H_2O) = 0.2 mg
Mn++ ($Mn SO_4 H_2O$) = 0.1 mg; Thiamine Hcl = 100 µg

Coconut liquid endosperm (coconut water) supported good growth and sporulation of *Trichoderma* and *Gliocladium* (Table 1 15). This could be effectively utilized for mass culturing of these fungi. In cardamom *Trichoderma* isolates were mass multiplied on partly decomposed coffee husk and applied in 0.4 ha of rhizome rot prone plantation. In the first years result , rhizome rot incidence was 1.2% in treated plots as against 5.3% in untreated plot.

BIOLOGICAL CONTROL OF INSECT PESTS OF SPICES

S Devasahayam

1 Identification of natural enemies of insect pests of ginger and turmeric

The incidence of natural enemies of shoot borer (*Conogethes punctiferalis*) and rhizome scale (*Aspidiella hartii*) on ginger and turmeric was studied. Larvae of shoot borer (collected from Peruvannamuzhi) and rhizomes of ginger and turmeric infested with scales (collected from Peruvannamuzhi and Mananthavady) were observed in the laboratory for the occurrence of natural enemies. The natural enemies recorded include two species of hymenopterous parasites and an entomophagus nematode on shoot borer and two species of hymenopterous parasites and a species of predatory beetle and ant on rhizome scale.

2. Seasonal incidence of natural enemies of shoot borer of ginger

The seasonal incidence of natural enemies of shoot borer of ginger was studied at Peruvannamuzhi. Larvae of shoot borer were collected at regular intervals during the crop period July to December and brought to the laboratory and observed for the occurrence of natural enemies. The entomophagous nematode parasitized larvae of shoot borer during July to November with a peak parasitisation of 72 per cent during August. The hymenopterous parasites were observed during October to December with a peak parasitisation of 28 per cent during November.

3. Bioassay of *Bacillus thuringiensis* against shoot borer of ginger

Laboratory bioassays were conducted to test the efficacy of a commercial formulation of *Bacillus thuringiensis* (Dipel) against larvae of shoot borer. Ginger pseudostems were split into two and dipped in 0.25%, 0.50% and 1.00% concentrations of the product and healthy larvae were introduced into them. A control without application of *B. thuringiensis* was also maintained. The mortality of larvae in various treatments was recorded at 24 h intervals after application.

The formulation was highly effective resulting in 100 per cent mortality of the larvae 1, 3 and 5 days after treatment at 1.0, 0.5 and 0.25% concentrations' respectively.

4. Evaluation of *B. thuringiensis* against shoot borer of turmeric

The commercial formulation of *B. thuringiensis* (Dipel) was evaluated against shoot borer of turmeric in the field at Peruvannamuzhi. The treatments included three rounds of spraying with two concenttrations of Dipel (0.50 and 0.75%) and Malathion 0.1% (present recommendation) during August, September and October. An untreated control was also maintained. The percentage of tillers infested by the pest was recorded during November and the data were subjected to statistical analysis. The trials indicated that all the treatments were effective in controlling the pest infestation when compared to control. Dipel 0.75% was the most effective being significantly superior to other treatments

BIOLOGICAL CONTROL OF NEMATODES IN SPICES

Santhosh J Eapen, K V Ramana and Y R Sarma

1. *In vitro* studies

Trichoderma harzianum (two isolates), *T. hamatum*, *T. aureoviridae*, *T. viridae*, *T. polysporum*, *T. longibracheatum*, *T. koningi*, *T. pseudokoningi* and *Gliocladium virens* were tested under *in vitro* conditions to study their interaction with root knot nematodes. All the fungi colonised egg masses of root knot nematodes, but the colonisation level varied between isolates. *T. harzianum*, *T. longibracheatum*, *T. koningi*, *T. viridae* and *G. virens* were better colonisers. However, no hyphal development was observed on individual eggs or larvae. Distortion of eggs were commonly seen and was more pronounced with regard to *T. harzianum* (Isolate No.7 and 44), *T. viride* and *G. virens*, suggesting the involvement of toxic metabolites. However, culture filtrates of all the fungal isolates killed the second stage juveniles of *M. incognita* within 24 hours, in a separate study.

2. Pot culture studies

I) Effect of Trichoderma isolates on root knot nematodes of cardamom

Four isolates of *Trichoderma spp.* and a *Gliocladium* isolate from cardamom plantations of Coorg were tested against root knot nematodes of cardamom in a pot trial started during 1993. Among these isolates, one *T. harzianum* isolate and another unidentified *Trichoderma* species suppressed root knot nematodes to the maximum extent. The results are given in Table 1 16. *ii)*

ii)Effect of Pseudomonas fluorescence on root knot nematodes

Four isolates of *Pseudomonas fluorescence*, collected from black pepper soils of Eastern Ghats in Andhra Pradesh were tested against root knot nematodes using tomato as a test plant. Tomato plants were dipped in the bacterial suspension at the time of transplanting. After establishment, these plants were inoculated with 500 second stage juveniles of *M. incognita*. The root weight, number of egg masses and the final nematode level in roots were recorded after two months. Isolate No.1 and No.44 were found to possess maximum inhibitory effect on root knot nematodes.

Table 1 16 Effect of *Trichoderma* isolates on growth of cardamom seedlings and root knot nematode development

Treatment	Total Biomass / Seedling			Final nematode level / g root		
	S-	S+	Difference	S-	S+	Difference
Trichoderma Is.1	22.58	23.01	0.43	1.307	0	1.307*
T.viridae	24.62	21.08	3.54	0.451	0	0.451
T.harzianum Is.1	19.04	22.12	3.08	0.512	0	0.512
T.harzianum Is.2	26.75	25.00	1.75	1.304	0	1.304*
Gliocladium sp.	21.46	22.86	1.40	0.458	0	0.458
All isolates together	29.12	19.20	9.92*	1.136	0	1.136*
Trichoderma Is.1+N	17.02	15.17	1.85	2.216	2.457	0.241
T.viridae +N	18.25	17.37	0.88	2.025	2.828	0.803
T.harzianum Is.1+N	15.21	17.92	2.71	2.074	1.943	0.131
T.harzianum Is.2 +N	22.85	16.50	6.35*	1.630	2.416	0.786
Gliocladium sp. +N	15.08	18.96	3.88	2.504	2.654	0.150
All isolates together +N	20.54	17.08	3.46	1.748	2.572	0.820
Nematode alone	11.33	15.33	4.00	2.380	2.818	0.438
Check	20.29	19.16	1.05	1.120	0	1.120*
$LSD_{0.05}$	4.50	4.50	-	0.938	0.938	

N- Root knot nematode; S- native soil; S+ sterile soil;

* Significant difference between means in a row.

ISOLATION AND IDENTIFICATION OF NATURALLY OCCURRING COMPOUNDS AGAINST MAJOR PESTS AND PATHOGENS OF BLACK PEPPER

N K Leela, K V Ramana and M Anandaraj

Leaves of *Piper colubrinum* and *Chromolaena odorata* were extracted with various solvents and tested against *Phytophthora capsici*. Petroleum ether fraction showed maximum inhibition (Table 1 17). The petroleum ether fraction from *Piper colubrinum* chromatographed on silica gel were eluted with benzene-chloroform and chloroform-thanol with increasing polarity. This yielded 5 fractions, the first fraction rechromatographed on silica gel and chloroform. This showed four UV absorptive maxima at 278, 261, 255 & 242 nm. This is being purified further. Petroleum ether retracts from *Chromolaena odorata* were chromotographed on neutral alumina with chloroform - Methanol mixture. This yielded fair fraction among which the first fraction showed maximum inhibitory effect on *P. capsici*.

Table 1 17 Inhibition of *P. capsici* by leaf extracts of *Piper colubrinum* and *Chromolaena odorata*

Extractant	Concentration (%)	Per cent inhibition	
		P. colubrinum	*Chromolaena odorata*
Petroleum ether	0.5	41.3	22.5
Petroleum ether	1.0	47.6	44.0
Chloroform	0.5	17.6	14.2
Chloroform	1.0	37.0	37.0
Methanal	0.5	13.4	16.1
Methanal	1.0	29.0	49.1
Acetone	0.5	0.0	-
Acetone	1.0	2.5	-
Water	0.5	-	0.0
Water	1.0	-	0.0

MINI MISSION II :DEVELOPING AGROTECHNIQUES FOR INCREASING PRODUCTION OF SPICE CROPS

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 and K Kandiannan

1. NPK Experiment

The experiment started during 1987 with four levels of nitrogen (50,100,150 and 200g per vine /year) four levels of potassium (70,140,210 and 280g per vine/year) along with contrl, consisting of twenty one treatment combinations was laid out in RBD with three replications. The black Pepper variety Karimunda Planted by using *Erythrina indica* as standards. The final cumulative yield of five years presented in table 2 1. Application of 150g N and 280g K_2O /vine/year recorded higher yield.

2. Critical Nutrient Indexing

This experiment initiated during 1993-94. Black Pepper garden was identified as pulpally, Wynad district, for sampling. Hundred high yielding each fifty medium and low yielding vines were selected from the garden. The leaf samples (8 leaves/vine) were collected during April and analyzed for major, secondary and micro-nutrients critical nutrients content were worked out and presented in the Table 2 2.

Table 2.1 Cumulative green pepper yield (1990 - 91 to 1994 -95) (kg/vine)

Treatment(g/vine/year)				Cumulative Yield
N	K	Ca	Mg	
50	70	-	-	4.416
50	140	-	-	5.347
50	210	-	-	5.649
50	280	-	-	6.370
100	70	-	-	7.678
100	140	-	-	8.871
100	210	-	-	10.392
100	280	-	-	11.022
150	70	-	-	6.767
150	140	-	-	11.991
150	210	-	-	12.518
150	280	-	-	15.381
200	70	-	-	9.013
200	140	-	-	9.845
200	210	-	-	8.071
200	280	-	-	6.370
50	140	50	-	3.880
50	140	-	50	4.776
50	140	50	50	4.416
0	140	-	-	3.288
0	0			2.980
$CD_{(0.05)}$				1.010

* P- common dose

3. Irrigation experiment.

trial was started during 1988. Black pepper variety Karimunda planted by using *Erythrina Indica* as standards. As per the suggestion of staff Research Council the treatments were modified during 1993-94. Thirteen treatments replicated two times in completely randomized Design. The yield recorded treatment wise and presented in Table 2.3. Highest yield was recorded by daily irrigation with drip during October to May.

Table 2 2 Critical nutrients content (averege) in black pepper

Nutrient element	High yielding (100)*	Medium yielding (50)*	Low yielding (50)*
N(%)	2.67 (10.2)**	2.51 (13.9)	2.40 (13.0)
P(%)	0.25 (16.7)	0.22 (26.6)	0.19 (21.7)
K(%)	2.10 (19.8)	1.95 (1.58)	1.78 (19.9)
Ca (%)	1.78 (14.1)	1.58 (22.7)	1.45 (22.0)
Mg(%)	0.36 (18.2)	0.33 (21.5)	0.29 (16.0)
S(%)	0.26 (20.8)	0.23 (21.0)	0.19 (15.7)
Zn (ppm)	39.0 (17.7)	32.0 (7.2)	25 (6.5)
Mn(ppm)	60.0 (23.9)	53.0 (13.8)	47 (17.4)
Fe(ppm)	152.0 (22.1)	145.0 (25.6)	141 (28.5)
Cu(ppm)	10.0 (23.9)	7.5 (20.0)	6 (20.0)

*Number of experimental vines
**Coefficient of variance

Table 2.3 Effect of irrigation on green pepper yield

Treatment	Yield (kg/vine/year)
Irrigation at 0.3 IW/CPE	1.733
a - Oct. - March	2.125
b - Oct - April	2.031
c - Oct - May	2.231
Irrigation at 0.6 IW/CPE	2.250
a - Oct. - March	2.265
b - Oct - April	2.267
c - Oct - May	2.278
Irrigation at 0.9 IW/CPE	2.318
a - Oct. - March	2.385
b - Oct - April	2.563
c - Oct - May	2.585
Control	1.566
$CD_{(0.05)}$	0.456

INVESTIGATIONS ON SPICES BASED CROPPING SYSTEMS

V S Korikanthimath, R Hegde and K Sivaraman

The field study consisted of 8 crop combinations with each combination in an area of o.1 ha. The study was inirtiated during 1991, at Cardamom research centre Appangala. The objectives of the study were to investigate the crop compatability, utilization of natural resources like solar

radiation water and nutrients, organic recycling of crop wasteds and also to study the microbial behaviour, besides yield and economics.

Growth parameters: Differences in height, number of bearing and non bearing tillers of cardamom grown in combination with pepper, cinnamon, clove, nutmeg, all spice, coffee didnot differ significantly. Average height of cardamom was 220.5 cm and total number of tillers were 40.00. The cardamom clumps werehaving on an average 28 panicles and length of panicles was 41.0 cm. The number of nodes was 16.00 per panicle.

Yield of Cardamom: An average yield of 0.17 kg dry cardamom per clump and 436 kg / ha as recorded during the fourth year of planting. The component crops except coffee are yet to commence the bearings. The differences in yield of cardamom grown with different components was not significant.

Leaf nutrient content: There were no significant differences in the leaf nutrient content (N and P) of cardamom grown with different component crops. The leaf nitrogen content of cardamom was 3.1 per cent and 0.42 per cent was the Phosphorus content.

WATER REQUIREMENT OF SPICES IN MULTIPLE CROPPING SYSTEM

C K Thankamani, K Sivaraman, K Kandiannan, B Krishnamoorthy

The title of the experiment changed as 'Irrigation requirement of black pepper, clove mixed cropping system' initiated during 1995. Following are the treatments replicated thrice in RBD.

As drip:

T1 10 l/day with full dose of fertilizer
T2 15 l/day with full dose of fertilizer
T3 20 l/day with full dose of fertilizer
T4 25 l/day with full dose of fertilizer
T5 10 l/day with half dose of fertilizer
T6 15 l/day with half dose of fertilizer
T7 20 l/day with half dose of fertilizer
T8 25 l/day with half dose of fertilizer
T9 25 l/day with 1½ dose of fertilizer
T10 Control

Ailanthus sp seedlings are planted as standards.

VERMICOMPOST PRODUCTION USING ORGANIC WASTES AVAILABLE IN CARDAMOM AREAS

R Hegde, and V S Korikanthimath

An investigation was initiated to find out the possibility of converting various kinds of organic wastes available in cardamom growing areas into nutrient rich compost using earthworms as the digesters. During the first year of study (1994-95), a species of local earth worm and an introduced earthworm species (*Eudrillus eugenia*) were being multiplied on a mixture of shade tree leaf litter and cowdung (10:1). The initial observations have revealed that the introduced earth worms were efficient in conversion of organic wastes. Their multiplication rate was also considerably high compared to local earthworms and studies are in progress.

NUTRITIONAL REQUIREMENT OF IMPROVED VARIETIES OF SPICES

A K Sadanandan, K Sivaraman and V S Korikanthimath

1 Nutritional requirement of improved varieties of black pepper

The field experiment laid out during 1991-92, with the objective to work out the optimum response of the improved varieties of Pepper released (sreekara and subhara) to graded dose of NPK and micronutrients on living and non-living standards was maintained. Yield data of vines recorded. Vines receiving the treatment NPK @ 150, 60, 270 with micro nutrients recorded the highest yield, during first year of harvest. (Table.2.4).

Table 2.4 Response of black pepper variety to nutrients under different standards(Yield kg/ha)

Treatment	Sreekara		Subhakara		Overall mean
	Living	Non living	Living	Non living	
Control	75	70	94	67	77
NPK @ 50:20:70	88	80	116	83	92
NPK @ 100:40:140	115	100	137	102	114
NPK @ 150:60:270	177	171	144	159	163
NPK @ 50:20:70	117	93	140	105	114
+Micronutrient	186	176	178	169	177
NPK @ 150:60:270					
+Micronutrient	126	115	135	114	123

2 Nutritional requirement of bush pepper

Two field experiments laid out in 1992-93 with two varieties of bush pepper (Panniyur-1 and Karimunda) with two spacings (1 x 2 m, 2 x 2 m and NPK applied @ 10, 5, 20 g per plant in January, May and September. Growth and yield were recorded. Among the varieties maximum yield (wet) record was 1850 g for Karimunda and 2350 g for Panniyur-1 per bush during the second year of planting. Among the spacing 2 x 2 m registered 1897 kg/ha while 2 x 1 m recorded 950 kg/ha (Table 2.5)

Table 2 5 Response of bush pepper for spacing (Green pepper yield Kg/ha)

Spacing	2 X 1 m	2 X 2 m	Overall mean
Panniyur - I	820	1873	1347
Karimunda	1080	1920	1500
Mean	950	1897	

Table 2 6 Effect of residues of organic cakes on soil properties and turmeric yield

Treatment	Soil Properties		yield (t/ha)
	Moisture (%)	Bulk Density (g/cc)	
Check	8.5	1.21	15.5
FYM	11.2	1.14	17.1
Neem Cake	10.5	1.03	17.3
Cotton Cake	10.2	1.08	17.6
Brassica Cake	10.4	0.98	18.5
Groundnut Cake	11.6	0.85	17.8
Gingelly Cake	11.2	0.94	18.4
Fertilizer NPK	10.0	1.12	16.5
CD at 5 %	NS*	0.09	2.1

3 Lime requirement of pepper

The effect of application of lime in a red laterite soil studied using bush pepper. Application of lime at 3/4 lime requirement was on par with full lime requirements.

4 Sources of potassium for black pepper

The effect of different sources of K (Potassium chloride, Potassium sulphate, Potassium nitrate and wood ash) for black pepper was studied using bush pepper. Soil availability of potassium and yield response were recorded. Potassium sulphate was found to be a better sources of potassium for pepper.

5 Organic farming of bush pepper

Green house experiments using bush pepper to study the effect of application of organic manures (poultry manure, goat manure, pig manure and farm yard manure), laid out in 1994-95 was continued. Poultry manure followed by goat manure were found to be superior than farm yard manure.

6 Studies on residual effect of organics in ginger and turmeric

In ginger, field experiment laid out in 92-93 and applied with five sources of organic cakes, which was kept fallow during 93-94 was planted with

ginger, cv Maran without application of any manure/fertilizer with the objective to study the residual effect of applied organics.

In turmeric, the field experiment laid out in 92-93 with four varieties of turmeric (Suvarna, Suguna, Sudarshana and Alleppey) with five sources of organic cakes, kept fallow during 93-94 was planted with the same variety without application of any manure with the objective of studying the residual effect with respect to physical property and turmeric crop was harvested, yield data recorded. The soil samples collected and analysed for physical and chemical properties. Application of organics, reduced soil bulk density, increased root growth, nutrient uptake and yield (Table 2.6).

7 Studies on nutrient buffer power of potassium in different soils

The nutrient buffer power of potassium was studied in three soil series (Peruvannamuzhi series 1, 2 and 3) using turmeric cv Alleppey as a test crop. Potassium was applied at four levels (0, 100, 200, 400 ppm). Soil potassium was extracted using two extractants (Ammonium acetate - 1N and Calcium 0.01 m) during critical stages of turmeric growth 40, 90 days and at maturity. Nutrient uptake and curcumin recovery of turmeric was studied at maturity. Yield and curcumin recovery was maximum in Peruvannamuzhi - 3 soil series.

Economics of black pepper cultivation

(Jose Abraham)

Survey of 50 pepper gardens were done in Calicut district and data on various inputs like planting materials, fertilizers, plant protection chemicals and labour were recorded. Preliminary observations showed that the major component of cost is labour. Very few farmers purchased planting materials from out side agencies. Use of fertilizers for black pepper is also very meagre, most of the farmers were using only farm yard manure for black pepper, which is generally available at the house hold. Lime was also applied by a few of them. The highly fluctuating market price of black pepper, the high incidence of foot rot disease and the increased labour cost are the deterrent factors for scientific cultivation. It is observed that, based on the changes in the input costs, a tentative estimate of Rs.26.60 per kg. of black pepper was obtained.

MINI MISSION III : INCREASING PRODUCTIVITY OF SPICE CROPS THROUGH CROP IMPROVEMENT

Collection, conservation, cataloguing and evaluation of black pepper germplasm

Johnson K George, P N Ravindran, B Sasikumar and V S Korikanthimath

Sixty-one wild *Piper* collections were made from Gorusappa, Jog Falls, Akumbe, Kudremukh and Talakaveri areas in Karnataka and Sugandagiri / Chempra estate areas in Kerala. The collections

include *P. attenuatum, P. argyrophyllum, P. hymenophyllum, P. brachystachyon, P. sugandhi* and a distinct plant related to *P. sugandhi* with very long spikes (28 cm) and bold berries. Wild *P. nigrum* collections consisted of high altitude types with bold berries and low altitude types with smaller berries. An exotic *Piper* species was collected from TBGRI, Trivandrum. Ten cultivated black pepper germplasm collections from Kerala and Karnataka include three drought tolerant types from South Kanara district in Karanataka. Preliminary studies on the characterization of *Piper* using electrophoretic pattern of proteins were undertaken. Proteins with molecular weight ranging from 14 to 42 KD were separated in the gel and high concentration of high molecular weight proteins observed in the wild species, as compared to cultivated types.

Collection, conservation, cataloguing and evaluation of cardamom germplasm

Ravindra Mulge

A Total of 282 accessions of cardamom and related genera were maintained at the Center. Evaluation of Wynad collections along with checks revealed that height of the tallest tiller and number of bearing tillers per plant did not differ significantly among the entries. Total number of tillers per plant differed significantly at P=0.05 and number of leaves per plant differed significantly at P=0.01 among the entries. Entries differed significantly (at P=0.01) for cumulative wet capsule yield per plant. The highest cumulative wet capsule yield was recorded in Vazhukka suckers (2106.5 g/plant) followed by APG 223 (1713.25 g/plant), APG 215 (1583.00 g/plant), APG 230 (1569.00 g/plant) and Vazhukka seedlings (1561.75 g).

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

P N Ravindran, B Sasikumar, Johnson K George and R R Nair

1 Genetic resources:

I)Ginger : Eight cultivated types from South Karnataka, Thenmalai and Trivandrum areas, one cultivated type from Brazil (Courtesy : Project Co-ordinator (Spices) and two cultivated types from Thalakaveri and Peruvannamuzhi areas were collected and added to the germplasm repository.

ii) Turmeric : Seven cultivated types of *Curcuma longa* L. collected from South Karnataka and Western UP, and an accession of *Curcuma amada* Roxb. collected from South Karnataka and an accession of *Curcuma anguistifolia* Roxb. collected from Raipur (Courtesy : Director, IISR) and one accession of *Curcuma* sp were added to the germplasm repository.

2 Maintenance

Four hundred and twenty eight accessions of ginger, 697 accessions of turmeric and 9 accessions of *Kaempferia galanga* were maintained.

3 Multi location trials in ginger

Fifteen cultivars of ginger were evaluated for the 4 th consecutive year at Peruvannamuzhi and Muvattupuzha. The same materials were also evaluated at Ambalavayal, Niravilpuzha (both hilly tracts of Wynad) and Peechi (Trichur) during the year. Differences among the entries were significant at all the locations (Table 3 1).

Another ginger yield trial with eleven selected entries was also laid out at Peruvannamuzhi and Ambalavayal. Differences among the entries were significant at both the places. At Peruvannamuzhi the trial was repeated for the 3 rd year. At both the locations the differences among the entries were significant (Table 3 2).

4 Multi location trials in turmeric

Seven OP progenies and 4 controls were evaluated at Muvattupuzha and Peruvannamuzhi for the 4 th consecutive year and at Coimbatore for the 2 nd year. Observations were recorded as plant height, tiller number, maturity and yield. Differences among the entries were significant at all the locations for fresh rhizome yield/ 3 m^2 bed (Table 3 3).

5 New turmeric and ginger varieties

Based on the cumulative yield and quality performance of the past 3 years, two new high curcumin turmeric varieties and a new high yielding good quality ginger line was proposed for release (Table 3 4 and 3 5).

6 Evaluation of high curcumin turmeric lines

Ten high curcumin turmeric lines were evaluated for fresh yield at Peruvannamuzhi. Four of these lines were also evaluated at Coimbatore. It may be mentioned here that out of the 10 lines only 2 lines (Acc.109 and Acc.126) were found to be consistent in performance with respect to curcumin content of about 7 per cent. The lines differed significantly for fresh yield/bed. Acc.44 ranked first with 17.87 kg rhizomes / 3 m^2 bed.

7 Multiplication of 'Alleppey turmeric' and A.P. collections of turmeric and ginger

Sixty-two accessions of Alleppey turmeric collected from Muvattupuzha and adjoining areas during 1992 were multiplied for further evaluation, in addition to the multiplication of 39 turmeric accessions and 11 ginger accessions collected from Andhra Pradesh during 1993.

8 Open pollinated progeny raising in turmeric

Open pollinated seeds from 28 accessions were collected and sown. Germination has been observed in 10 of the accessions.

9 Multiplication of wild species of *Curcuma*

Twelve large bulb species *Curcuma* were multiplied and dry recovery recorded. The same are being analyzed for curcumin content. Dry recovery of these 12 accessions are given in Table 3 6. These accessions are characterized by very big mother rhizomes and very few fingers. The dry recovery varied from 22 (Acc.469) to 33.5 per cent (Acc.459).

Table 3 1 Yield and dry recovery of ginger at different locations

Accession Number	Mean fresh yield kg/ 3m² bed					Dry recovery			
	Peruvanna muzhi	Muvattu-puzha	Ambala-vayal	Peechi	Niravil puzha	Peruvanna muzhi	Ambala vayal	Peechi	Niravil puzha
51	9.5	9.43	6.28	7.17	11.08	19.5	24.0	24.0	16.0
64	11.17	11.5	7.38	9.83	11.0	21.0	23.0	24.0	20.0
141	9.83	9.83	6.78	8.00	10.0	20.5	18.00	20.0	19.0
251	12.33	8.17	6.09	8.83	9.47	20.0	23.0	19.0	19.5
222	10.17	8.0	5.17	7.83	6.92	20.5	22.0	22.0	22.0
63	10.83	9.0	6.87	7.67	10.83	18.5	21.0	17.0	14.0
151	11.0	9.27	6.30	8.17	8.10	20.0	19.0	24.0	20.0
53	11.0	10.33	6.41	9.83	9.60	20.0	15.0	20.5	19.4
11	10.6	9.0	6.47	7.17	9.67	17.5	14.0	20.5	19.5
249	10.1	10.0	6.00	8.33	9.16	17.5	17.0	20.5	20.5
65	9.83	10.5	5.33	7.33	11.0	20.0	20.0	21.5	20.0
250(Himachal)	10.17	10.5	6.10	8.16	10.23	21.0	22.5	25.0	21.4
293 (Suprabha)	11.17	9.67	7.25	7.83	11.28	18.5	15.0	19.0	15.1
295 (Maran)	10.17	8.83	7.23	9.0	7.36	21.5	19.0	20.0	22.2
252 (M'puzha)	11.0	8.83	6.70	8.16	7.83	20.0	16.0	19.0	19.27
CD	0.62	0.51	0.54	0.745	0.90				
CV	47.88	17.19	11.27	12.1	12.6				

Table 3 2 Yield of promising ginger accessions at two locations

Accession Number	Fresh yield kg / 3m²	
	Peruvannamuzhi	Ambalavayal
101	12.5	6.91
215	12.17	4.94
226	10.83	5.70
293	10.83	5.97
238	10.33	5.10
106	10.83	6.45
231	10.33	5.32
74	9.0	5.13
2	11.67	5.08
179	10.83	4.88
117	12.3	5.38
CD	0.90	0.696
CV%	11.26	12.11

Table 3 3 Yield and dry recovery of open pollinated progeny lines of turmeric and controls at different locations

Acc. No.	Mean fresh yield / 3 m²					Dry recovery				
	Peruvanna muzhi	Muvattu puzha	Coim-batore	Mothe r	Finger	bulk (computed)	Coimbato re bulk	Muvattu puzha bulk
366	19.33	15.83	24.0	21.75	11.5	16.6	18.17	20.0
364	22.83	19.0	19.33	23.5	11.25	17.37	14.0	15.5
363	23.67	16.0	15.0	16.5	11.5	14.0	14.0	14.5
360	15.78	15.17	20.33	24.0	17.0	20.5	20.6	19.5
367	15.63	19.30	18.67	26.5	18.0	22.25	20.0	15.5
361	16.17	19.83	23.33	23.25	14.0	18.62	22.0	21.1
358	22.33	17.90	14.67	16.0	8.5	12.5	12.0	22.2
Suvarna	17.67	15.67	18.33	26.0	20.0	22.0	15.17	22.2
Suguna	25.0	22.0	9.67	18.0	10.5	14.5	13.0	14.1
Sudarshana	23.50	23.67	11.33	17.0	10.5	13.75	14.0	16.1
Alleppey	12.50	16.0	22.0	22.75	17.5	20.53	18.1	17.0
PTS-10	-	18.67	23.67	-	-	-	20.0	16.0
CD (0.05)	1.70	1.77	1.13					
CV(%)	9.82	11.43	7.21					

Table 3 4. The salient features of new turmeric varieties.

Identity	Breeding method	Average yield(t/ha)*	Maturity (days)	Dry recovery(%)	Curcumin %	Curcumin (kg / ha)
Acc.360	Open pollinated	35.67	200	19	7.2	432..95
Acc.361	progeny selection	38.6	198	180	7.0	423.00

Table 3 5 The salient features of new ginger variety.

Iden-tity	Breeding method	Average yield(t/ha)	Maturity (days)	Dry recovery (%)	Edible oil (%)	Crude fibre (%)	Oleor-esin (%)
Acc. 64	selection	27.0	200	19.9	1.8	3.95	6.0

Table 3 6 Dry recovery of wild *Curcuma* species

Acc.No.	Dry recovery (%)
458	28.5
459	33.5
469	22.0
472	31.0
476	24.0
478	25.0
479	23.5
487	26.0
488	23.5
489	24.0
490	27.5
491	29.0

Collection, conservation, cataloguing and evaluation of tree spices germplasm

B Krishnamoorthy, J Rema and V S Korikanthimath

1 Collection and conservation

Germplasm collection surveys were made in Kanyakumari (Tamil Nadu) and Wynad (Kerala) districts. One elite nutmeg tree and two elite clove trees were located. Three morphological variants, (two dwarf types; one king clove type and three small leafed types) in clove and one floral variant in nutmeg were also identified in the Ashamboo hills, where clove was originally

introduced in the early 19 th century by the British.

One wild nutmeg type (*Myristica beddomeii*) from the Sugandhagiri forests of Wynad, seven new nutmeg collections, four *Cinnamomum verum* types and twelve *C. malabaricum* types, two allspice types were also the other important additions made. Thus the genetic resources of tree spices being conserved in the germplasm conservatory is given in Table.3 7.

Table 3 7 Genetic resources of tree spices

Crop	Number of Accessions			
	Exotic	Cultivated	Wild and related	Total
Cinnamon and Cassia	14	192	56	262
Nutmeg	Nil	405	18	423
Clove	2	210	1	213
Allspice	Nil	137	-	137

Table 3 8. Morphological observations in 3 year old cassia plants

Characters	Range	Mean
Plant height (cm)	40-340	159.4
Plant canopy width (cm)	5-90	41.3
No. of main branches	1-3	1.1
No. of secondary branches	1-19	7.3
Girth (mm) at 40 cm above ground level	1.5-10	4.8

Cassia cinnamon

A gene pool of 32 cassia plants were maintained. Morphological observations in 3 year old cassia plants were recorded and they are presented in Table 3 8.

Cinnamon

The yield evaluation trial of elite cinnamon lines was maintained. Table 3 9 indicates the performance of clonal progenies of the nine elite lines during 1994.

Table 3 9 Performance of clonal progenies of cinnamon elite lines (1994)

Elite line No.	Height (cm)		Total no. of branches		Fresh bark weight (g)		Dry weight of bark (g)		Recovery(%)	
	Mean	CV %	Mean	CV %	Mean	CV(%)	Mean	CV(%)	Mean	CV(%)
5	105.7 (7)	50.1	3.3 (7)	48.5	42.5 (2)	58.4	25.0 (2)	84.8	53.3	35.5
44	157.9 (19)	32.8	4.8 (19)	58.3	82.9 (12)	50.4	39.2 (12)	50.5	46.8 (12)	11.1
53	205.3 (19)	33.3	6.6 (19)	36.4	144.7 (18)	77.3	69.4 (18)	73.9	46.4 (18)	13.6
63	239.8 (20)	17.1	9.2 (20)	26.1	210.8 (19)	54.0	100.3 (19)	57.6	47.9 (19)	16.3
65	246.6 (19)	19.0	8.1 (19)	44.4	257.4 (19)	46.2	120.3 (19)	47.7	46.5 (19)	7.7
189	268.2 (19)	27.2	7.3 (19)	38.4	317.5 (16)	61.1	135.3 (16)	59.7	42.6 (16)	10.8
203	231.8 (19)	29.2	6.7 (19)	44.8	163.8 (16)	56.3	75.6 (16)	63.5	44.5 (16)	13.0
310	153.0 (15)	45.6	6.1 ((14)	60.7	122.5 (8)	86.7	54.4 (8)	85.7	45.0 (8)	12.2
312	191.9 (13)	36.5	5.5 (13)	61.8	143.3 (6)	51.6	65.0 (6)	51.1	47.1 (6)	10.6

(Figures in parentheses indicate the number of progenies/elite line studied)

Maximum dry bark weight per plant (135.3g) was recorded by In 189 followed by SL 65(120.3g)

Table 3.10 Performance of elite clove progenies at Peruvannamuzhi

Elite line No.	Height (m)		Max.canopy width (m) at 1 m. height		Girth at 40 cm. (mm)		No.of main stems		No. of branches	
	Mean	CV (%)	Mean	CV (%)	Mean	CV (%)	Mean	CV (%)	Mean	CV (%)
K-6	1.78	30.3	1.03	39.8	4.78	31.8	1.00	-	23.50	69.2
B-76	2.65	34.7	1.41	41.8	7.25	39.7	1.00	-	28.10	43.3
B.95	3.04	27.3	1.74	37.4	9.05	27.5	1.13	31.0	31.75	44.7
B.59	3.13	14.1	1.64	18.9	9.61	23.3	1.00	-	33.80	32.1
C	2.94	18.0	1.68	14.9	7.98	23.7	1.25	56.8	33.00	18.8

Clove - progeny evaluation trials

Fourteen elite lines planted at Calicut (Chelavur campus) and another progeny evaluation trial with 14 lines with a control are being maintained. Table 3.10 gives the data regarding various growth characters recorded on 2 Kallar and 2 Burliar elite clove progenies along with control. This trial was laid out in a arecanut plot at Peruvannamuzhi during 1992.

Germplasm evaluation

Zanzibar clove (Acc.180) outyielded the other accessions. Table 3.11 gives the quality parameters of 24 accessions.

Nutmeg

Fifty per cent of the 106 nutmeg grafts of the clonal progenies of nutmeg selection A-11 / 170 planted during 1992 started flowering during 1994.

Germplasm evaluation

Accession No.A-9/79 recorded the maximum yield of 534 fruits/tree with a total fruit weight of around 30 kg. Maximum single fruit weight of 103.8 g was recorded by Accession No. A9/150. Per nut weight was maximum (25.9 g) in Accession No.A11/42. Maximum mace weight/fruit (5.2 g) was observed in A9/1.

Immature fruit drop in nutmeg:

Immature fruit fall was found to be maximum in May (30.5%), followed by April (26.9%) in the germplasm conservatory. The fruit fall was 100% in Accession No.A9/28. Out of 33 accessions studied, 32 recorded more than 30 per cent fruit fall, indicating the severity of the problem in nutmeg germplasm conservatory. A mean fall of 189 immature fruits/tree was observed with a range of 44 to 600 with the coefficient of variation of 73.6 per cent. Inducing flowering/fruit set in allspice:

Drenching paclobutrazol 1g. a.i. (4 ml of cultar, a suspension concentrate containing 250 g paclobutrazol / l) gave profuse flowering.

Table 3.11 Quality analysis of clove accessions (93-94 harvest)

Accession No.	Bud oil (%)	Eugenol (%)	Eugenyl acetate (%)
1	15	61	24
39	13.4	65	21
40	13	83	6.4
42	18	61	20
43	18	61	20
45	19	68	15
46	16.6	74	-
47	14.3	61	20
49	15	74	10
50	18	59	23
69	14	88	7.8
70	13	71	19
79	14	71	20
82	12	71	23
83	14	69	19
112	18.5	72	15
119	14	65	20
134	17	75	15
135	20	66	20
155	11	NA	NA
169	14	71	20
178	18.5	74	NA
180	19	62	24
189	15.2	72	18

Vegetative propagation of tree spices

J Rema & B Krishnamoorthy

1 .Allspice

Layering : Layering was carried out at bimonthly intervals on the terminal shoots in allspice using seradix and a combination of NAA and IBA. The combination of NAA and IBA at 4000 ppm aided in the production of adventitious roots.

Approach grafting : Approach grafting was carried out in allspice in mature and seeding using two different root stocks viz. 2 year old allspice and 1 year old *Eugenia jambolana*. No graft union was observed up to 8 months after grafting. however, a pseudo union was observed on Eugenia jambolana root stock.

Budding : Dormant buds of allspice was patch budded on to 3 year old Eugenia jambolana. No bud take was observed.

2. Nutmeg

Budding : Forket and patch budding was carried out bimonthly intervals on cultivated and wild (*Gymno uanthera*) species of nutmeg. Bud union was observed in 30-45 per cent of the plants. However, bud sprout is yet to be observed.

In situ grafting : A trial on in situ grafting in nutmeg was undertaken to improve the existing method of epicotyl grafting.

3 Clove

Field evaluation of approach grafts of clove : 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.

4 Cinnamon

Biochemical constituents and their relation to rooting

Variation in rooting percentage were observed in five5 Sri Lankan accessions of cinnamon, Biochemical parameters such as nitrogen, carbohydrates reducing sugars, non reducing sugar, total phenols and amino acids were analyzed to study their changes while rooting of cuttings and to work out their relation to rooting.

Breeding for high yield and resistance to *Phytophthora* and nematodes in black pepper

B Sasikumar P N Ravindran, Johnson K George and R R Nair

Yield evaluation trials :

The existing yield trials (CYT.II, CYT.III & CYT.IX) were maintained. Observations on fresh weight of the berries were recorded from CYT.III & CYT.IV.

At the high altitude trial at Valparai, (1067 m above MSL, hybrids 34, 105, 728, 769, 778 and 813 were found promising. Observations on various reproduction characters and yield are recorded (Table 3.12).

Table 3.12 Reproductive characters and yield of promising hybrids of black pepper at Valparai

Hybrid	Mean spike length (cm)	Mean no. of fully developed berries	Mean no. of half developed berries	Mean no. of pin heads	Max. no. of berries in a spike	100 berry wt (g)	100 berry vol. cc	Mean yield / vine	Dry* recovery (%)
34	13.02	60.60	10.0	6.28	78.0	9.26	8.50	1.83	39.5
105	11.05	59.56	2.44	9.52	82.0	9.60	9.0	2.29	36.7
728	10.77	63.70	6.12	3.44	92.0	7.35	8.0	1.05	32.0
769	13.06	47.20	4.44	5.80	62.0	12.4	12.0	-	39.0
778	11.64	48.65	5.28	9.80	78.0	5	10.0	-	38.2
813	10.90	45.0	6.20	7.96	56.0	9.11 11.60	11.0	1.66	34.80

* Sun dry basis

Observational trial on black pepper grafts : An observational trial on black pepper grafts wherein three different scion materials viz. laterals, runners and orthotropic shoots of two different black pepper varieties viz. Panniyur-1 and Karimunda grafted on to two different root stocks viz. cuttings and seedlings of *Piper colubrinum* was laid out.

Studies on OP progenies of bold berried P. nigrum cultivars : About 500 seedlings each of the two bold berried accessions viz. 'Vadakkan' and 'Perumkodi' were raised. Seedlings of 'Vadakkan' exhibited wide morphological variation where no such variation was observed in the progenies of 'Perumkodi'.

Intervarietal hybrids : Eight intervarietal hybrids involving the triploid cultivar 'Vadakkan' and female parent were attempted.

Breeding cardamom for high yield and resistance of Katte disease.

Ravindra Mulge, M.N. Venugopal

Evaluation of selections in MLT

In MLT-1, five Mysore type selections are being assessed for growth and yield parameters along with CCS-1 & CL-37 as local checks in RBD trial with 4 replications. Among the entries, total number of tillers per plant, number of bearing tillers per plant, height of the tallest tiller and number of leaves per plant did not differ significantly.

In MLT-2, 13 Malabar type entries are being assessed for growth and yield parameters along with CL.37 and Malabar bulks as local checks in RBD trial with 3 replications. Entries differed significantly (at P=0.01) among themselves for

total number of tillers per plant, number of bearing tiller per plant, height of the tallest tiller and number of leaves per plant (Table-3.13).

Evaluation of Hybrids

Six hybrids (including reciprocal crosses) along with four parents and one local check are being assessed for growth and yield parameters in RBD trial with 4 replications. Among the entries total number of tillers per plant and number of leaves per plant did not differ significantly. Number of bearing tillers per plant (at p=0.01) differed significantly among the entries (Table 3.14).

Hybridization between selections

A total of 140 plants are derived for eight cross combinations using selected parents. These seedlings are being maintained in poly bags to plant them in main field in the ensuing planting season.

Table 3.13 Morphological parameters observed in entries of MLT-2

Entry	Total tillers/ plant	Bearing tillers/ plant	Plant height (cm)	No. of leaves / plant
872	26.5 (5.19)	4.93 (2.32)	154 (12.41)	144 (11.94)
893	20.1 (4.51)	2.93 (1.84)	151 (12.31)	141 (11.81)
800	51.7 (7.03)	6.53 (2.52)	158 (12.49)	213 (14.28)
Cl.679	23.9 (4.75)	3.93 (2.05)	169 (12.95)	179 (12.99)
Cl.683	18.3 (4.17)	3.00 (1.81)	158 (12.59)	96 (9.49)
Cl.726	22.5 (4.76)	2.33 (1.65)	125 (11.18)	138 (11.74)
MUD-1 (P1)	4.6 (2.25)	0.80 (1.11)	141 (11.58)	28 (5.25)
PV-1	42.1 (6.47)	6.33 (2.59)	185 (13.59)	250 (15.67)
SKP 14	29.6 (5.41)	5.53 (2.43)	163 (12.77)	177 (13.15)
SKP 72	30.9 (5.58)	8.20 (2.93)	187 (13.63)	299 (17.01)
SKP 21	34.4 (5.91)	8.93 (3.07)	224 (14.89)	342 (18.42)
SKP 100	34.1 (5.79)	4.50 (2.23)	158 (12.58)	168 (12.82)
MCC 34	12.2 (3.42)	1.93 (1.46)	120 (10.95)	62 (7.55)
Cl.37 (sd)	33.1 (5.78)	9.93 (3.17)	202 (14.18)	301 (17.17)
Mal. Bulk	33.7 (5.85)	8.00 (2.90)	180 (13.42)	247 (15.68)
F test	**	**	**	**
SEm+-	0.263	0.252	0.614	1.348
CD(0.05)	1.43	0.73	1.78	3.91

** significant at P = 0.01

Note: ANOVA performed after square root. transformation and values in parentheses are sqare root. transformed values.

Screening of `Katte' resistant plants

Screening of `Katte' resistant plants for field resistance was continued in the center's sick plot and in 3 different hot spots. Sixteen clonal accessions continue to show resistance to natural infection. Mild breaking symptoms were noticed in 3 accessions (NRE-16, NKE-71 & NKE-28) which was not observed in subsequent leaves. Back indexing showed that three entries are free from virus infections. Selfed and OP progenies have been raised from all these 16 clonal accessions and screening against `Katte' is under progress.

Comparative yield evaluation of `Katte' resistant plants

In the on-going yield evaluation trial all the 16 promising `Katte' resistant plants are being evaluated in comparison with local cultiver and two pre-release selections. In the first year's crop 11 accessions of `Katte' resistant plants yielded significantly superior over local Malabar cultivar. In these 11 accessions the mean yield/plant varied from 1500 g to 2027 g compared to 1158 g in local Malabar cultiver.

Table 3 14 Morphological parameters observed in entries of hybrid trial

Entry	Total tillers / plant	Bearing tillers / plant	Plant height (cm)	No. of leaves / plant
800 x EB	35.0	5.65 (2.45)	175 (13.23)	213
872 x EB	29.7	4.70 (2.19)	150 (12.25)	219
893 x EB	23.0	2.70 (1.75)	138 (11.72)	150
EB x 800	40.4	6.35 (2.59)	180 (13.42)	308
EB x 872	34.5	4.90 (2.28)	177 (13.31)	234
EB x 893	30.0	3.40 (1.93)	157 (12.53)	187
800	37.5	5.60 (2.45)	207 (14.37)	246
872	36.1	4.10 (2.14)	157 (12.55)	230
893	33.0	3.70 (2.04)	167 (11.95)	217
EB (suckers)	39.1	6.50 (2.61)	157 (11.52)	224
Cl. 37 (sd)	39.1	5.85 (2.48)	192 (13.54)	245
F test	NS	*	**	NS
SEM+-	0.373	0.189	0.367	0.975
CD (0.05)	-	0.5	1.06	-

NS : Not significant
* : Significant at P = 0.05
** : Significant at P = 0.01
Note: ANOVA performed after sqare root. transformation and figures in parentheses are square root. transformed values.

Cytogenetic investigations in black pepper and related taxa

R Ramakrishnan Nair

Indexing of chromosome number of 96 accessions of black pepper was done. All except 3 accessions were found to show a somatic chromosome number of 2n=52. One accession (Acc.656) showed a somatic chromosome number of 2n=104.

A new tetraploid (2n=104) of Panniyur-1 was produced by treating the seedlings of Panniyur-1 cultivar with colchicine for 24 hours (root dipping in colchicine solution).

Quality evaluation in spices

T .John Zachariah and N K Leela

Turmeric

Location studies in turmeric : Turmeric accessions cultivated at Muvattupuzha, Calicut and Coimbatore were compared. The details are given in Table 3 15.

Table 3 15 Location studies on curcumin content

Accession Number	Curcumin (%)			Difference (%)
	Calicut	Moovattupuzha	Coimbatore	
360	7.0	7.0	5.5	21
361	7.1	7.2	4.5	38
352	6.7	7.2	5.6	16
364	6.8	5.3	4.8	29
Suvarna	3.5	3.0	2.3	34
Suguna	5.8	5.5	4.4	19
Sudarshana	6.0	5.4	4.6	19

Evaluation for curcumin content : About 150 accessions from germplasm, North East collections, North East (aromatica) and general selections from Peruvannamuzhi farm were evaluated for its curcumin content. About 14 accessions were found to contain more than 7% curcumin. Accn. 290 and 351 contained 8% curcumin. Accn. 360 and 361 had 7% curcumin. It had about 11% oleoresin.

Ginger: Among the accessions cultivated at Moovattupuzha and Calicut which were evaluated for crude fibre Accns. 64, 250, 226 and 106 contained relatively low fibre (about 3%). Accession 71 contained 11% oleoresin with 2.9% essential oil.

Cardamom

Among the segregants evaluated for oil and quality ASH-A-MB 37, ASH-A-V-2 and ASH-B-B-1 contained about 9% oil. As the quality is indicated by the terpinyl acetate, ASH-A-E-7, ASH-C-MB 39 contained about 50% terpinyl acetate and 30% cineole.

Clove

Among the samples from Peruvannamuzhi no.135 contained 20% volatile oil and no.69 had 88% eugenol in the oil. Other high oil accessions are no.45 and 180 (19%).

Micropropagation of black pepper

J Rema, K Nirmal Babu, Johnson K George and B Sasikumar

In vitro plant regeneration of economically-important _Piper_ species

The relative effectiveness of different explants on in vitro regeneration of four economically-important piper species viz. P. nigrum L., *P. betle* L., *P. longum* L. and *P. chaba* Hunt. in Woody Plant Medium was studied.

Response of species : All the species studied responded readily to WPM supplemented with BA 3 mg/l and Kinetin 1 mg/l. In vitro regeneration through direct and indirect organogenesis was observed from shoot and leaf explant. The four species showed variation in their degree of response to the media. However, *P longum* was quick to respond where as the response of *P. nigrum* was slow.

Morphogenetic response of explants:

Leaf

Among the four species, leaf explants of *P. longum* was best to respond. In this species, there was direct development of shoot primordia (50-100 nos.) from the leaf margin without callus formation. Indirect regeneration was also observed from the cut surface touching the media. Tender leaves of *P. betle* with a portion of the petiole intact was ideal for plant regeneration, shoot formation was observed in 65% of the cultures through direct organogenesis giving rise to 10-12 plantlets. The response of P. nigrum was relatively poorer when compared to P. betle. After 3-5 subcultures into the same medium (90-150 days), there was regeneration in 15% of the cultures, the number of shoots ranging from 2-10. The response of *P. chaba* was similar to that of *P. longum* except that the regeneration efficiency was lower (20-40 shoot primordia in 45 days).

Shoot

As in the case of leaf explants, the shoot explants of P. longum was quick to respond. Callus development was observed in 70% of the cultures within 20-30 days and organogenesis in the form of numerous shoot primordia (10-100 nos.) was obtained from the callus cultures. Direct organogenesis was observed in 30% of the cultures. The response of *P. chaba* was similar to that of P. longum. The response was slower

and the regeneration efficiency (5-15 shoots) was low. Direct regeneration was observed from shoot explants of P. nigrum, the number of shoots ranging from 6-10 within a period of 60-90 days. Multiple shoot formation was observed in *P. betle* without callus formation in 50% of cultures while in the rest there was callus development and subsequent organogenesis. The number of shoots ranged form 5-10.

Root

The in vitro grown roots of *P. nigrum*, *P. betle* and *P. chaba* did not respond to the medium. Regeneration was observed in the roots of *P. longum* in 40 days.

Regeneration of black pepper callus

Callus was induced from leaf, stem and petiole of seedling explants of black pepper. Regeneration of plantlets was obtained from all the explants in WPM supplemented with BAP and Kinetin. The plantlets were rooted in hormone free WPM. The rooted plantlets were hardened and transferred to soil.

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

In vitro grafting of P. nigrum on P. colubrinum: *In vitro* grafting of *P. nigrum* was successfully done on rooted plantlets of *P. colubrinum* grown. In vitro grown P. nigrum shoot were wedge grafted on to decapitated *P. colubrinum* shoots and grown in vitro for 2 weeks for successful graft union.

Tissue culture for rapid multiplication of elite clones of cardamom.

Ravindra Mulge and M N Venugopal

For assessing the mosaic virus resistance, yield and quality parameters of somaclonal plants, 100 plants are being maintained in the field. In glass house 237 somaclonal plants derived from callus of CL.37 x PVI are being screened for mosaic virus resistance. Shoot tip and rhizomes of 6/13 and CCS-1 are being induced for callus formation.

In vitro selection for resistance to soft rot and bacterial wilt in ginger

K Nirmal Babu, T G N Rao, G N Dake and N K Leela

Field evaluation of somaclones:

Over one hundred somaclones were evaluated in pot culture experiment for yield and six lines were promising.

Multiplication of disease escapes:

Twelve lines viz. 47-4, 51-1, 61-9, 63-1, 70-3, 70-4, 72-4, 73, 75-4, 81-2, 85-4, 99 and 5 lines viz. 51-3, 53-3, 64-4, 67-3, OCP-1351 which were identified as disease escapes for *Pythium aphanidermatum* and *Pseudomonas solanacearum* respectively were multiplied in nursery for further screening.

Multiplication and maintenance of cultures:

Over 1000 cultures of ginger embryoids and organogenetic callus were maintained for routine screening and production of somaclones.

Field establishment of somaclones:

Fifty lines of somaclones were transferred and established in soil (poly bags)

Isolation of toxin from culture filtrate of Pseudomonas solanacearum :

The culture filtrate from *P. solanacearum* was reduced to 1/10 of its initial volume and extracted with ethyl acetate (thrice). The ethyl acetate fraction yielded a white solid and an oily material upon evaporation under reduced pressure. White solid material did not show toxic symptoms in vivo assays. But the oily material showed toxicity. However, further studies could not be taken up because of the poor yield of this material

SUPPORTIVE RESEARCH PROGRAMME

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 ,M N Venugopal and R Hegde

For transferring high production technology of pepper in farmers fields ten plots at Peruvannamuzhi were selected. Bench mark survey was carried out for assessing the input requirements which will be supplied and monitored during the onset of monsoon.

Adoption of high production technology was monitored both in mono and mixed cropping of cardamom with coffee(Robusta and Arabica), arecanut and coconut. Intensive cultivation of cardamom in Home stead was taken up. Conversion of low lying lands for profitable cultivation of cardamom was monitored. Based on the yield obtained economic returns were worked out. The economic analysis and the labour employment opportunities are worked out in the above on farm trails. The pest and disease were also monitored in the fields.

Production of parental materials and breeders stock of Spices

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

Black pepper

About 2.75 lakh rooted cuttings of released 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 also supplied to progressive farmers.

Cardamom

Over 300 kg of cardamom seed capsules from elite lines from Cardamom Research Center,

Appangala and 1200 kg from Research cum demonstration plots at Coorg were supplied to developmental departments and farmers. Twenty six thousands cardamom seedlings distributed to farmers. Totally 1500 clonal material(Suckers) from CCS-1 and other elite lines were raised for supplying to farmers and for mass multiplication through tissue culture.

Turmeric

About 30 tonnes of seed rhizomes of improved varieties of turmeric viz., Suvarna, Suguna, Sudarshana and Alleppey were distributed as nucleus planting materials.

Tree spices : Twenty three thousand eight hundred seedlings / grafts were produced and distributed.

Training of extension and research workers

Johnson K George, M.N.Venugopal and C K Thankamani

Printing and distribution of annual training programme schedule

The training programme schedule was printed and distributed to various extension and developmental agencies of different states and union territories and to universities having centres of All India Coordinated Research Project on Spices.

Conducting training programmes

Two training programmes were organized at Calicut. The duration varied from 1-6 days. Sixteen officials sponsored by agricultural/ horticultural departments of different states and union territories were participated in training programmes.

Table 4 1 programmes conducted during 1994-95.

Title of training	Duration	Venue	No.of participants
Spices production technology	21-26 Nov '94	Calicut	4
On farm processing of spices	8 -9 Feb '95	Calicut	3
Nursery Management in Spices	14 - 15 Feb '95	Calicut	9

ICAR AP CESS FUND SCHEMES

1 BIOLOGICAL CONTROL OF SCALE INSECTS INFESTING BLACK PEPPER

S Devasahayam, S Selvakumar and Mini Kallil

1 Survey for collection and identification of natural enemies of scale insects

Surveys were carried out in Wynad (14 locations) and Idukki (18 locations) districts of Kerala and Coorg (12 locations) district of Karnataka during December 1994 and March 1995 to record the incidence of natural enemies of scale insects of black pepper. Severe infestations of *Aspidiotus destructor* were observed in most of the locations viz. 12, 12 and 9 locations in Wynad, Idukki and Coorg districts respectively. Infestations of *Lepidosaphes piperis* were observed in some locations viz., 5, 3 and 3 locations in Wynad, Idukki and Coorg districts, respectively.

The natural enemies recorded on both the species of scale insects from all the districts surveyed include *Pseudoscymnus* spp. (Coccinellidae), *Chilocorus circumdatus* (Coccinellidae), *Pharoscymnus horni* (Coccinollidae), *Cybocephalus* sp. (Nitidulidae) and *Encarsia lounsburyi* (Aphelenidae). *Mallada boninensis* (Chrysopidae), *Lestodiplosis* sp. (Cecidomyiidae) and *Karnyothrips melaleucus* (Phlaeothiripidae) were recorded from Wynad district, the former two being new records of predators of scale insects of black pepper.

2 Biology of natural enemies

Preliminary studies on the life cycle of *P. horni* were completed. The egg, larval, prepupal and pupal stages were completed in 4-5, 9-10, 1 and 4-5 days respectively, during March-April. The feeding behaviour and potential of adult coleopteran predators was studied. Adults of *Pseudoscymnus* sp.(1), *Pseudoscymnus* sp. (2) and *C. circumdatus* fed on 28-44, 36-38 and 40-75 individuals of *A. destructor* per day. *P. horni* predated on 3-9 individuals of *L. piperis* per day.

3 Standardization of techniques for mass culturing of scale insects and their natural enemies.

Twelve plant materials viz., pumpkin (*Cucurbita moschata*), serpent melon (*Cucumis sp.*), green lemon (*Citrus* sp.), sweet orange (*C. sinensis*), bottle gourd (*Lagenaria siceraria*), ash gourd (*Benincasa lispida*), sweet potato (*Ipomoea batatas*), Colocasia (*Colocasia esculenta*), elephant foot yam (*Amorphophallus campanulatus*), potato (*Solanum tuberosum*), coconut leaflets (*Cocos nucifera*) and rooted laterals of black pepper (*Piper nigrum*) were evaluated for their suitability as host material for mass culturing *A. destructor*.

Among the plant materials evaluated, coconut leaflets, rooted laterals of black pepper and pumpkin were more suitable for the settlement, growth and multiplication of *A. destructor*. Cultures of *L. piperis* on rooted laterals of black pepper. *Aspiella hairdo* on turmeric rhizomes and *Unaspis* sp. on pumpkin were also initiated, the latter two which could serve as additional prey for the coccinallid predators.

2 The Parasitic Nematode, *Trophotylenchulus piperis* Mohandas, Ramana & Raski 1985 and its Interaction with black Pepper

K V Ramana, P Sundararaj and M S Mohammed Mustaffa

Seven districts in Kerala were surveyed for the incidence of *T. piperis* on black pepper. Out of 140 samples collected , the nematode was found in 65 samples (45.8%) with the population range of 24 - 248 nematode cases / g of roots.

Second stage larvae of *T. piperis* entered into the black pepper roots within three days after inoculation and formation of case started between 30 - 40 days after inoculation

Brownish necrotic region at the port of entry proved the involvement of phenolic substances and the total life cycle is completed between 50 to 55 days after inoculation *Glyricidia sepium* and *Artocarpus heterophyllus* are new hosts recorded for *T. piperis*

More number of cases are found on the fibrous roots than the main roots.

Population dynamics of the nematode is being monitored in a naturally infected black pepper garden

Pathogenicity of the nematode on black pepper is initiated.

DBT Funded research schemes

1 Rapid clonal propagation of tree spices

P N Ravindran, K Nirmal Babu, J Rema, Minoo Divakaran, Mini P Mathai, Sajina Adams and John C Zachariah

Cinnamon

Micropropagation of three species *Cinnamomum verum*, *C camphora* and *C cassia* were standardized. The micropropagated plantlets were hardened by transferring to soil - rite mixture keeping them in incubation room for a month and then establishing them in soil under nursery conditions. About 100 plants of *C camphora* have already been established in soil. Suspension cultures of *C verum*, *C camphora* and *C tamala* have been established for studies on production of secondary metabolites *in vitro*. "Synseeds" or artificial seeds of *C verum* and *C camphora* have been made by encapsulating shoot buds and calli in sodium alginate.

Clove

Standardization of micropropagation: *In vitro* rooting and multiple shoots have been induced

but the results are inconsistent. However multiple shoots up to 15 could be induced from a single node. Callus induction and regeneration studies : Callus could be induced and initial attempts led to development of morphogenetic calli and stress in the medium led to development of roots from callus.

Nutmeg

Attempts to induce multiple shoots as well as rooting has not yielded any results so far. Efforts are in progress to standardize a medium for nutmeg.

2 *in vitro* conservation of spices germplasm

(K V Peter, P N Ravindran, K Nirmal Babu, Geetha S Pillai and C Manjula)

Standardized cryopreservation method in black pepper and cardamom. Programmable freezer, cryocans and other accessories were procured and installed. Arrangements have been made to ensure regular supply of liquid nitrogen for cryopreservation experiments. Isolation and culture of meristem in cardamom and embryo I black pepper have been initiated for cryopreservation studies. Initial experimentation to cryopreserve black pepper embryos and cardamom seeds are under way. Standardization of slow growth method in ginger and turmeric. The method standardized for cardamom was suitable for ginger and turmeric. Based on these 24 treatments were imposed in ginger for further studies. Refined the existing slow growth method in cardamom. Further experiments were initiated for this in during 1994 and it was observed that modifying the culture medium by increasing 5 g l^{-1} each of sucrose and mannitol led to healthier growth of cultures and addition of glycerol induced slow growth but led to callusing of tissues. Cultures maintained under slow growth were transferred to normal multiplication medium and later to soil. Preliminary studies based on morphological and biochemical parameters to analyze the genetic stability of retrieved material has been initiated.

Collected *Piper schidti* , *P wighti*, *P mullasua*, and *P silentvaliensis* . Added six new additions in the *in vitro* repository. Cultures of seed and herbal spices, *Cinnamomum verum* and allspice are now maintained under slow growth conditions.

3 Development of Phytophthora resistance in black pepper through biotechnological approaches

Y R Sarma, M Anandaraj, Shaji Philip and M R Bindu

Protocols have been standardized to induce callus and regeneration into whole plants in 100 days. Callus initiation was noticed in 20-25 days, regeneration in 40-60 days and rooting in 30

days. The plantlets were hardened in polythene chambers for 10 days before planting in pots. Friable calli has been obtained in various culttivars. Standardization of protocols to obtain cell cultures are inn progress. Crude toxin has been obtained from all free culture filtrates and zoospore germination fluid and is being used for in vitro screening. Protocols have been standardized to isolate protoplasts from leaves of black pepper. The viable protoplasts showed multiplication and micro callus has been obtained. Isolation of protoplasts has been successful from *Piper colubrinum*.

4 Development of production and demonstration of biological control agents under integrated pest management

Y R Sarma, M Anandaraj and P Lakshmi

Cardamom

In Karnataka, cardamom nursery management for the control of rhizome rot was undertaken in four nurseries in Coorg district in collaboration with Spices Board. The seeds were treated with biocontrol agents and later the beds (4.5 x 1m) were treated with 100 g inoculum / bed as a basal application. The recovery of the plantable seedlings ranged form 66.6-78.4% compared to 57.8% in control.

Ginger

Biocontrol inoculum for the management of *Pythium aphanidermatum* was distributed to 40 farmers around Peruvannamuzhi for soil application.

Black pepper

Farmers Day / Seminars / Group meetings were conducted at Mercara, Chickmagalur & Saklespur in Karnataka, Pulpally in Wynad district and Peruvannamuzhi of Calicut district to explain the importance of biocontorol in managing *Phytophthora* foot rot. A programme on biocontrol in foot rot management in black pepper was telecast from Doordarshan on 20 th July 1995.

Nursery management:

Nursery mixture with *Trichoderma hamatum, T. harzianum* and *Gliocladium virens* cultured on sorghum/coffee bark has been used to raise nucleus planting material. About 1.5 lakh rooted cuttings were then treated (calculated area 95.00 ha).

Preplant application

Biocontrol inoculum of *T. hamatum, T. harzianum* and *G. virens* was applied to the planting pits along with FYM. About 20 ha has been covered in pepper plantations in Kerala, Karnataka and Andhra Pradesh. The treated plants showed 90-95 establishment and were

robust. Field application of biocontrol inoculum was carried out in farmers' field. About 60 ha has been covered so far during the year.

COLLABORATIVE PROJECT

ICAR AP Cess fund project : Water requirement of multiple cropping system with spices

K V Satheesan (CWRDM Calicut) and A K Sadanandan

An automatic weather station to monitor the evapotranspiration and drought of pepper vine has been installed in a 5 ha plantation of seven year old pepper at Pulpally (Wynad district) the traditional pepper growing tract of Kerala. The meteorological techniques called Bowen ratio energy balance method to measure evapotranspiration is employed. Sensors to measure air temperature, vapour pressure at different heights of pepper canopy along with the sensors for direct measurement of radiation, wind speed, soil heat flux and soil temperature were used. The system is powered by an 18 watt solar panel. Weather parameters are automatically and continuously stored in a data logger from which it is retrieved using a storage module and fed to computer. Studies are in progress.

ALL INDIA CO-ORDINATED RESEARCH PROJECT ON SPICES

The AICRP on Spices is vested with a mandate to develop location-specific agrotechniques for sustainable spices production. A multi pronged approach is envisaged and research projects formulated to tackle pests and diseases. There are 67 projects and discipline wise distributions are 31 in Crop Improvement (including Genetic Resources), 11 in Crop Production, 5 in Quality Improvements and 14 in Crop Protection. The crop wise distribution of projects are pepper 8, small cardamom 6, large cardamom 3, ginger 7, turmeric 5, tree spices 6, seed spices 24 (coriander 7, cumin 6, fennel 6 and fenugreek 5).

1 GENETIC RESOURCES

1 1 Black pepper

The Yercaud Center collected 20 elite lines from Shevroys Hills. The Sirsi Center undertook a survey of the Terihalli forests, Honnavar & Karsur areas in search of germplasm, similarly the Chintapalli Center took up the survey in Tintada and Pontapadu areas. The work on evaluation of germplasm has been initiated at the Yercaud Center. At Panniyur, Karimunda-III gave a mean green berry yield of 2.17 kg/vine, followed by TMB-IV and Balancotta-1. Panniyur-1 continued to perform as the best variety in the Chintapalli zone, giving the highest yield of 4.17 kg/vine. The Panniyur, Sirsi, Chintapalli and Yercaud Centres maintained 76, 58, 46 and 106 accessions respectively.

1 2 Cardamom

Among the 72 accessions evaluated at Pampadumpara in IET, accession No.57 gave the highest yield of 507 g dry capsule/plant. Among the 195 accessions from Mudigere, CL-698 was found superior in sucker and panicle production. The Pampadumpara and Mudigere centres maintained 89 and 243 accessions respectively.

1 3 Ginger

At Pottangi, the mutant V_3S_1-8 gave the highest yield of 3.075 kg fresh rhizomes/3 m^2 plot. The Solan and Pottangi Centres maintained 132 and 138 germplasm accessions.

1 4 Turmeric

One more new accessions has been added in Pottangi center bringing the total to 191 which includes 20 wild and related species. Accessions No.6 gave the highest yield of 8.53 kg/3 m 2 at Pottangi. Among the 164 accessions at Solan Center, ST-616, ST-154, ST-330, ST-323, TC-4, ST-55 and ST-491 are promising. From Jagtial, entries PTS-24, PTS-383 and PTS-1 were found promising; besides, 22 accessions showed resistant reaction to *Taphrina* disease. The Pottangi, Jagtial and Dholi centres maintained

191, 188 and 58 accessions respectively.

1 5 Tree spices

The Yercaud center added 13 elite lines to their collections of clove.

1 6 Coriander

The Jobner, Jagudan, Coimbatore, Guntur, Hisar and Dholi centres maintained 683, 146, 372, 230, 58 and 100 accessions respectively. The promising entries identified from different centres were TG-400, from Jobner, LCC-25 from Guntur, DH-13 from Hissar and J.Co-45 and J.Co-126 from Coimbatore.

1 7 Cumin

The Jobner and Jagudan centres maintained 224 and 467 accessions. From the Jagudan center, 131 accessions were selected based on genetic diversity for further studies. The Jobner center recorded the highest yield of 4.1 q/ha from variety RZ-19. The entry JC-147 gave 7.68% higher oil content that the control.

1 8 Fennel

The Jobner, Jagudan, Hisar & Dholi centres maintained 139, 98, 44 and 56 accessions respectively. At Hisar, the accessions HF-71, HF-102, HF-104 and HF-119 gave better performance.

1 9 Fenugreek

The germplasm collections maintained at Jobner, Jagudan, Coimbatore, Guntur, Hisar and Dholi were 270, 47, 179, 70, 82 and 58 respectively. The promising germplasm identified were UM-124 & UM-144 from Jobner, HM-110, HM-129, HM-141 and HM-145 from Hisar and JF-10 from Coimbatore. At Guntur, 70 selections showed diversity in their performance. At Coimbatore, accession No.464 was identified as a superior line, giving an yield of 380 kg/ha in the IET. In CYT at Coimbatore, accession CF-390 gave the highest yield of 433 g/plot.

2 CROP IMPROVEMENT

Several MLTs are in progress viz. five in black pepper, two in cardamom and turmeric and one each in clove and ginger. In seed spices, the decisions of the Workshop were reinforced by the recommendations made during the Group Meeting (exclusively for seed spices) held in November 1992 (Coimbatore) and accordingly, a number of MLTs are in progress in all the 6 centres; Coriander, Fennel and Cumin in Jobner, Jagudan and Hisar and Fenugreek in Jobner, Jagudan, Guntur, Coimbatore and Hisar. In the case of fenugreek, a second MLT (1993-Series II) has also been initiated at Guntur, Coimbatore, Jobner and Jagudan centres.

2 1 Black pepper

At Panniyur in the intervarietal hybridization trial, cultures 5308, 4700, 5198 and 4563 performed well, producing more than 1 kg green berries/vine. In the MLT, Culture 1171 gave the highest yield of 1.14 kg green berries/vine. In the CYT, Karimunda and Panniyur-5 were promising.

2 2 Cardamom

The MLT III series (1991) laid out with Mysore types and Malabar types during 1993 have come to bearing this year.

2 3 Ginger

In the CYT at Pottangi, V_1E_8-2 was the top yielder with 18 t/ha at Pottangi center. At Solan, $V_1E_8$2, SG-692, SG-671 and SG-702 have given the higher yield than control viz. SG-666. In the MLT-III at Pottangi, V_2S_1-7 gave the highest yield of 15.3 t/ha.

2 4 Turmeric:

PTS-19 was the top yielder with an yield of 21.6 t/ha and 5% curcumin at Pottangi; among the 13 cultivars tested. In the CYT, however, PTS-19 gave an yield of 19.5 t/ha and topped the 6 entries tested. Accession No.PTS-43 was identified as the best (yield 25.31 t/ha) in the IET, followed by PTS-8 (23.23 t), PTS-59 (17.06 t) and PTS-15 (16.06 t). At Dholi, variety Sugandham gave the best yield of 38.79 t/ha in the IET. Cultivar Duggirala gave 17.83 kg/3 m 2 at Jagtial, followed by TC-2 (16.76 kg) and check Armoor (12.56 kg)

2 5 Tree spices

As a follow up of the group meeting on tree spices (May 15, 1992), the work has been initiated at Yercaud and Ambalavayal centres in 1992-93 and later at Pechipara and Thadiyankudissai. A MLT with 5 elite lines of clove has been laid out in Yercaud and Pechiparai. In Cinnamon, a MLT has been laid out with 5 promising lines at 4 centres viz. Yercaud, Ambalavayal, Pechiparai and Thadiyankudissai. In vegetative propagation of nutmeg, root stocks selected at 2 leaf stage gave the maximum percentage of success viz. 52.50%.

2 6 Coriander:

In the IET at Coimbatore, out of the 11 entries under evaluation, CC-745 an CC-748 recorded higher yields of 583 kg/ha which is 20.7% higher than the check viz. Co-3. At Guntur, the highest yield of 1050 kg/ha was obtained from ATP-147 whereas at Dholi, accession DH-38 was found most promising. Among the leafy types, Pant Dhania-1 gave the highest leaf yield followed by RCr-41. Accessions JCo-123 and CC-964 gave 6.37% and 10.34% higher yields respectively than Guj. Coriander-2 at Jagudan Center. At

Coimbatore, JCo-64 gave an yield of 683 kg/ha compared to 583 kg/ha of Co-3, a 17.2% increase. The MLT at Guntur center revealed that CC-964 gave the highest yield of 1078 kg/ha followed by ATP-77 giving 1025 kg/ha. In the evaluation of mutants at Coimbatore, the line 16/6 gave an yield of 550 kg/ha while Co-3 gave 517 kg/ha.

2.7 Fennel

At Jobner, accession UF-125 was identified as superior with high yield potential, earliness and dwarfness. The Hisar accessions HF-33 and HF-39 gave a maximum of 1.5% volatile oil as well as high yields.

2. 8 Fenugreek

CC-464 was found to be most promising with a yield of 380 kg/ha at Coimbatore. At Dholi and Hisar centres, HM-103 performed very well and gave maximum seed yield. At Jobner, the irradiated seeds which were put under an IET indicated that "40 Kr-3-4" gave 12.6 Q/ha and had less incidence of powdery mildew.

3 CROP PRODUCTION

3 1 Black pepper

At Panniyur center, the irrigation-cum-fertilizer trial with 2 varieties indicated that irrigation at IW/CPE ratio of 0.25 was found best for maximum yield. The cuttings soaked in 1% Potassium Sulphate for 12 hours gave 66% establishment at Thadiyankudissai.

3 2 Cardamom

Spacing of 0.3 m x 0.9 m increased the sucker production to 1.25 suckers/ha at Mudigere. The clonal material gave 37% more yield than seedlings material. Phosphobacteria applied @ 4 g/kg of soil gave highest number (3.6) of branches and in combination with *Azospirillum*, recorded still higher number viz. 9.0, as reported from Thadiyankudissai.

3 3 Tree spices

Hard wood cuttings of cinnamon gave high percentage of rooting (82.6%) when dipped in NAA 2500 at Thadiyankudissai. There was increase in tree girth, mean fruit yield and fruit girth (size) in nutmeg by application of Azospirillum and Phosphobacteria.

3 4 Ginger

At Pottangi center, an yield of 14.15 t/ha rhizomes was obtained at 125:100;100 kg NPK/kg. The profit was Rs.53,000/ per ha.

3.5 Turmeric

Intercropping bhendi with turmeric was

profitable at Dholi center; the ideal spacing for turmeric as monocrop being 30 cm between rows and 20 cm between plants. At Pottangi, soybean as intercrop after the first mulching has been recommended.

3 6 Coriander

Pendimethalin @ 1 kg/ha with one hand weeding gave a net profit of Rs.15,177/ha and a cost benefit ratio of 2.93 at Jobner center. Guntur center recommended DH - 5(from Hisar) for light soils in Andhra Pradesh.

3 7 Fennel

t Jobner, hand weeding done thrice in Fennel gave an yield of 1.02 t/ha and a net profit of Rs. 15177 / ha and a cost : benefit ratio of 3.35. In Hisaar, application of Pendimethalin (1 Kg/ ha) followed by one hand weeding 45 days after sowing gave maximum seed yield.

3.8 Fenugreek

Preplanting application of Fluochloralin @ 0.75 kg/ha plus one hand weeding gave maximum seed yield of 1.598 t/ha with a net profit of Rs.14,621/ and benefit cost ratio of 2.33. At Dholi, variety Rajendra Kanti gave the highest yield when sown on 26 October and at 20 cm x 10 cm spacing and at Hisar gave maximum yields obtained when sown on 5 November.

4 CROP PROTECTION

4 1 Black pepper

At Panniyur, the Phytophthora foot rot incidence was low in plots receiving 1 kg neem cake + 3 g Phorate + spraying 1% Bordeaux mixture + drenching with 0.2% Copper Oxychloride. Sirsi had similar results. At Chintapalli, Akomin treatment gave better results, when followed to neem cake + Phorate+ Bordeaux mixture; the treatments reduce disease incidence and defoliation. In biocontrol of this disease, *Trichoderma harzianum* inoculations reduced the disease incidence to 16%.

Nursery diseases at Pannniyur are controlled by Bordeaux mixture sprays. Stunted disease has been noticed in the Lower Pulneys of Tamil Nadu. Defoliation due to semilooper insect has been noticed in Chickmagalur district, Karnataka.

4 2 Cardamom

Selective thrashing during Feb. - March combined with insecticidal application controlled borer infestation. Spraying Monocrotophos controlled thrips at Mudigere, when followed after thrashing in Feb and May. Neem pesticides like Nemark, Nimbecidine are also useful in controlling the thrips.

4 3 Ginger

Seed rhizomes dressing with Indofil M-45 + bavistin recorded minimum disease incidence at Solan Center. Soil application with *Trichoderma harzianum* resulted in reducing the disease incidence.

4 4 Turmeric

PCT-10, PCT-13 and PCT-14 were free from rhizome rot disease in Jagtial center and gave 30 t seed rhizomes/ha.

4 5 Large cardamom

Cultivar Golsey was found to be tolerant to both Chirckey and Foorkey diseases of large cardamom. Anthracnose has been controlled by spraying Dithane M-45 (0.2%), Kavach (0.1%) or Cuman L (0.2%).

4 6 Cumin

A three year crop rotation with clusterbean-cumin-cluster bean - mustard gave the maximum yield of 257.59 kg/ha and wilt incidence of 36% as compared to 96.27 kg/ha and 57% disease in one year rotation.

4 7 Coriander

Seed treatment with *Trichoderma harzianum* @ 4 g/kg of seed reduced wilt. Neem cake @ 150 kg/ha also reduced wilt in Coimbatore. Coriander powdery mildew was controlled by foliar spraying with onion leaf extract (5%), among fungicides, Calixin was effective.

5 QUALITY EVALUATION

SG-710 ginger selection from Solan gave highest oil content. High volatile oil in cumin was from jobner and recommended for export purposes. The Jobner center has undertaken the analysis of seed spices received from all the centres.

KRISHI VIGYAN KENDRA

The Krishi Vigyan Kendra (KVK), for Calicut district is located at NRCS Experimental Farm, Peruvannamuzhi and is funded by the Indian Council of Agricultural Research (ICAR), New Delhi. It was established on 16 th November, 1992. During 1994-95, various training programmes were organized for farmers, rural youth and extension functionaries. Field days, conventions and exhibitions were also organized.

Five training programmes under crop production and three in horticulture were organized for farmers on various aspect of spices. Two trainings for rural youths in crop production and for extension functionaries, one in crop production and three in horticulture were also organized. One field day and two conventions were arranged for 17 and 25 participants, respectively. Three exhibitions were conducted and five radio talks delivered on various aspects of spices production technology. Front-line demonstration (FLD) on production technology of green gram for rice fallows was organized. Totally 612 participants attended 23 courses organized by KVK.

The KVK has linkages with the Department of Agriculture, Kerala, Spices Board, Cochin and Gandhi Smarak Grama Nirmana Samiti. These linkages help in organizing training programmes and implementation of various schemes of KVK.

Regarding infrastructure facilities, administrative building including seminar hall, the work is being taken up by the CPWD. The schematic plans are prepared by the CPWD for Home Science block, staff quarters and sheds for demonstration units. Two hectares of land are developed and horticultural/spice plants are planted in the Horticulture Farm.

COMPLETED PROJECTS

1 Investigations on plant parasitic nematodes associated with cardamom (Santhosh J Eapen and M N Venugopal)

Objectives

- To find out the plant parasitic nematodes associated with cardamom in different areas.
- To find out the role of plant parasitic nematodes, if any in the incidence of disease like 'Katte', clump rot, immature fruit drops, etc.
- To study the effects of nematodes on growth and yield of cardamom.
- To develop control measures against nematodes.

Technical Programme

a. Survey and collection of soil and root samples from different cardamom growing areas.

b. Identification of various plant parasitic nematodes associated with cardamom.

c. Studying the pathogenicity of nematodes on cardamom.

d. Studies on interaction of nematodes with other disease causing organisms of cardamom.

e. Screening of germplasm to locate resistance / tolerance to major nematode parasites.

f. Developing various pre sowing and post sowing control measures to manage nematode problems in cardamom nurseries and in fields.

A. Survey

Materials and methods

Random samples of soil (250 g) and roots (10-15g) were collected from nurseries and main fields of various plantations in Kerala, Karnataka and Tamil Nadu. Nematodes were extracted from soil samples and roots through standard methods and were identified to species level.

Results and discussion

Twenty five species of plant parasitic nematodes were found associated with cardamom (Table 1). The root knot nematode (*Meloidogyne incognita*) was detected in almost 98% of samples while *M. arenaria* was found only in Rajapalayam taluk (Tamil Nadu) and *M. javanica* in Chittoor and Wynad areas of Kerala State. Among these, *Radopholus similis* and Pratylenchus coffea were found in samples from mixed plantationsin Sirsi Taluk of North Kanara and Kodagu districts respectively. Other

economically important nematodes of common occurrence were *Rotylenchulus* spp. and *Helicotylenchus* sp.

B. Pathogenicity of *M. incognita* on cardamom

Materials and methods: A trial was laid out using monoclonal vegetative suckers of a cardamom accession (P_1). There were five treatments (O,100, 1000, 10000 and 100000), and ten replications. The design was RBD and observations on nematode multiplication, growth and yield were recorded at regular intervals. The final observations were recorded after five years.

Results and discussion: Monitoring of growth and yield of test plants revealed that significant reduction in number of tillers occurred six months after inoculation while the other parameters were mostly uniform in all the treatments. Highest reduction in the first year yield was noticed at Pi =10,000 followed by Pi =1000. The pathogenic effects were not correspondingly related to the initial nematode population. The cumulative damage and crop loss were maximum at lower initial populations and minimum at higher initial inoculum levels (Fig 1). Final observations showed that root knot nematode infestation, caused stunting and narrowing of leaves in cardamom plants. Apart from these, nematodes reduced the total biomass production, the most noticeable and early detectable being the reduction in number of tillers.

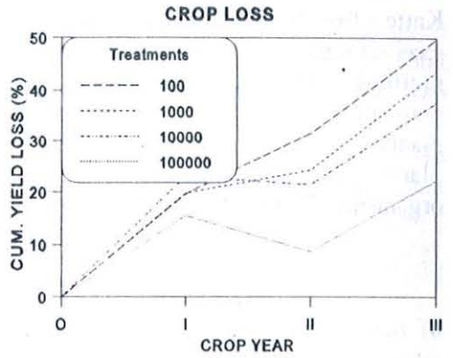

Figure 2: Effect of *M. incognita* on cardamom yield

C. Interaction Studies

a) Interaction between M. incognita and 'katte' virus.

Materials and methods

Samples from 'Katte' affected and 'Katte' free cardamom plants were collected and analyzed for nematode presence. A pot trial was conducted using uniform cardamom seedlings in which the plants were inoculated with *M.incognita* and 'Katte' virus in various sequences. Final nematode counts and disease symptoms were recorded after seven months.

Results and discussion

Root samples from Katte affected plants yielded

an average population of 416.7 root knot nematodes / g root, while this was only 64 in Katte - free (healthy) plants. All the plants that received Katte viruses exhibited the characteristic mottling symptoms on leaves. Highest population of *M. incognita* was recorded in plants pre infected with the virus, followed by plants infected simultaneously by both organisms. This study established that infection by virus increased the susceptibility of cardamom plants to root knot nematodes.

b) Interaction between M. incognita, Rhizoctonia solani and Pythium vexans

Materials and methods

The prevalence of damping off and rhizome rot diseases in the nematode infected nurseries was studied in a survey of four districts of Karnataka. Diseased cardamom seedlings (6-21 months old) were removed with intact roots at random from each nursery site for assessing nematode population and for isolation of fungi. Two separate trials were conducted to study the interaction between *M. incognita* and *Rhizoctonia solani* and *M. incognita* and *Pythium vexans*. Nematodes and fungi were inoculated alone and together in various sequences. Four field trials were conducted in nurseries of Spices Board and that of the research center at Appangala to evaluate the effect of post sowing application of different fungicides alone and in combination with nematicide to control damping off and rhizome rot diseases in cardamom nurseries.

Results and discussion

All the nine nurseries were infested with high populations of root-knot nematodes. Damping off and rhizome rot diseases were noticed in 6-21 months old seedlings of different cultivars in seven nurseries. Isolation studies from roots and rhizomes revealed the presence of five genera of fungi viz. *Fusarium* sp., *Rhizoctonia solani*, *Pythium*sp., *Cylindrocarpon* sp. and *Sclerotium rolfsii*. *R. solani* and *Pythium* sp. were found associated either singly or together wherever disease was present. In the pot experiment with *R. solani*, maximum mortality was observed when *R. solani* was inoculated after nematode infestation. Root rotting was more severe wherever nematodes were associated with the fungus. Similar studies with *Pythium* showed that the fungus alone can cause the disease within eight days and root knot nematodes had no significant role in causing disease. In the field trials, least mortality of cardamom seedlings was noticed when fungicides were applied in combination with nematicide and the best results were given by Ridomil and carbofuran combination.

D. Population dynamics

Materials and methods

Root and soil samples were collected at monthly intervals for three years from an infested field. Soil samples were collected up to a depth of 45 cm in three parts 0-15, 15-30 and 30-45cm from three spots each, 30 and 45 cm away from the

base of the plant. Rainfall, soil temperature and moisture were also monitored.

Results and discussion

The population levels were comparatively high in samples collected at 30 cm distances and 15-30cm depth. Therefore, this can be considered as the optimum zone for sampling in cardamom. The J2 densities in soil increased from December onwards and reached the peak during March (224.8 / 250cc). In roots their densities reached maximum during November - December and the minimum densities were observed during the monsoon season, i.e. June - September. Among the various ecological factors, monthly rainfall and number of rainy days showed a negative correlation with root knot nematode population in cardamom roots.

E. Developing control measures

a) Chemical control

1.Pre sowing treatments

Materials and methods

Several trials were conducted at Chithirapuram and at Appangala to compare the efficacy of fumigants viz. Formaldehyde solution, Methyl Bromide, Ethylene di bromide and Durofume as a presowing measure against plant parasitic nematodes

Results and discussion

It was found that fumigation with MBr enhanced the germination and growth of seedlings. Total elimination of nematodes and weeds was also encountered in this study. Application of EDB @ 20l/ha was also found economic and effective against root knot nematodes. While MBr and Durofume were found effective against nematodes and other soil borne fungi like *Rhizoctonia solani, Pythium* sp. and *Phyllosticta elettaria*, EDB was effective against nematodes alone.

2. Post sowing treatments

Materials and methods

Efficacy of aldicarb, carbofuran and phorate at three dosages (5, 10 and 15 kg. a.i. / ha) were evaluated in a cardamom nursery at Appangala. Ten seedlings were removed from each bed after three months and the growth characters were recorded. Pre and post treatment nematode levels in these beds were assessed through soil sampling. In another study, fenamiphos was tested in an infested cardamom nursery where Cl 37 seedlings were raised in 6 x 1m nursery beds. About 200 seedlings were retained in each bed and after two months they were treated with fenamiphos by soil drenching and foliar spray at three dosages. The experiment was concluded after three months and observations were made as described above.

Results and discussion

Root knot nematode level was quite high in untreated beds and the seedlings showed narrowing of leaf lamina, rosette appearance and stunting. Highest reduction in nematode population was recorded in aldicarb followed by carbofuran and phorate @ 15 kg a.i. / ha. However, seedling growth was comparatively better in carbofuran treated beds compared to corresponding treatments of aldicarb and phorate. All the nematicide treatments provided increase in root and shoot length, rhizome girth and total biomass over control. Fenamiphos, applied by soil drench and foliar spray, reduced the nematode population with the higher doses being better than the lower ones. Plant growth was also much better than untreated at all levels with maximum number of tillers, better rhizome development, increase in the root, shoot and leaf area recorded at 15 kg / ha level . Generally plant growth was better with soil drenches than foliar application.

3. In main fields

Materials and methods

A field trial was initiated in 1988 at Appangala with monoclonal suckers of cardamom (P1) in an area of 0.9 ha. The experiment was laid down in a split plot design, where five plants in five rows comprised a subplot and seven subplots a main plot. Each subplot contained 12 test plants surrounded by a guard row of boarder plants. The main plot treatments were neem oil cake at 0, 250 and 500 g per clump. Carbofuran, phorate and quinalphos each at 2.5 and 5g applications were done twice a year and observations on growth, yield, nematicide residues and nematode population level in soil and roots were recorded every year for five years.

Results and discussion

Plants treated with carbofuran and phorate had given significantly higher yields than the rest of the treatments, the lowest being recorded in plots treated with quinalphos (Table 1). Phorate at both levels increased the yield, improved the size of the capsules and reduced the damage due to thrips by 32.1 - 37.6%. Neem oil cake alone or in combination with nematicide failed to boost the crop production. This may be due to the poor quality of the neem oil cake (oil content, 3.4 approx.). However, there was significant reduction in the nematode population with neem oil cake as with carbofuran and phorate. It was also noticed that clump rot incidences were more in untreated control plots, followed by neem cake treated ones. Cardamom samples, collected at 2, 4 and 6 weeks after application of the above chemicals, were analyzed for detecting pesticide residues, if any. Carbofuran residues were found even at four week interval while no residues were detected in samples of phorate (2.5 g a.i./ plant) treated plants at the same interval.

b) Host resistance

1.Standardization of screening methodology

Materials and methods

P1 monoclinal vegetative suckers were planted in sterile soil and were inoculated with 500, 1000 and 5000 root-knot nematode (*M. incognita*) larvae per plant. Five plants in each treatment were uprooted 2, 3, 4, 5 & 6 months after inoculation. Number of galls and nematode level in the roots were assessed for each plant and gall index, reproduction factors etc. were worked out.

Results and discussion

The data showed a gradual increase in galling, nematode population and their multiplication with the increase in exposure period. However, the variation was not uniform with the increase in Pi. The greatest rate of population increase occurred at the lowest Pi, the rate decreasing as Pi increased. Susceptible reactions (G > 2 and R>1) were consistently observed with 100 and 500 initial populations at all intervals. Moreover, they showed significant differences in GI and Pf from the rest of the Pi at the 3-month interval. Therefore, an initial inoculum level of 500 nematodes and an exposure period of 3 months were found optimum for screening of cardamom germplasm suckers.

Table 1 Effect of three granular pesticides on growth and yield of cardamom - Pooled data for 1990-91 to 1993-94.

Treatment		Height (m)	Number of			Yield wet wt. (g/plant)
			Tillers	Panicles	Capsules	
Carbofuran	2.5 g*	1.76**	17.20	12.95	123.32	207.66
	5.0 g	1.86	19.33	15.71	177.04	282.41
Phorate	2.5 g	1.96	17.47	15.04	210.98	324.86
	5.0 g	1.96	18.30	16.81	239.72	380.23
Quinalphos	2.5 g	1.81	15.97	13.13	125.12	190.47
	5.0 g	1.74	16.53	12.09	117.46	181.59
Check		1.83	16.37	13.41	122.01	198.57
$L.S.D_{0.05}$		0.08	1.35	1.62	41.26	49.50

* Dosages are g a.i. / plant for single application. ** Data are means of four replications, combined over three neem cake levels and four years.

2. Screening of germplasm

Materials and methods

Five units of 48 cardamom germplasm accessions were planted in sterile soil. After establishment, they were inoculated with 500 root-knot nematode larvae per plant. Gall index and reproduction factor for each plant were recorded and the plants were classified for their reaction to root knot nematodes.

Results and discussion

All the accessions tested against root-knot nematodes, *Meloidogyne incognita* were susceptible. However, there was wide variability in their reaction to root-knot nematodes. Some accessions that showed low rates of multiplication of *M.incognita* are accessions with wide variability in their reaction to root knot nematodes.

c)Biological control

1. Interaction between *M. incognita* and V.A. Mycorrhizae

Materials and methods

Six VAM fungi, viz. *Glomus fasciculatum, G. versiforme, G.macrocarpum, Gigaspora margarita, G. calospora* and *Acaulospora* sp., were tested alone and in the presence of root knot nematodes in various sequences. There were 26 treatments and each was replicated six times in a completely randomized design. Three replications each were removed after six and 12 months for assessing the growth of plants and for observing nematode and mycorrhizal colonization.

Results and discussion

Inoculation with *Gigaspora margarita* and *G. fasciculatum* resulted in a maximum of 10 and 12-fold increase in the shoot dry weight as compared to control. The detrimental effects of nematodes were observed when they were inoculated alone or inoculated before inoculations with VA mycorrhizal fungi. Number of nematodes in roots decreased in presence of VAM fungi. The study revealed that *G. margarita* and *G. fasciculatum*, when inoculated before nematode inoculation, significantly reduced the nematodes in roots and improved the vegetative growth of cardamom plants. Maximum root colonization of *G. margarita* and *G. fasciculatum* was observed when they were inoculated alone or prior to nematodes.

2. Interaction between *M. incognita* and *Paecilomyces lilacinus*

Materials and methods

In a pot trial, *P. lilacinus* multiplied on coffee husks was incorporated into the top 20 cm of soil around the cardamom seedlings inoculated with 5000 larvae of *M. incognita.* The growth of the plants and nematode build up were studied. Further, *P. lilacinus* was evaluated under field

conditions in cardamom nurseries. The fungus was added to the soil using rice grains as the carrier (Spore load of 2.9 x 10^7-g). It was incorporated in seedlings furrows @ 50g/4.5 x 1m bed at the time of sowing and three months after germination.

Results and discussion

There was no significant difference in growth of plants in the pot study. However, about 48.5 to 57.0 per cent reduction in nematode population was observed in plants that received *P. lilacinus*. Incorporation of *P. lilacinus* in primary nursery beds has not given any additional improvement to germination of cardamom or their growth. This may be because of the poor colonization of the fungi in the soil or because of the low population of the target organism viz. *Meloidogyne* spp. in the above site.

d) Integrated nematode management

Materials and methods

Nursery beds were prepared at two sites (0.15 ha each)in the summer season. Half part of this area was solarized using 400 gauge transparent polythene sheets for 45 days while the remaining part was left as such. Sowing in these beds was taken up @ 1000 cardamom seeds (Cl37) per bed (4.5x1 m) in September 1991. At the time of sowing biocontrol agents (7-day-old culture of *Trichoderma* isolates on decomposed coffee husks -3.7 x 10^7 conidia/g and 15 days-old cultures of *P. lilacinus* on rice grains -2.9x10^7 spores/g) were also incorporated in selected beds. They were used @ 2.5 kg and 50g per bed. A booster dose of the above fungal antagonists was given after three months as described earlier. Simultaneously other treatments, viz. phorate @ 5g a.i. / bed, 0.2% copper oxychloride @ 20l/bed and phorate + copper oxychloride, were also imposed. Suppression of nematode and fungal populations, weed growth, germination and growth of cardamom seedlings were monitored during the experiment at different intervals.

Results and discussion

Mean soil temperature during the solarization period increased by 8.7°C in beds covered with polythene sheets and number of days > 40°C was 2-17 in solarized beds at different depths of soil. Germination of cardamom seeds was enhanced by 25.5% while weed growth was reduced 82% in solarized beds. Populations of *Rhizoctonia solani*, *Phyllostica elettaria*, *Meloidogyne* sp., *Rotylenchulus reniformis*, *Helicotylenchus* sp. were suppressed to varying levels and *Pythium vexans* was eliminated. Solarization was also found to influence the growth and vigour of cardamom plants. Incidences of leaf spot disease were comparatively high in the non solarized plots (Table 2). Incorporation of biocontrol agents and phorate helped in production of healthy and vigorous seedlings than the other treatments (Table 3).

Table 2 Effect of soil solarization on growth of cardamom seedlings and pests and diseases in cardamom nurseries (data are means of 28 replications).

Treatment	Germination (%)	Weed growth wet wt. (g / m²)	Growth of seedlings			Pest & disease control			
			Height (cm)	No. of tillers	Biomass wet wt. (g / plant)	Leaf spot		Gall index	Root grub[b]
						Incidence[b]	Severity[c]		
S	54.77	24.0	38.8	1.88	36.25	1.9	0.5	0.9	7.2
NS	43.33	140.4	35.7	2.04	35.08	20.2	8.6	1.0	13.5

[a] Observations recorded 9 months after germination[b] Percentage of seedlings affected[c]. Disease severity.
[d] Gall index based on a scale of 0 -10, 0 - no galling and 10 - maximum galling.

Table 3 Effect of biocontrol agents and plant protection chemicals alone and in combination with soil solarization in cardamom nurseries

Treatment	Total biomass (g / plant)	Std. seedlings* (%)	Rhizome rot incidence (%)	Root grub damage[a]	Root knot nematode Final population[b] *
Trichoderma spp.	42.99	52.63	26.44	1.87	2.215
P. lilacinus	54.14	51.32	28.49	2.00	2.007
Tricho. + P.lilacinus	51.67	54.59	27.61	1.83	1.709
Phorate	47.16	51.17	30.35	0.46	1.967
Copper oxychloride	40.66	52.77	30.58	1.96	2.380
Phorate + copper oxy.	45.68	52.10	27.49	0.21	1.768
Check	43.29	46.11	42.47	2.04	2.593
$LSD_{0.05}$	8.69	3.73	3.96	0.775	0.401

NS - Not solarized, S - Solarized. * Transformed data. [a] Based on a 0-5 scale. [b] Nematode population per g root.

2 EVOLVING A DISEASE INDEX FOR *PHYTOPHTHORA* / NEMATODE INDUCED DAMAGE IN BLACK PEPPER

Jose Abraham, M Anandaraj, K V Ramana and Y R Sarma

Objectives

To evolve an indexing technique for quantifying the severity of disease on *Phytophthora* / Nematode affected black pepper.

Technical Programme

1. Selection of a large sample of black pepper vines in the hot-spot areas of Calicut, Wynad and Idukky and labeling them serially.
2. Monitoring the wines for recording the disease scores by allocating scores from '0' to '4' depending on the percentage of foliage affected.
3. Soil and root sampling for assessing the inoculum load of Phytophthora and Nematodes.
4. Statistical analysis of data and preparation of report.

Material and methods

The study was carried out in three locations, viz. Calicut, Wynad and Idukki. A large sample of 1500 vines in the disease affected gardens in these districts were selected and monitored for three years during 1991 to 1993. During the first year of the study, the frequencies of incidence of the visual symptoms of Foliar Yellowing (FY), Defoliation (DF), Foliar Infection (FI), and Collar Infection(CI) were recorded for the three locations of Peruvannamuzhi farm at Calicut district, Kuppady plantations in Wynad district and in a farmers' plot at Nedumkandam in Idukki district. The incidence of disease in these gardens were severe and vines of all stages of the disease were present for observation. In order to study the relationship between the symptom expressions and the root damage in the vines, the data generated by a pot culture study conducted by the Pathology Section of National Research Centre for Spices were utilized. The growth parameters like, Height (Ht.), No. of nodes (N), Root Volume (RV), Root Weight (RW) and Shoot Weight (SW) were recorded. The vines which were inoculated with the pathogen, were also scored from '0' to '3' visually, depending on the expression of foliar yellowing and root rotting as Foliar Index (FI) and Root Index (RI).

Results and discussion

For identifying the predominant symptoms in foot rot/nematode infected black pepper vines, a sample of 1,000 vines were scored for various symptom expressions viz., Yellowing, Defoliation, Foliar infection and Collar infection. Scores from '0' to '4' were allocated for 'healthy', '1 to 25%', '26 to 50%', '51 to 75%' and 'above *75%*' of the foliage affected, respectively (Table 1.).

Table 1. Percentage Incidence of various symptoms in foot rot/ nematode affected Black pepper gardens

Score	Yellowing	Defoliation	Foliar	Collar infection
0	41.0	36.7	97.7	92.6
1	42.4	31.3	1.9	6.8
2	13.1	22.6	0.3	0.6
3	3.3	8.0	0.0	0.2
4	0.2	1.4	0.2	0.0

The correlations between these scores were also worked out to study whether there is any interrelationship between these symptoms. In general, defoliation had significant positive correlation with yellowing, foliar infection and collar infection.

The data from the pot culture experiment revealed that there exists a significant positive correlation between root rot index (RI) and foliar yellowing index (FI) while these indices have significant negative correlations with the growth parameters viz., Height (Ht), Root Volume (RV), Shoot Weight (SW) and Root Weight (RW) (Table-2). The percentage distribution of these vines in relation to these indices were worked out and are given in Table-3.

Table-2. Correlations between Root Index (RI), Foliar index (FI) and Growth factors

Factor	RI	FI	Ht	RV	RW
RI	-	-	-	-	-
FI	0.5124	-	-	-	-
Ht	-0.4862	-0.3178	-	-	-
RV	-0.7201	-0.4276	0.6651	-	-
SW	-0.5181	-0.3518	0.8255	0.7085	-
RW	-0.6758	-0.4232	0.6300	0.9108	0.6962

All the correlations are significant ($p<0.01$).

Table 3 Percentage distribution of vines in relation to RI and FI

Index	Percentage of vines expressing symptoms on	
	Roots	Foliage
0	8.2	37.4
1	25.7	46.5
2	34.2	12.6
3	31.9	3.5

It is seen from the table that, even though, only 8.2% of the vines were free from the disease (root index = 0), 37.4% were apparently healthy (foliar index = 0), indicating that at the initial stages of infection at the roots, the vines do not express any external symptoms. This is more apparent in the case of vines with root rot index 3. While 31.9% of the vines are in the advanced stages of infection, only 3.5% of the vines are showing advanced stages of foliar yellowing. Hence, it is evident that there is a time lag between the root rot and its foliar expression as yellowing, leading to a delay in detecting the disease at the initial stages, which could be the reason for poor response of affected vines to control measures.

From the frequencies of incidence of the symptoms viz., foliar yellowing (FY), defoliation (DF), foliar infection (FI) and collar infection (CI), it was found that 59 and 64 percent of the vines showed mild to severe yellowing and defoliation, only 2.3 and 7.4 percent of the vines were showing foliar infection and collar infection respectively. Hence it was found that foliar yellowing and defoliation are the more prominent and persistent symptoms which could be scored for working out an index. Accordingly, scores from `0' to `4' were allocated for these two symptoms, depending on the percentage of the foliage affected, say, the score `0' for healthy, `1' for those vines showing up to 25% of the foliage affected, score `2' for 26 to 50%, `3' for 51 to 75% and the score `4' for those vines having more than 75% of the foliage affected. Scoring was done separately for yellowing and defoliation for all the selected vines based on the above criteria. The frequencies of incidence of these scores were recorded for 8 rounds in different seasons and the average of these scores worked out with a view to get the ratio of occurrence of these scores. The percent distribution of these scores were obtained and are given in Table 4.From the table it is seen that 48% of the vines were having score `0' for yellowing and 51% were having score `0' for defoliation. This means that the remaining 52 and 48 percent of the vines are having the symptoms of yellowing and defoliation respectively indicating that a 1:1 ratio exists in the expressions of these symptoms in the affected vines.

Table-4. Percent distribution of different scores for FY and DF

Score	FY	DF
0	48.2	51.1
1	34.6	20.4
2	10.4	13.6
3	1.7	7.1
4	5.1	7.8

Further, the mean score for yellowing and defoliation works out to be 0.81 and 1.00 respectively, which is also closer to the ratio 1:1. Thus, giving equal weightage to these symptoms for obtaining a simple index for the disease is justified. Integrating these two scores by taking the total of these scores and converting to percentage of the total of maximum possible scores for these two symptoms (4+4 = 8), will give a simple index for the disease. Thus, if `y' stands for the score for yellowing and `d' for defoliation score, then the index 'I' for the vine is given by

$$I = \frac{Y + D}{8} \times 100$$

Foot rot disease of black pepper, though, conventionally known as 'quick wilt' disease, it was observed that once the feeder roots get affected the process of decline of the vines are gradual and foliar symptoms express only after a substantial portion of the feeder roots are damaged. Sudden death of the vines occur only when the collar region of the vine is affected. Also, depending up on the root regeneration capacity of the vines and the favourable weather conditions, the remission of the symptoms are often observed.

Summary and conclusions

For indexing the foot rot disease of black pepper, the visual symptoms of foliar yellowing and defoliation are scored separately from `0' to `4' depending on the percentage of the foliage affected. As these two symptoms are found to be the consequence of the feeder root damage and is directly related to the degree of damage occurred to the roots, the index derived by adding these scores and converting to percentage gives a realistic measure of the extend of damage caused to the vine. When the collar region of the vine is directly affected by the fungus, the death of the vine is faster and the symptoms of foliar yellowing and defoliation may not manifest on the foliage. However, the frequency of collar infection is only in 7% of the vines observed, while foliar yellowing and defoliation was found in about 50% of the vines in the affected gardens. Hence, the index was developed based on the prominent and more persistent symptoms of

foliar yellowing and defoliation. Also these are the two symptoms which can easily be visualized and assessed for allocating the score.

REFERENCES

George, M V and Radha, K 1973 Computation of disease index of root (wilt)disease of coconut. Indian J agric. Sci. 43: 366-370

George, M V Jacob Mathew and Nagaraj, B 1980 Indexing of yellow leaf disease of arecanut. J. Plantion Crops 8: 82-85

Jacob mathew, Nambiar, K K N , Jose, C T and Anil kumar 1989 Stem bleeding disease of coconut -a method for indexing the disease severity. J. Plantation Crops. 17(2): 80-84

Nambiar, P T N and Pillai, N G 1985 A simplified method for indexing root (wilt) affected coconut palms. J. Plantation Crops. 13(1): 35-37.

Rama pandu S and Rajamannar M 1983 Symptomatology and indexing of Tatipaka disease of coconut. Indian Phytopath. 36: 608-612

Vijayan, K M and Natarajan, S 1975 Influence of fertilizer and manuring on the incidence and progress of coconut wilt disease of Tamil Nadu. Cocon. Bull. 5: 1-5

3 Studies on coccids infesting black pepper

K M Abdulla Koya and S Devasahayam

Objectives

The project aims at identifying the various species of cooccids (scale insects and mealy bugs) infesting black pepper and studying the nature of damage, life cycle, seasonal population, incidence of natural enemies and evolving suitable control measures against major species.

Technical programme

Survey for distribution of scale insects and mealy bugs in major black pepper areas
Nature of damage and life cycle of scale insects
Seasonal population of natural enemies of scale insects
Identification of natural enemies of scale insects
Seasonal population of natural enemies of scale insects
Evaluation of insecticides for the control of scale insects in the field.

Materials and methods

1 Distribution

Surveys were conducted in 165 locations in Trivandrum, Kottayam, Ernakulam, Palaghat, Malappura, Kozhikode, Wynad,, Kannur and Kasaragod districts of Kerala; Kodagu, Uttara Kannada and Shimoga districts in Karnataka and Kanyakumari, Salem and Nilgiris districts in Tamil nadu to study the distribution of various species of scale insects and mealy bugs in major black pepper areas. Three gardens were surveyed in each location and 15 vinnes were selected at each, location and 25 laterals branches were observed critically too record the incidence of scale insects and mealy bugs on them. The various species collected were identified by the International Institute of Entomology, United Kingdom.

2 Nature of damage and life cycle

i) Nature of damage

The nature of damage caused by L. piperis and A. destructor was studied in detail. Infested leaves and lateral branches of rooted laterals in the green house and vines in the field were tagged and the progress of various symptoms was observed at regular intervals.

ii) Life cycle

The life cycle of L. piperis and A. destructor was studied in the green house. portions of ifnested stems and leaves of black pepper were collected from the field and 'clipped on' to leaves of healthy rooted laterals raised in pots and the emerging crawlers were allowed to settle on them. The progress in development of settlers was observed under a steromicrscope at daily

intervals to determine the duration of various stages and life cycle.

3 Seasonal population

The seasonal population of *L. piperis* and *A. destructor* was recorded at monthly itnervals at Kalpetta (Wynad dist. Kerala). Infested leaf samples were collected from vines (var. Pannnkyur-1) and brought to the laboratory. The number of crawlers and scales present on them was cousnted under a stereomicrsscope in three 1 x 1 cm areas from the distal, middle and basal portions of each leaf.

4 Identification of natural enemies

Natural enemies of scale insects and mealy bugs were collected from the field during the survey for the incidence of the pest in various areas. The predatory, parasitic activity of the natural enemies was confirmed in the laboratory. The natural enemies were identified by the International Institute of Entomology, united Kingdom.

5 Seasonal population of natural enemies

The seasonal populatiion of important natural enemies of L. piperis and A destructor was recorded at monthly intervals at Kalpetta. Leaf samples isnfested with scale insects were collected from vines (var. Panniyur-1) and brought to the laboratory for re3cording the natural enemies. The number of scales parasitised by *E. lousburyi* was recorded in three 1 x 1 cm areas forom the distal, middle and basal portions of the leaf. The number of larvae/ adults of C. circumdatus and Pseodoscymnus sp. was recorded frosm each sampled leaf.

6 Control

Six insecticides viz. monocrotophos, phosphamidon, dimethate, dichlorvos, methyl parathion and malathion (0.1% each) were evaluated in the field for the control of *L. piperis*. The trials were laid out in a 15 year old black pepper (cv. Kariimunda) plantation at Kuppadi (Wynad district). A radomised block design was adopted and each treatment was replicated four times. The insecticides were sprayed twice at 30 days interval with a rocker sprayer to run off level after harvest of the crop during early February. An untreated control was also maintained. the population of life sclae insects was determinned 15 and 30 days after the first spray and 15 days after the second spray by sampling stem portions of laterals from various treatments. The trials were conducted for two years consecutively and the data were subjected to pooled analysis.

Results and discussion

Distribution

Eleven species of scale insects and 5 species of mealy bugs were observed to innfest black pepper 11 of them being first records ont he crop. Among the various species Lepdiosapahes pipers and Aspidiotus destructor Sign. were more

common and serious. Infestations of L. piperis were relatively higher at Trivandrum, Idukki, Wynad, Kodagu and Niligiris districts. A. destructor was smore serious at Idukki, Wynad, Kodagu, North Kanara, Shimoga, Salem and Nilgiris districts). *L. piperis* was also common on older rooted cuttings and laterals inn nurseries. The incidence of both the species was more serious at higher altitudes.

Nature of damage

L. piperis infested main stems (in younger vines) stems of lateral branches, mature leaves and berries. the pest infestation resulted in chlorotic patches, yellowing and drying of leaves. younger vines succumbed tto the pest attack during the course of 2-3 syears. On older vines, the ifested lateral branches wislted and dried. *A destructor* generally ifnested leaves and rarely stems of lateral branches and berries. The pest infestation resulted in chlorotic patches on leaves and their subsequent yellowing. The other species of scale insects resulted in localised necrotic patches on leaves. the mealy bugs generally infested tender shoots and leaves; however, infestation by Plannococcus sp. was also observed at the basal portions of stems near the root zone and the roots.

4 Studies on effect of organic nutrition and secondary nutrients on establishment, growth and yield of black pepper

K Kandiannan, K Sivaraman, C K Thankamani, M Anandaraj and K V Ramana

This observational trial was started during. With the objective to study the effect of organics and secondary nutrients on reducing the yellowing and defoliation of black pepper.

Materials and methods

There were sixteen treatments formulated by combining following eight components, apart from maintainign control as normal recommended practice. These seventeen treatments ere imposed on each two healthy and diseased vines of Karimunda variety trailed on concrete posts.

Treatments

1. PO - No plant protection
2. P1 - Plant protection (30 g phorate/vine + Ridomil 0.25% 5-10 litres/vine (spray + drenching/year)
3. M1 - Organic manure - 30 kg cow dung/vine/year
4. M2 - Inorganic fertilizer (100:40:140 g N, P2O5, K2O / vine/ year
5. Cao - No calcium
6. Ca1 - 900 g Ca/vine/year
7. Mgo - No magnesium

8. Mg1 - 300 g Mg/vine/year

Technical programme

* Yellowing and defoliation index were worked out as per the method evolved by Jose Abraham et al (1994).
* Appropriate leaf and soil samples were drawn and analysed for major and secondary nutrients as per the standard procedures

Results (Table 1) and summary

Table 1 Effect of secondary nutrients and organic matter yellowing and defoliation of black pepper

Treatments	Healthy				Disease			
	Yellowing		Defoliation		Yellowing		Defoliation	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
P0 M1 Ca 0 Mg 0	0.5	1.5	1.0	1.5	0.5	1.0	2.5	2.5
P0 M1 Ca 0 Mg 1	1.0	0.0	1.0	1.0	1.0	0.5	3.0	3.0
P0 M1 Ca 1 Mg 0	1.0	0.5	1.0	0.5	0.5	0.5	3.5	3.0
P0 M1 Ca 1 Mg 1	0.5	0.0	1.0	0.5	0.0	1.0	3.0	2.5
P0 M2 Ca 0 Mg 0	0.5	1.0	1.5	1.5	0.5	2.0	3.0	3.0
P0 M2 Ca 0 Mg 1	0.5	0.0	1.5	1.0	0.5	1.0	3.0	2.5
P0 M2 Ca 1 Mg 0	0.5	0.0	1.5	1.0	0.5	1.0	3.5	3.0
P0 M2 Ca 1 Mg 1	0.5	0.0	1.0	0.0	0.0	0.0	3.0	3.0
P1 M1 Ca 0 Mg 0	0.0	0.5	1.0	1.0	1.0	1.0	3.0	3.0
P1 M1 Ca 0 Mg 1	1.0	0.5	1.0	0.5	1.0	0.5	3.5	3.0
P1 M1 Ca 1 Mg 0	1.0	0.5	1.0	0.5	1.0	0.5	3.0	3.0
P1 M1 Ca 1 Mg 1	1.0	0.0	1.0	0.0	0.5	0.5	3.5	2.5
P1 M2 Ca 0 Mg 0	1.0	0.5	1.0	1.0	0.5	1.0	1.0	2.0
P1 M2 Ca 0 Mg 1	0.5	0.0	1.0	0.5	0.5	2.5	3.5	3.0
P1 M2 Ca 1 Mg 0	1.0	0.5	1.5	1.0	0.5	2.5	4.0	4.0
P1 M2 Ca 1 Mg 1	1.0	0.0	1.0	0.0	1.0	2.5	3.5	3.0

Scale : 0 = No yellowing / defoliation ; 1 = up to 25 % ; 2 = 26 - 50 % ; 3 = 51 - 75 % 4 = 76 - 100 %

P0 = No Plant Protection; P1 = Plant Protection ; M1 = Organic manuring ;
M2 = Inorganic Nutrient ; Ca 0 = No Calcium ; Ca1= Calcium
Mg 0 = No Magnesium; Mg 1= Mg1 = Magnesium

1 Combined application of organic or inorganic nutrition along with calcium, magnesium and plant protection improved the growth of healthy vines
2 The yellowing and defoliation index remain unaltered even after imposing treatments in diseases vines.
3 Nutrient content of healthy vines wer higher than the diseased vines
4 Death of vines were noticed when there was higher yellowing and defoliation
5 The feeder roots were less or absent in diseased vine compared to healthy ones
6 The application of either organics or inorganic along with calcium, magnesium and plant protection improves the growth of the vine which begin to show yellowing and defoliation symptoms.

Reference

Jose Abraham, Ramana, K V, Sarma Y R and Anandaraj M 1994 Evolving a disease index for Phytophthora / Nematode induced damage in black pepper . p - 4. In Annual Report 1993 - 94. National Research Center for Spices, Calicut Kerala

PUBLICATIONS

Anandaraj, M., Sarma, Y R. & Ramachandran, N. 1994. *Phytophthora* foot rot of black pepper in relation to age of the host and its culmination in foot rot. Indian Phytopath: 47: 203-206

Anandaraj, M., Ramana, K.V., & Sarma, Y.R., 1994. Slow decline disease of black pepper. Paper presented in first International symposium on plantations crops (PLACR-OSYM- XI Nov. 30 - Dec.3 1994, Calicut

Anandaraj, M & Sarma, Y.R. 1994 Etiological and epidemiological studies on *Phytophthora* induced diseases. Paper presented at National group meeting on *Phytophthora* diseases of horticultural crops 21-23 September 1994 Calicut

Anandaraj, M., Ramana, K.V. and Sarma, Y.R. 1994 Role of *Phytophthora capsici* in the etiology of slow decline disease of black pepper. Paper presented in first international symposium on plantation crops, Calicut Nov 30-Dec 3, 1994

Anandaraj, M., Sarma, Y.R. & Ramachandran, N 1995 *Phytophthora* infections in black pepper in relation to crop phenology. Presented at the Global Conference on recent advances in plant diseases and their management. 12-17 Feb 1995 Udaipur, India

Anandaraj, M & Sarma Y R 1994 Effect of vesicular arbuscular mycorrhizae on rooting of black pepper Journal of Spices and Aromatic Crops 3(1): 39-42

Anandaraj, M & Sarma, Y R 1994 Biological control of black pepper diseases. Indian Cocoa, Arecanut and Spices Journal 18(1): 22-23

Dake, G.N. (1994) Diseases of ginger and their management. Paper presented in the National Seminar on Diseases of Spices, National Research Center for Spices, Calicut April 7-8, 1994 (Abstract)

Dake, G.N., Anandaraj, M., Raju, C.A. and Rohini Iyer (1994) Effect of seed treatment and lining material on rhizome rot of ginger in storage. Paper presented in the first International Symposium on Plantation Crops (PLACROSYM-XI) , Calicut, Nov.- 30 to Dec. - 3, 1994 (Abstract)

Dake, G.N. (1994) Integrated Management of Bacterial Wilt of Ginger Spices India 7(11): 14-16

Devasahayam, S. 1994. Management of insect pests of black pepper. Spice India 7 (9) : 27-29.

Devasahayam, S. 1995. Insect pests of spices and their management. Manual - Refresher Training Course in Plantation Crops. Central Plantation Crops Research Institute. Kasaragod.

Devasahayam, S. and Abdulla Koya, K.M. 1994. Natural enemies of major insect pests of black pepper . Journal of Spices and Aromatic Crops 3 : 50 - 55.

Devasahayam, S. and Abdulla Koya, K.M. 1994. Seasonal incidence of *Hexamermis* sp (Dor., Mermithidae) parasitising larvae of top shoot borer *Cydia hemidoxa* Meyr. (Lep., Tortricidae) on black pepper. Journal of Applied Entomolgy 117 ; 31-34.

Devasahayam, S. and Abdulla Koya, K.M. 1994. Field evaluation of insecticides for the control of mussel scale *(Lepidosaphes piperis)* on black pepper. Journal of Entomolgical Research 18 : 213 - 215.

John Zachariah, T. 1994 The chemistry behind flavour and fragrance of spices. Spice India (Malayalam) 7(10) : 2-4

John Zachariah, T. 1994 Spices quality research at NRCS. Spice India (Malayalam) 7(11): 3-5

Kandiannan, K., Sivaraman K and Thankamani C K 1994 Growth regulators in black pepper production. Indian Cocoa, Arecanut and Spices J. 18 (4) : 119 - 123.

Krishnamoorthy, B. and Rema, J. 1994 Genetic resources of tree spices. In: Advances in Horticulture (Vol.9): Plantation and Spice Crops. Part I (Eds.) Chadha, K.L. and Rethinam, P., Malhotra Publishing House, New Delhi pp.169-192

Krishnamoorthy, B. and Rema, J. 1994 Air layering in cassia cinnamon (Cinnamomum aromaticum Nees). Journal of Spices and Aromatic Crops, 3 (1): 48-49

Krishnamoorthy, B., Sasikumar, B. and Rema, J. 1994 Genetic variability and segregation of sex in nutmeg. Paper presented in the first International Symposium on Plantation Crops (PLACROSYM-XI), Calicut , Nov 30-Dec 3, 1994

Krishnamoorthy, B. and Rema, J. 1994 Tree spices crop improvement Spice India 7 (11) 24-30

Krishnamoorthy, B. 1994 Drying black pepper on polyethene materials. Spice India 7 (7): 21-22

Krishnamoorthy, B. and Rema, J. 1994 Three promising morphological variants in clove (*Syzygium aromaticum* from Tamil Nadu, India: Journal of Spices and Aromatic Crops 3 (2): 168-169

Krishnamoorthy, B. and Rema, J. 1995 Nutmeg and cinnamon. Souvenir of Calicut Flower Show 1995 pp. 9-14

Krishnamoorthy, B., Sasikumar, B. and. Rema J 1994 Genetic variability and segregation of sex in nutmeg. Paper presented in the first International Symposium on Plantation Crops (PLACROSYM-XI), Calicut, Nov 30-Dec 3, 1994 .

Leela, N.K. 1994. Chemical constituents of spices, Spice India (Mal.), 7: 12-15.

Nair, R R. and Ravindran P N 1994. Somatic association of chromosomes and other meiotic abnormalities in *Vanilla planifolia* (Andrews). Caryologia, 47 : 65 - 73

Nirmal Babu, K.,Geetha S P ,Manjula C, Ravindran P N and Peter K V 1994. Medium term conservation of cardamom germplasm - an *in vitro* approach. Second Asia - Pacific Conference on Agricultural Biotechnology 6-10 March, 1994.

Peter, K.V. 1994. Spices - Mixed performances. The Hindu Survey of Indian Agriculture, 1994. p. 91-96.

Peter, K.V. 1994. Spices scenario. Pepper, the biggest foreign exchange earner. Agri. Research Year Book 124 -129.

Peter, K.V. 1994. Gearing up Spices Research to meet the emerging challenges. Indian Hort. 39 (3) : 7-10.

Peter, K.V. 1994. A Curtain raiser to PLAC-ROSYM XI. Indian Coconut J. 24 (4) : 4-7.

Peter, K.V. 1995. Trends in vegetable spices production. Paper presented in National Symposium on Vegetable Improvement held at IGKV, Raipur from 2-5 Feb. 1995.

Premkumar, T., Devasahayam, S. And Abdulla Koya, K.M. 1994. Pests of spice crops. In: Chadha, K.L. and Rethinam, P. (Eds.). Advances in Horticulture, Vol. 10, Plantation and Spice Crops - Part 2. Malhotra Publishing House, New Delhi. Pp.787 - 823

Ramana K V 1994 Efficacy of *Paecilomyces lilacinus* (Thom.) Samson in suppressing nematode infestation in black pepper *(Piper nigrum* L.) Journal of Spices and Aromatic Crops 3: 130-134

Ramana K V and Santhosh J Eapen 1995 Nematode problems of Spices and condiments. In: Nematode Pest Management. An appraisal of eco-friendly approaches (Eds. G Swarup, D.R. Dasgupta and J.S.Gill) pp. 263-270 Nematological Society of India, New Delhi

Ramana, K V and Santhosh J Eapen 1994 Parasitic nematodes and their management in major spices. National Seminar on Diseases of Spices. 7-8 April 1994 Calicut

Ramana, K V, Mohandas, C and Santhosh J Eapen 1994 Plant Parasitic Nematodes and slow decline disease of black pepper. national Research Center for Spices, Calicut 14 pp.

Ravindran, P N , Sasikumar B., Johnson K George, Ratnambal, M.J., Nirmal Babu, K., Zachariah, T.J. and R.R. Nair, 1994 Genetic resources of ginger (*Zingiber officinale* R.) and its conservation in India. Plant Genetic Resources News Letter 98: 1-4

Ravindran, P.N. and Peter, K.V. 1994. Genetic Resources of Spices in Kerala and their conservation. International Congress on Kerala Studies, AKG Center for Research and Studies, Trivandrum (Abstract): 12-12(Vol.4)

Ravindran, P.N., B. Sasikumar, Johnson, K. George M.J. Ratnambal, K. Nirmal Babu, T. John Zachariah and R.R. Nair. 1994. Genetic resources of ginger (*Zingiber officinale* Rosc.) and its conservation in India. Plant Genetic Resources Newsletter 98: 1-4

Rema, J. and Krishnamoorthy, B. 1994 Vegetative propagation of clove (*Eugenia caryophyllus* Sprengel, (B. & H) Tropical Agriculture (Trinidad) 71 (2) : 144-146

Rema, J. and Krishnamoorthy, B. 1994 Approach grafting of clove. Indian Hort. 39 (3): 53-54

Rethinam, P. and A.K. Sadanandan, 1994 Nutrition Management of Seed Spices, Chapter in Advances in Horticultur(Ed.) Chadha K L and Rethinam, P. Malhotra Publishing House, New Delhi 9: 423-456

Rethinam, P., Edison, S., Sadanandan, A.K. and Johny, A.K. 1994 Major achievement of AICRPS, Indian Cocoa, Arecanut and Spices Journal 18 (1): 16-21

Rethinam P, Sivaraman K and P K Sushama 1994 Nutrition of turmeric. pp- 477 - 489. Chapter in Advances in Horticulture (Ed.) Chadha K L and Rethinam, P. Malhotra Publishing House, New Delhi 9: 477 - 489.

Santhosh J Eapen 1993 Seasonal variations of root knot nematode population in a cardamom plantation. Ind J .Nematol. 23: 202-207

Santhosh J Eapen 1994 Pathogenicity of *Meloidogyne incognita* on small cardamom (*Elettaria cardamomum* Maton) Ind J Nematol. 24: 31-37

Santhosh J Eapen 1994 Effect of three granular pesticides on damage by thrips (*Sciothrips cardamomi* R) on small cardamom (*Elettaria cardamom* Maton). J Ent Res 18: 181-183

Santhosh J Eapen 1993 Plant parasitic nematodes of small cardamom and their management. Planters' Chronicle 88: 169-171

Santhosh J Eapen 1994 Diseases of black pepper. Spice India (Malayalam) 7(11): 6-7 and 12-13

Santhosh J Eapen and M N Venugopal 1995 Field evaluation of *Paecilomyces lilacinus* and *Trichoderma* spp. in cardamom nurseries for the control of root knot nematode and rhizome rot disease. National Symposium on Nematode Problems of India - An appraisal of the nematode management with eco-friendly approaches and bio-components 24-26 March 1995 New Delhi

Sarma, Y.R., Anandaraj, M. and Rajan, P.P. 1994. *Phytophthora* - a threat to black pepper - present status and future strategies of disease management. Spice India 7 (11) : 10-13.

Sundararaj, P, Ramana, K V and Santhosh J Eapen 1995 Observations on the life cycle of *Trophotylenchulus piperis* Mohandas, Ramana and Raski 1985 in roots of black pepper *(Piper nigrum* L.). National Symposium on Nematode Problems of India -An appraisal of the nematode management with eco-friendly approaches and biocomponents 24 -26 March 1995 New Delhi.

Sadanandan, A.K. 1994 Black pepper nutrition. Chapter in Advances in Horticulture (Ed.) Chadha, K.L. and Rethinam,P. Malhotra Publishing House New Delhi 9 : 499-513

Sadanandan, A.K., Bhargava, B.S. and Hamza, S. 1994 Leaf nutrient norms for black pepper (*Piper nigrum* L.) using DRIS. Paper presented at Ist International Symposia on Plantation Crops - PLACROSYM-XI, NRCS, Calicut Nov 29-Dec 3, 1994 p.6-7

Sadanandan, A.K. and Hamza, S. 1994 Response of four turmeric (*Curcuma longa* L.) varieties to nutrients in an oxisol on yield and curcumin recovery. Paper presented at Ist International Symposium on Plantation Crops -PLACROSYM-XI, NRCS, Calicut Nov 30-Dec 3, 1994 .

Sadanandan, A.K. 1994 'Doubling our production of Spices' aiming through infrastructure spread and research; All India Co-ordinated Research Project on Spices. Indian Horticulture 39 (3): 10-16

Sadanandan, A.K. and Hamza, S. 1994 Importance of organic manures in spices cultivation (Malayalam). Kerala Karshakan 20(4): 15-19 & 30, 3-4 & 29

Sadanandan, A.K. and Johny, A.K. 1994 Research Highlights of AICRPS, Spice India 11-21

Sadanandan, A.K. and Hamza, S. 1995 An overview of first International Symposium on Plantation crops (Malayalam) Kerala Karshakan 40(7): 15-19 & 30

Sadanandan, A.K. and Johny, A.K. 1995 High yielding varieties in spices - 'The Hindu'

Sadanandan, A.K. and Johny, A.K. 1994 Annual report of AICRP on Spices 1993-94, NRCS,

Sadanandan, A.K. and Johny, A.K. 1994 Research Highlights - AICRP on Spices 1993-94 NRCS Calicut

Sasikumar, B. and K. Veluthambi 1994 Strain and vector specificity in *Agrobacterium* - black pepper interaction. Paper presented in the first International Symposium on Plantation crops (PLACROSYM-XI), Kozhikode Nov 30-Dec 3 1994

Sasikumar, B. and K. Veluthambi 1994 Kanamycin sensitivity of cultured tissues of *Piper nigrum* L. Journal Spices and Aromatic Crops 3:(2) (in press)

Sasikumar, B., Nirmal Babu, K., Jose Abraham and Ravindran P N 1992 Variability, correlation and path analysis in ginger germplasm. Indian J. Genetics and plant breeding, 52: 428-431

Sasikumar, B., Ravindran, P.N. and Johnson K George 1994 Breeding ginger and turmeric. Indian Cocoa, Arecanut & Spices Journal 18(1) :10-12

Sasikumar, B. 1994 Genetic vulnerability in nutmeg. Spice India (Malayalam) 7(12): 1

Sasikumar, B. 1994 Sex segregation in nutmeg. Spice India (Malayalam) 8(3):1

Sivaraman, K. , Kandiannan K and Thankamani C K 1994 (Ed.) Annual Report 1993-94. NRCS, Calicut

Sivaraman, K. Thankamani C K and Kandiannan K 1994 Advances in Black pepper production. Spice India 7 (9) :9-11

Sivaraman, K. , Thankamani C K and K. Kandiannan (Ed) 1995 Research Highlights 1994 - 95, NRCS.

Sivaraman, K 1995. Production Technology of Ginger and Turmeric. Manual - Refesher Training Course in Plantation Crops. Central Plantation Crops Research Institute. Kasragod.

Sivaraman K and Palaniappan SP 1994 Turmeric -maize and onion intercrropping systems. 1 Yield and land use efficiency journal of Spices and Arromatic Crops 3: 19 - 27

Sivaraman K and Palaniappan SP 1994 Yield advantages of turmeric - maize intercropping systems. Paper presented in the first International Symposium on plantation Crops. Nov. 30 - Dec 3 1994, Calicut, Kerala

Thankamnai, C.K., Sivaraman , K, Kandiannan K and Peter K V . 1994 Agronomy of tree spices.(clove, nutmeg, cinnamon and allspice) - a review. Journal of Spices and Aromatic crops. 3(2): 105 - 123.

Thankamnai, C.K., Sivaraman K and Kandiannan K 1994 Rapid multiplication of black pepper. Spice India(Malayalam) 7(9): 11 - 13.

Thankamnai, C.K., Sivaraman K and Kandiannan K 1995 Vesicular Arbuscular Mycorrhizae. Environment friendly fungi for improving soil fertility. Spice India 8(1): 2 - 3.

PARTICIPATION IN SYMPOSIA / SEMINARS / CONFERENCES / GROUP MEETINGS / LECTURES

All the Scientists

National Seminar on Diseases of Spices 7-8 April 1994. Indian Society of Spices . Calicut

International Symposium on Plantation Crops PLACROSYM-XI 30 Nov.30-Dec.3 Calicut

Anandaraj M

National Group meeting on *Phytophthorra* diseases of horticultural Crops 21-23 September 1994 Calicut

Global Conference on recent advances in plant diseases and their managementt 12-17 Feb 1994 Udaipur

Third National Conference on Mycorrhizae 13-15 March 1995 New Delhi

Dake, G.N.

Scientific Panel Meeting of Horticulture, Indian Council of Agricultural Research, Krishi Bhavan, New Delhi from July 7-8, 1994

National Group Meeting on *Phytophthora* diseases of Horticultural Crops held at National Research Center for Spices, Calicut during September 21-23, 1994

Devasahayam, S.

National Group Meeting on *Phytophthora* Diseases of Horticultural Crops, 21 -23 September 1994, Calicut.

John Zachariah, T.

Delivered talk on Processing and value addition of spices in the technology clinic organized by STED project of Govt. of Kerala at Calicut and Kottayam on 6th and 10th of June 1994 respectively.

Presented a talk on Advances in Processing and value addition in spices for the Agricultural Officers of scheduled and Gramin Banks organized by NABARD on 31st January 1995.

Attended workshop on Quality Maintenance and safety in spices and the role of irradiation organized by Spices Board and Bhabha Atomic Research Center, Bombay on 1995 February 20 and 21 at Cochin.

Krishnamurthy B.

Course on 'Exchange and quarantine of plant genetic resources' from 10.1.95 to 24.1.95 conducted by NBPGR, New Delhi

Peter, K.V.

Seminor on Biofertilizers and Bioagents organized by Spices Board, Cochin. April 22 1994

Review Meeting, Dept. of Biotechnology, New Delhi, 4-5, July 1994

National Hotricultural Research and Development Foundation-Research Advisory Committee Meeting, 28 September 1994. New Delhi

National Seminar on Garlic and Onion, Sept. 28-29, 1994

Central Sub-Committee on Seed Certification, Krishi Bhavan, New Delhi, Sept. 30.1994
ICAR- Directors Conference, 7-8, Nov.1994.New Delhi

Directors of Horticultural Division Conference, ICAR, 9, Nov. 1994, New Delhi

Ramana, K.V.& Santhosh J Eapen

National Group Meeting on *Phytophthora* diseases of horticultural crops, Calicut Sept 21-23, 1994

National Symposium on Nematode problems of India - An appraisal of the nematode management with eco-friendly approaches and biocomponents, IARI, New Delhi March 24-26 1995

Ninth Biennial Group Meeting of All India Co-ordinated Research Project on Plant Parasitic Nematodes with Integrated Approach for their Control, IARI, New Delhi March 22-23, 1995

Sasikumar, B.

Attended the seminar and panel discussion on Breeding Perennial Crops - traditional and molecular approaches at Rubber Research Institute, Rubber Board, Kottayam 16 Jan 1995

Underwent advanced training in plant molecular biology (RAPD and genetic transformation using particle gun) at the Plant Biotechnology Institute, National Research Council, Saskatoon, Canada for 3 months (24.4.94 to 2.8.94) as part of DBT National Associate ship.

Award / recognition

A k Sadanandan and S Hamza - Dr. R L Narasimha Swamy Memorial Award for the second best original research paper presented at First International Symposia on Plantation Crops - PLACROSYM-XI, Nov 29 - Dec 3, 1994

PERSONNEL

STAFF LIST - CALICUT

SCIENTIFIC

Dr. K V Peter, Director
Dr. M Aravindan, Principal Scientist
Dr. S Edison, Project Co-ordinator (Spices)
Dr. Y R Sarma, Principal Scientist, Plant Pathology
Dr. P N Ravindran, Principal Scientist, Plant Breeding
Dr. A K Sadanandan, Principal Scientist, Soil Science
Dr. K V Ramana, Principal Scientist, Nematology
Dr. G N Dake, Senior Scientist, Plant Pathology
Dr. K Sivaraman, Senior Scientist - Agronomy
Mr. M Anandaraj, Scientist (SG), Plant Pathology
Mr. Jose Abraham, Scientist (SG), Statistics
Mr. S Devasahayam, Scientist (SG), Entomology
Mr. B Krishnamoorthy, Scientist ((SG) Plant Breeding
Dr. T G Nageshwar Rao, Scientist (SG) Plant Pathology
Mr. K M Abdulla Koya, Scientist (Sr.Scale) Entomology
Mr. K Nirmal Babu, Scientist (Sr.Scale), Plant Breeding
Dr. T John Zachariah, Scientist (Sr.Scale) Biochemistry
Dr. B Sasikumar, Scientist (Sr.Scale) Plant Breeding
Mr. K Johnson George, Scientist (Sr.Scale) Genetics & Cytogenetics
Dr. J Rema, Scientist (Sr.Scale) Horticulture
Mr. Santhosh J Eapen, Scientist (Sr.Scale), Nematology
Mr. R Ramakrishnan Nair, Scientist (Genetics & Cytogenetics)
Ms. N K Leela, Scientist (Organic Chemistry)
Ms. C K Thankamani, Scientist, Agronomy
Mr. K Kandiannan, Scientist, Agronomy
Mr. K S Krishnamurthy, Scientist, Plant Physiology
Mr. M V Prasad, Scientist, Agrl. Extn.

ADMINISTRATIVE

Ms. K Usha, Asst. Administrative Officer
Mr. T Gopinathan, Asst. Finance & Accts. Officer
Mr. M K Sachidanandan, Superintendent (A&A)
Mr. V L Jacob, Superintendent (KVK)
Mr. A P Sankaran, Assistant
Mr. C Padmanabhan, Assistant
Mr. V Vijayan, Assistant
Ms. V Radha, Senior Assistant
Ms. C Sunanda, Senior Clerk
Mr. P K Janardhanan, Senior Clerk
Mr. K S Sreekumaran, Senior Clerk
Mr. S Hareendrakumar, Junior Clerk
Mr. R N Subramanian, Junior Clerk
Ms. K Padminikutty, Junior Clerk
Mr. P Sundaran, Junior Clerk (KVK)
Mr. S M Chettiar, Senior Stenographer
Ms. P V Sali, Stenographer
Ms. Alice Thomas, Stenographer
Ms. C K Beena, Junior Stenographer

TECHNICAL

Dr. Johny A Kallupurackal, Technical Information Officer (T7)
Mr. P Azgar Sheriff, Technical Officer (T5) (Lib.)
Mr. Hamza Srambikkal, Technical Officer (Lab) (T5)
Mr. V Balakrishnan, Technical Assistant (T4)
Mr. K Samsudeen, Technical Assistant (T4)
Mr. M M Augusthy, Technical Assistant (T4)
Mr. V Sivaraman, Jr. Tech. Assistant (T-I-3)
Ms. P K Chandravally, Jr. Tech. Assistant (T2)

AUXILIARY

Mr M Vijayaraghavan, Driver (T-I-3)
Mr N Chandrahasan, Driver (T-I-3)
Mr K Balan Nair, Driver(T-1-3)
Mr T C Prasad Driver-cum-Mechanic (A) (KVK)
K K Bhaskaran Tea maker
M K Purushu Wash boy

SUPPORTING

Mr K Keeran SS Gr. III (Lab attender)
Mr N Ayyappan SS Gr. III (Mazoor)
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. (Lab attender)
Mr T Ammed Koya SS Gr. (Watch man)
Mr M Koru SS Gr. I (Watch man)
Mr V Balakrishnan SS Gr. I
Mr T Balakrishnan SS Gr. I (Mazdoor)
Mr K Balakrishnan Nair SS Gr. I (Mazdoor)
Mr P Prabhakaran Nair SS Gr. (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 K 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 P Gangadharan SS Gr. (Mazdoor)

NRCS EXPERIMENTAL FARM PERUVANNAMUZHI

TECHNICAL

Mr. V K Abubacker Koya, Farm Superintendent (T6)
Mr. K A Somanna, Farm Assistant (T4)
Mr. K T Muhammed, Jr. Technical Assistant (T-I-3)
Mr. V P Sankaran, Jr. Technical Assistant (T-I-3)
Mr. N A Madhavan, Jr. Technical Assistant (T-I-3)
Mr. N P Padmanabhan, Jr. Technical Asisstant (T2)
Mr. K Kumaran, Jr. Technical Assistant (T2)
Mr. K Chandran, Jr. Technical Assistant (T1)
Mr. K Krishnadas, Mechanic cum Pump Operator (T2)
Mr. P Bhaskaran, Jr. Technical Assistant (T1)
Mr. D K Eswara, Jr. Technical Assistant (T1)
Mr. A K Balan, Jr. Technical Assistant (T1)
Mr. K P Premachandran, Jr. Technical Assistant (T1)
Mr. K K Sasidharan, Jr. Technical Assistant (T2)

AUXILIARY

Mr. Ramanna Gowda, Driver (A)

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)
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)

AUXILIARY

Mr. K K Ravindran, Tea Maker
Ms. P N Kausalaya, Wash woman

KRISHI VIGYAN KENDRA

Mr. P S Manoj, Technical Officer (T6)
Mr. K D Prathapan, Technical Officer (T6)
Mr. K M Prakash, Training Asst cum Tech. Assistant (T4) KVK

SUPPORTING - (KVK)

Mr. C V Ravindran, SS.Gr.I (Mazdoor)12:52PM12:52PM
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)

IISR RS APPANGALA

SCIENTIFIC

Mr. V S Korikanthimath, Scientist (SG) Agronomy
Dr. M N Venugopal,Senior Scientist (Plant pathology)
Dr. Rajendra Hegde, Scientist (Agronomy)
Mr. P Rajeev, Scientist (Agrl. Extn.)
Dr. Ravindra Mulge, Scientist (Hort.)
Mr. S J Anke Gowda Scientist, (Plant physiology)

ADMINISTRATIVE

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

TECHNICAL

Mr. M K Appaiah, Sr. Farm Assistant (T4)
Mr. L Balakrishna, Jr. Technical Assistant (T2)
Mr. L Ananda, Jr. Technical Assistant (T1)
Mr. K B Prasanna Kumar, Jr. Technical Assistant (T1)
Mr. G Arumugham, Jr. Technical Assistant (T1)

AUXILIARY

Mr. H G Nanamaiah, Driver (T2)

SUPPORTING

Mr. B J Lakkaiah, Supporting Staff Gr. IV (Mali)
Mr. H Y Erappa, Supporting Staff 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. H 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)

Budget (in Rs.)

Item of expenditure	Plan	Non-plan
Establishment	29,698.00	72,72,140.00
TA	99,900.00	1,99,957.00
Expenditure on Assets	113,80,231.00	2,70,206.00
Contingent expenditure	44,89,859.00	22,31,679.00
Total	159,99,688.00	99,73,982.00
AP Cess fund	1,90,501.00	
KVK	17,99,629.00	

LIBRARY

Eighty seven new books, 155 bound volumes and 30 reprints apart from subscribing to 90 Indian and 58 foreign journals. 27 foreign and Indian journals were also received on gratis in addition to Annual Reports, Technical Reports and Newsletters from ICAR Institutes and Agricultural University (Total expenditure in Library Rs.5.5 lakhs).

Bibiliography on Spices is published regularly in Journal of Spices and Aromatic Crops published by the Indian Society for Spices.

Content Page Service: Contents of pages of all the foreign journals received in this Library were photocopied and sent to IISR, Regional centre, Appangala every month. The requests for photocopies of articles from the content pages were also provided for the use of Scientists of the concerned Institutes. Four issues of Agri Science Tit Bits were compiled and distributed to various agencies involved in spices research

utilised the library facility available in the Research Centre. Interlibrary loan facilites were introduced in the Library. Annual Reports and other publications of the research centre were mailed to various organisations / Institutes.

IMPORTANT VISITORS

Dr. Hamdy M. Eisa	World Bank, New Delhi
Mr. T. C. Jain	World Bank, New Delhi
Dr. P. K. Iyengar	Chairman, STEC, Thiruvananthapuram
Sri. W. Pongte	Minister of Agriculture, Govt. of Arunachal Pradesh
Dr. Maxwell Noronah	Bishop. Kozhikode
Dr.V.Krishnabhramam	Director, CEDT, Kozhikode
Mr. O.B. Okwudiri	National Root Crop Res. Inst., Nigeria
Sri. Amitabh Kant	Dist.Collector, Kozhikode
Dr. B.S. Basnet	Director (Agri.), Gangtok, Sikkim
Sri. T.T. Dorji	Secretary (Agri.), Gangtok, Sikkim
Dr. K. L. Chadha	DDG (Hort.), ICAR, New Delhi
Dr. P. Rethinam	ADG (PC),ICAR, New Delhi
Dr. R.S. Paroda	Director General, ICAR, New Delhi
Smt. Neela Gangadharan	Secretary,(Agri.), Govt. of Kerala, Thiruvananthapuram
Dr. D.P. Singh	ADG (Crop Science), ICAR, New Delhi
Dr. C. R. Bhatia	Secretary, DBT, New Delhi
Dr. V. K. Vinayak	Advisor, DBT, New Delhi

Rainfall data of Peruvannamuzhi 1994-95

Month	Rainfall (mm)	Rainy days
April 1994	242.0	12
May	155.5	10
June	1369.0	29
July	1616.8	31
August	796.7	28
September	337.0	17
October	578.0	23
November	153.0	11
December	-	-
January 1995	9.0	1
February	34.0	3
March	8.0	1