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A view of berries of *Piper nigrum* - the 'King of spice'

Back cover
Major spices grown in India

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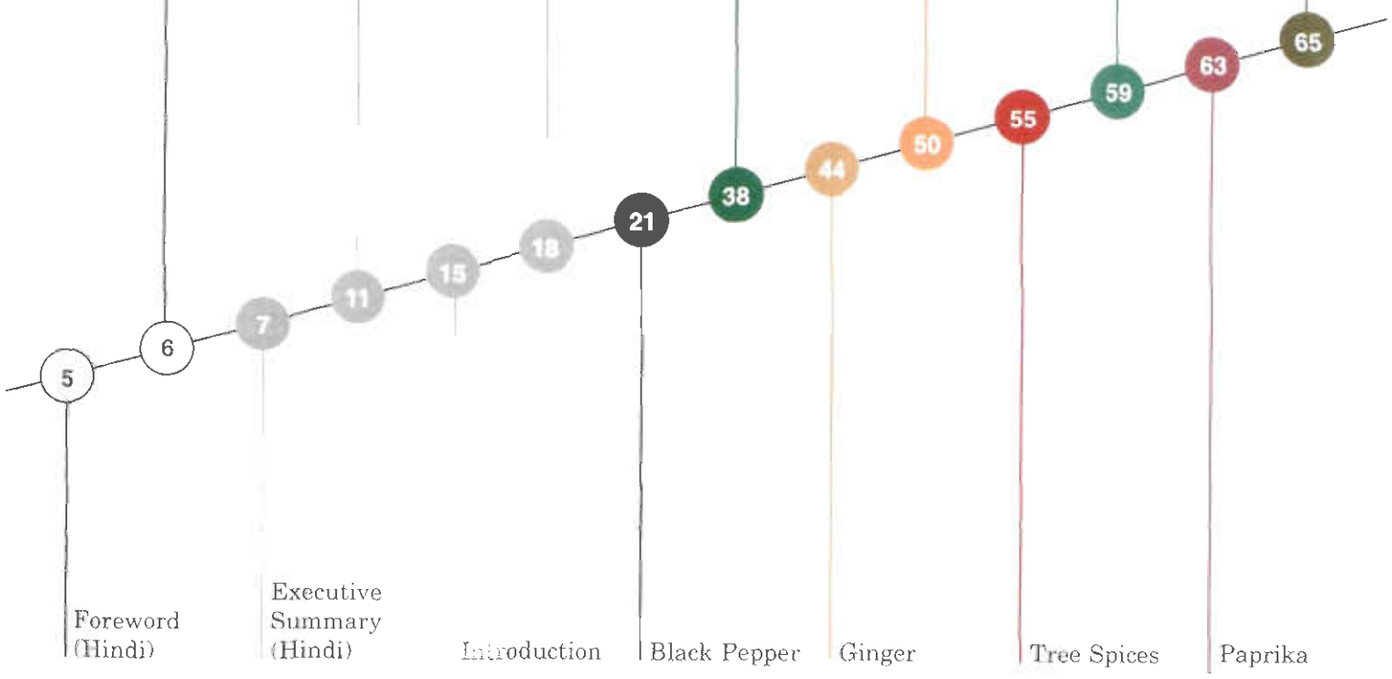

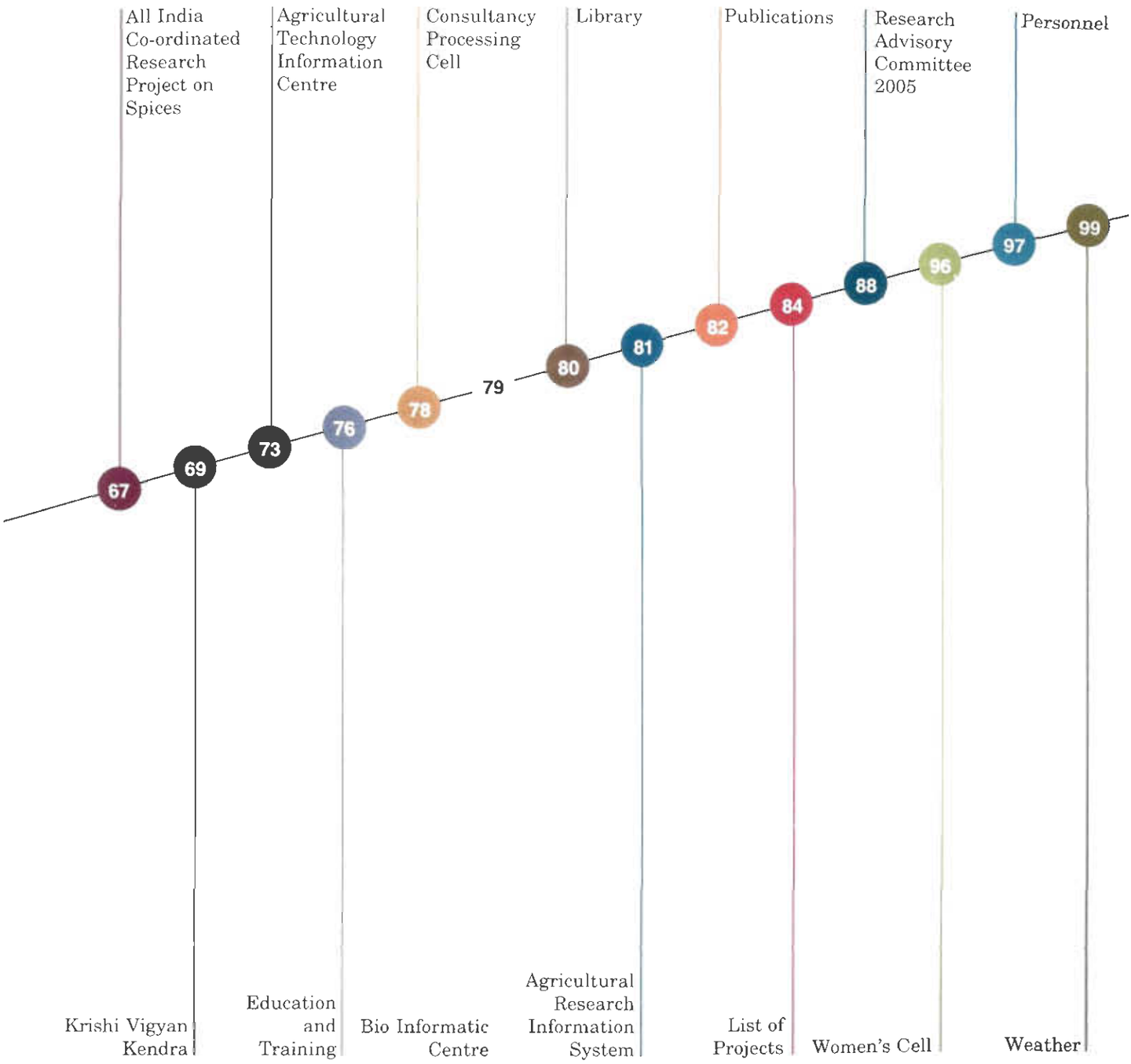
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भारतीय मसाला फसल अनुसंधान संस्थान द्वारा प्रकाशित वर्ष 2005-06 का वार्षिक प्रतिवेदन अनुसंधान, प्रसार तथा विकास के क्षेत्र में संस्थान द्वारा प्राप्त महत्वपूर्ण उपलब्धियों का संकलन है। मुझे यह बात कहने में गर्व का अनुभव हो रहा है कि इस संस्थान में दसवीं योजना में निर्धरित लक्ष्यों को लगभग प्राप्त करने में मेरे सहयोगियों का महत्वपूर्ण योगदान रहा है। इस दिशा में प्राप्त उपलब्धियों को शोध पत्र के रूप में प्रकाशित किया गया तथा जिनमें पिछले वर्षो की तुलना में काफी सुधार हुआ है। जैव -सूचना विज्ञान (बॉयो इंफारमेटिक्स) के उपकरणों के प्रयोग द्वारा सूचना तकनीक के उपयोग ने हमारी अनुसंधान समर्थताओं को अद्यतन करने में सहायता की है साथ ही मसालेवाली फसलों पर अखिल भारतीय समन्वित अनुसंधान परियोजनाओं के अन्तर्गत हमारे सहायक केन्द्रों से भी हमें काफी सहायता प्राप्त हुई है। हमारे आनुवंशिक संसाधन सदैव ही हमारी शक्ति का आधार रहे है और हम उन्हें भावी पीढियों के लिए अनवरत संपन्न कर रहे हैं।

हमें इन उपलब्धियों को प्राप्त करने में भारतीय कृषि अनुसंधान परिषद के महानिदेशक डॉ मंगलाराय, उपमहानिदेशक (बागवानी) डॉ गौतम कल्लू तथा सहायक महानिदेशक (रोपण फसलें) डॉ के वी रमणा,का भरपूर समर्थन एवं आशीर्वाद प्राप्त हुआ है। मैं उनके द्वारा दिए गए समर्थन और सहयोग के लिए उनका ह्दय से आभारी हूँ। डॉ एस कन्हैयन, अध्यक्ष, अनुसंधान सलाहकार समिति तथा समिति के सभी सदस्यों और संस्थान प्रबन्ध समिति के प्रति अपना आभार प्रकट करता हुँ जिन्होंने हमें अपने अनुसंधान कार्यक्रमों को सफल बनाने में अपना सहयोग दिया। इस वार्षिक प्रतिवेदन को प्रकाशित करने में संपादन समिति के अपने युवा और सक्रिय सदस्यों को भी धन्यवाद देता हूँ जिन्होंने जून के अंतिम सप्ताह के पूर्व ही बनाने इसे प्रकाशित कर सराहनीय कार्य किया है। मैं उन्हें ह्दय से धन्यवाद देता हूँ। वार्षिक प्रतिवेदन में और अधिक सुधार के लिए प्राप्त सुझावों और टिप्पणियों का स्वागत है।

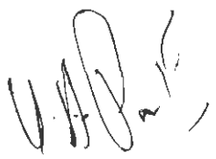
वी ए पार्थसारथी
निदेशक

जून 17, 2006

FOREWORD

The Annual Report for 2005-06 is a compilation of the significant achievements made by Indian Institute of Spices Research in areas of research, extension and development. I am very proud to place on record the significant contribution made by my colleagues at this institute is nearly achieving our set target for the 10th Plan. In this direction, the achievements made were published as research papers which have significantly improved over the years. The use of information technology through bio-informatics tools has helped in updating our research capabilities coupled with the able support received from our coordinating centres under All India Coordinated Research Project on Spices. Our strength has always been our genetic resources and we continue to enrich them for the posterity.

The achievements would have been made impossible but for the strong support we continue to receive from the Director-General, Dr. Mangala Rai and the Deputy Director-General (Hort.), Dr. G. Kalloo. Dr. K.V. Ramana, the Asst. Director-General (PC) stood solidly behind us. I thank all of them for the support they gave to us. The wise counsel of Dr. S. Kannaiyan, Chairman of Research Advisory Committee & the members of the RAC and Institute Management Committee helped us to fine tune our research programmes. My team of young and dynamic members of the Editorial Committee have done a good job in bringing the Annual Report before the last week of June. I thank them profusely. I would appreciate receiving comments and suggestions for improving our Annual Report.



June 17, 2006

V.A. PARTHASARATHY
DIRECTOR

कार्यकारी सारांश

कालीमिर्च

प्रतिवेदित अवधि के दौरान कालीमिर्च के जननद्रव्य रिपाजिटरी में कुल 62 प्रविष्टियों का समावेश किया गया। नेलियमपैथी वन से एकत्र किए गए नर प्रजाति के पी. गेलिएटम को इसके असमान्य रूप से लंबे स्पाइक के कारण अद्वितीय पाया गया जिसके स्पाइक की लंबाई 24.5 सेंमी. थी। कालीमिर्च जननद्रव्य के अभिलक्षणों से पाइपर सुगन्धि, पी. बाबाबुदानी, पी. स्मलि, पी. विग्टी तथा पी. नाइग्रम के बीच घनिष्ठ संबंध पाया गया। कालीमिर्च किस्मों में से अंतः माइकोसैटेलाइट क्षेत्र में कम विविधता पाई गई। दक्षिण भारत की 16 जंगली प्रजातियों की जैव जलवायु विश्लेषण तथा पूर्वानुमान पद्धति की तुलना से पता चलता है कि जहां काली मिर्च अधिक रूप से होती है वहां उनमें प्रचुर विविधता और धनिष्ठता पाई जाती है। सर्वाधिक सम्पन्न ग्रिड में 15–16 प्रजातियां पाई गईं जबकि उच्चतम विविधता मूल्य 1.8 से 3 के बीच पाया गया।

पी. कोलब्रीनम प्रजाति में विकृत प्राइमर के उपयोग द्वारा फाइटोफ्थोरा प्रतिरोध के लिए लक्ष्य जीन प्रवर्धन के प्रयोग से 252 बीपी सीक्वेंस का पृथक्कीकरण किया गया तथा 84 एमीनो अम्ल की कोडिंग की गई। ख्याति प्राप्त पराजीनी कालीमिर्च के पौधे जिनमें औस्मोटिन था को हार्डेनिंग के लिए लगाया गया। पी–24 (04–पी 24–1) तथा एच.पी.–1533 (04–एच.पी. 1533–1) में प्रत्येक की एक पौध ने फूट रॉट के प्रति सहिष्णुता दर्शाई।

कालीमिर्च के पी. कोलुब्रिनम मूलवृंत (पी.कैप्सिकी प्रतिरोधी) के मूल्यांकन से पता लगा कि रोपण के सात वर्ष पश्चात भी कलमें स्वस्थ थीं तथा असिंचित बागों में भी प्रत्येक बेल से 0.650 कि.ग्रा. (सूखा) उपज प्राप्त हुई।

कालीमिर्च के इंडोफाइटिक जीवाणु के 81 आइसोलेट्स का अभिलक्षणीकरण किया गया जिसमे फ्लोंरिसेंट स्यूडोमोनस के 15 विभेद, नॉन–फ्लोंरिसेंट स्यूडोमोनस के 12 विभेद, सेराटिया स्पीसीज के 2 उपभेद (स्ट्रेन्स), बैसिलस स्पीसीज के 42 स्ट्रेन्स, आरथोबेक्टर स्पीसीज के 22 स्ट्रेन्स, माइकोकोकस स्पीसीज के 6 स्ट्रेन्स और 10 अचिन्हांकित स्ट्रेन्स शामिल हैं । सिडोमोनस फ्लोरेसेंस के रूप में पहचानी गई प्रजाति की विशिष्ट प्राइमर्स के साथ पी सी आर एमपलीकेशन के द्वारा पुनःपुष्टि की गई है।
ओपन रीडिंग फेम I (ओ आर एफ I) तथा बैडना वायरस के ओ आर एफ III जो काली मिर्च को संकमित करते हैं कि अन्य ज्ञात बैडना वायरस से तुलना और सिक्वेंस विश्लेषण करने पर यह पाया गया कि पाइपर यैलो मोटल वायरस (पी वाई एम वी) ने उच्च स्तर की संक्रामकता दिखाई । जबकि इस कम में बनाना स्ट्रीक वायरस (बी एस वी) दूसरे स्थान पर था । संकमित काली मिर्च के पौधे एवं बहुविध पी सी आर से आर एन ए तथा डी एन ए का एक साथ अलगाव की विधि का मानकीकरण किया गया । ताकि सी एम वी तथा बैडनावायरस रोगों का एक साथ पता लगाया जा सके ।

आर. सिमलिस की पहचान के लिए आई टी एस जीन में सिक्युएंस आधारित प्रजाति विशिष्ट प्राइमर्स को विकसित किया गया । प्राइमर सैट ने एक एकल पी सी आर फ्रेगमेंट उत्पन्न किया जो लम्बाई में 400 bp था *आर सिमलिस* के लिए यह विशिष्ट पाया गया ।

लेबोरेटरी बायोएसेज में इमिडैक्लोप्रिड 0.025 प्रतिशत, लम्डा–साइहलोथ्रेन 0.025 प्रतिशत, एसिटामिप्रिड 0.025 प्रतिशत तथा कार्बोसल्फान 0.075 प्रतिशत को रूट मिलिबग के प्रति अच्छा पाया गया ।

जुलाई से दिसम्बर के बीच सामान्य से अधिक वर्षा फसल के लिए लाभदायक पाई गई तथा उपज वृद्धि में सहायक सिद्ध हुई । दिसम्बर के पश्चात सामान्य से अधिक वर्षा ने काली मिर्च की उपज में कमी दर्शाई ।

फार्म यार्ड मैन्योर एवं उसके बाद कृमि कम्पोस्ट मिलाकर प्रयोग करने से फास्फोरस अधिशोषण मैक्सिमा बहुत कम हो गई, इसके विपरीत नारियल मज्जा कम्पोस्ट का प्रयोग करने से अधिशोषण की मात्रा में वृद्धि हो गई। अधिशोषण मैक्सिमा उपलब्ध लौह एवं ऐलुमिनियम अवशेष का प्रयोग दोनों सुविचारित मृदा में नकारात्मक रूप से उपलब्ध फास्फोरस से बहुत सह–संबद्ध पाए गए ।

नर्सरी काली मिर्च मिश्रण में बालू के बदले ग्रेनाइट चूर्ण का प्रयोग अच्छे स्थानापन्न के रूप में पाया गया । बालू के बदले पत्थर खदान से प्राप्त वेस्ट पदार्थ ग्रेनाइट चूर्ण का प्रयोग अधिक किफायती पाया गया ।

काली मिर्च सुखाने में लगभग 36, 32 एवं 26 घंटे का समय लगता है तथा इसके लिए कमशः 50° से. 55° से. तथा 60° से. ताप की जरूरत पड़ती है तथा खुली धूप में पूर्ण रूप से सूखाने में 68 घंटे का समय लगता है । विवर्ण अवस्था में सूखाने से और अधिक समय लगता है। काली मिर्च की पांच पजातियां (प्रत्येक के 15 कि.ग्रा0) का चार अर्थात् 3.5 से 3.8 मि.मी., 3.8 से 4.8 मि.मी. एवं 74.8 मि.मी. आकार का श्रेणीकरण किया गया । इनमें 50 प्रतिशत दाने (बेरीज) 3.5 से 3.8 मि.मी. के आकार की पाई गई । आठ मास बाद खाली स्थानों में संग्रहित काली मिर्च के नमूने की गुणवत्ता उत्कृष्ट पाई गई।

जैविक रूप से बोई गई पन्नियूर–1 एवं करीमुण्डा प्रजातियों के आवश्यक तैल अवयवों में करियोफिलीन की उच्च मात्रा पन्नियूर–1 (30 प्रतिशत तक) तथा करीमुण्डा में 24 प्रतिशत पाई गई ।

इलायची

भूमि जननद्रव्य भंडार में कुल 416 नई प्रजातियों का संग्रह किया गया है। अभिलक्षणित 72 नई प्रजातियों (13 मिश्रित पुष्प गुच्छ एवं 59 मालावर नयी प्रजातियां) का आई पी जी आर आई विवरणात्मक पर आधारित 15 परिणात्मक गुणों की विशेषता बताई गई । इस वर्ष के दौरान केरल के कृष्य एवं जंगली क्षेत्रों से इलायची के कुल 23 जननद्रव्य संग्रह किए गए जिसमें इदुकी से संग्रहित विशेष रूपात्मक चिन्हित आकार की अर्थात बिना पीले धारी वाली सफेद चिन्हित पुष्प की प्रजातियां शामिल थीं । पैरामबी कुलम से संग्रहित मोटा जननद्रव्य एवं वन्य जननद्रव्य अन्य आशाजनक प्रजातियां हैं ।

भारत, श्रीलंका तथा ग्वाटेमाला से निर्यात की जाने वाली इलायचियों की श्रेणियों का भौतिक, जैव रसायन पैरामीटर एवं आण्विक तकनीक आधार पर अभिलक्षण करने पर भारतीय उत्पादों को भूसी अनुपात के अनुसार बीज, 100 कैपसूलों का वजन, कैपसूलों की संख्या 100 ग्राम में, अधिक घनत्व एवं आर्द्रता अपशिष्ट भौतिक पैरामीटरों के संबंध में उत्कृष्ट पाया गया।

23 सर्वोत्कृष्ट एक्सेशन की लीफ ब्लाइट तथा लीफ ब्लाच के प्रति स्वाभाविक प्रतिक्रियाओं को रिकार्ड किया गया। आठ उच्च पैदावार वाली नई प्रजातियों को पर्णीय रोगों के प्रति मध्यम रूप में प्रतिरोधी पाया गया।

इलायची जीन प्ररूप ग्रीन गोल्ड (ए पी जी–257),, मैसूर–2 (ए पी जी–414), मालावर–18 (ए पी जी–434) प्रजातियों में दबाव की वजह से उच्च जैव मात्रा एवं उच्च आपेक्षिक जल मात्रा कायम रही। आर्द्रता दबाव के प्रति अपेक्षाकृत सहनशील पाए गए । चार चयनित प्रजातियों सी एल–893 (ए पी जी 244), सी एल–893 ओ पी, सी सी एस आई x 893 प्रजातियों का मूल्यांकन एवं क्रास संयोग से स्थापना अवधि में अधिक मात्रा में किसानों की संख्या एवं पत्तियों की पैदावार में वृद्धि देखी गई ।

अदरक

नैपाल के अदरख के चुने गए जनन द्रव्यों का मूल्यांकन करने पर एक्सेशन–578 प्रजाति पैदावार एवं गुणवत्ता में उत्कृष्ट पाई गई। अदरक की विदेशी जननद्रव्य जिंजीबर ऑफीसिनेल किस्म रूबेन्स (किंटोकी) से 1.27 प्रतिशत रेशा, 1.5 प्रतिशत तेल, 3.35 प्रतिशत ओलियोरेजिन, 52.57 प्रतिशत स्टार्च तथा 43.8 प्रतिशत शुष्क पदार्थ की प्राप्ति हुई।

केरल, कर्नाटक, उत्तर प्रदेश और सिक्किम में अदरक में राइजोम रॉट पैदा करने वाली पिथियम की प्रजाति की पहचान पी. मिरियोटिलम के रूप में जिसे पीसीआर आधारित पद्धति का उपयोग करके पाया गया कि यह पी. मिरियोटिलम के जीनोमिक डीएनए में 150 बीपी सीक्वेश बढ़ाती है।

रैल्स्टोनिया सोलैनेसीरम की उत्तर पूर्व राज्यों, सिक्किम एवं केरल के अदरक में बैक्टीरियम विल्ट रोग के आइसोलेट्स रेप–पीसीआर प्रोफाइल में शतप्रतिशत समान पाए गए। भौगोलिक रूप से एक दूसरे से बिल्कुल अलग स्थानों पर पैदा होने वाली बहुत घनिष्ठ समानता गुणांक से प्रजातियों का एक स्थान से दूसरे स्थान पर स्थानान्तरण का पता चलता है।

हल्दी

एक्स–सीटू जीन बैंक में सैंकड़ों जिंजिबर और करक्यूमा का रखरखाव किया जा रहा है। सी.अमाडा नामक भारतीय मैंगों जिंजर को आर. सोलेनेसिएरम के प्राकृतिक संक्रमण के प्रति रोधी पाया गया।

16 करक्यूमा प्रजातियों के आण्विक आनुवांशिक फिंगरप्रिंट में 39 आर ए पी डी प्राइमर का प्रयोग करके तथा 8 इंटर सैम्पल सीक्वेंश रिपीट्स (आईएसएसआर) प्राइमरों से पॉलीमारफिज्म की उच्च अवस्था का पता चला। यूपीजीएमए एल्गोरिद्म का प्रयोग करके बैंडिंग पैटर्न के क्लस्टर विश्लेषण द्वारा 16 प्रजातियों को 7 वर्गों में रखा गया।

आधार पर के मुख्य स्यूडोस्टेम पर छेद करने के अलावा तना बेधक के लार्वा पत्तियों के पिटीओल पर छेद करके मुख्य केन्द्रीय प्ररोह में प्रवेश कर जाते हैं। इन मुलायम प्ररोहों तथा पत्तियों पर इस कीट के प्रकोप के प्रारंभिक लक्षणों की पहचान की गई। पेरूवन्नामुषि में तना बेधक के प्राकृतिक शत्रुओं में मरमिथिड तथा डरमेप्टेरस को दर्ज किया गया। मरमिथिड नीमेटोड्स को सम्पूर्ण फसल काल में देखा गया ताथा नीमेटोड द्वारा पेरासिटाइज्ड लार्वा की जनसंख्या का प्रतिशत अगस्त तथा सितम्बर में अधिक पाया गया।

वृक्ष आधारित मसाले

क्लोव, नटमेग तथा सभी मसालों के एक्सेशन हेतु आई सी नम्बर एनबीपीजीआर, नई दिल्ली से प्राप्त किए गए। केसिया सी1 (आईसी 370415) को एनबीपीजीआर, नई दिल्ली में आईएनजीआर 05029 को इसके उच्च ओलियोरेजिन कंटेन्ट (10.5 प्रतिशत) के रूप में पंजीकृत किया गया है। हॉट एयर ड्रायर का प्रयोग करते हुए मेस को सुखाने में लगभग साढ़े तीन घंटे लगे जबकि नट को 15 दिन (अर्थात् एक दिन तक 60^{0} सें0 पर एक दिन तक सुखाना तथा दो दिन तक टेंपरिंग, इसे 15 दिन तक दुहराया गया जब तक कि एक स्थिर भार प्राप्त हो जाए)।

मेस से प्राप्त ड्राइ–रिकवरी 35.6 प्रतिशत थी जब कि नट की 58.2 प्रतिशत। नट का मेस के प्रति रिकवरी का अनुपात 5.75:1 था। 300 ग्राम के पॉलीप्रापिलीन कवर में 180 दिन के संग्रहण के पश्चात मेस को उबलते पानी में दो मिनट तक ब्लां.च करने पर अच्छा कलर रिटेंशन मिला (लायकोपीन–49.9 प्रतिशत) जबकि तुलनात्मक रूप से एक मिनट की ब्लाचिंग तथा बिना ब्लाचिंग के लायकोपिन का प्रतिशत कमशः 38.7 तथा 9.98 प्रतिशत पाया गया।

वेनिला

वेनिला की पत्तियों में साधारण क्लोरोटिक मॉटल और स्ट्रीक्स पैदा करने वाले वाइरस की पहचान सिम्बिडियम मोजेक वाइरस (सिम एम वी) के एक स्ट्रेन (प्रभेद) के रूप में की गई जिसे कोट प्रोटीन जीन सीक्वेंश कम्पेरिजन तथा फाइलोजेनेटिक अध्ययनों के आधार पर ज्ञात किया गया।

इस वाइरस के कोट प्रोटीन जीन का क्लोनीकरण और सीक्वेंसिंग की गई। सीक्वेंश विश्लेषण से इस वाइरस के सिम एमवी के एक प्रभेद के रूप में पुष्टि हुई। भारत के विभिन्न आर्किड्स को भिन्न भिन्न प्रकार के सिमएमवी आइसोलेट्स द्वारा 92.3 से लेकर 97.3 प्रतिशत तक संक्रमित करते पाया गया जबकि उपलब्ध पारशियल सीपी सीक्वेंश के सिम एमवी आइसोलेट्स द्वारा वैनिला में संक्रमण 98.2 से 99.4 प्रतिशत तक पाया गया।

वेनिला प्रजाति के 10 टिश्यू कल्चर पौधों की स्क्रीनिंग की गई तथा फाइटोफ्थोरा मिएडी तथा फ्यूजेरियम ऑक्सीस्पोरम हेतु लगाई गई सीडलिंग प्रोजिनीज से पता चला कि सभी सीडलींग फ्यूजेरियम ऑक्सीस्पोरम के प्रति संवेदनशील थे जबकि 7 प्रोजिनीज एफ. ऑक्सीस्पोरम के प्रति सहिष्णु।

पपरिका

पपरिका के 31 संकर तथा 30 जननद्रव्य सैम्पल का उनके कलर मूल्य, ओलियोरेजिन तथा कैप्सेसिन तत्व के लिए मूल्यांकन किया गया। एक्सेसन 0107-7011 ने 15.9 प्रतिशत आजियोरेजिन तथा 1. 02 कैप्सेसिन प्रतिशतता के साथ 308 एएसटीए इकाई दर्शाई जबकि एमएस–2एक्स बी–2 ने 15.7 प्रतिशत ओलियोरेजिन तथा 1 प्रतिशत कैप्सेसिन प्रतिशतता के साथ 308 एएसटीए इकाई दर्शाई ।

मसालों में माइकोटॉक्सिन

बाजार से एकत्र किए गए मसाले के नमूनों से *एस्परजिलस नाइजर, ए. पेरासिटिकस, एस्परजिलस फ्लेवस, पेन्सिलियम स्पी.* तथा *म्यूकर स्पी.* का पृथक्कीकरण किया गया। इन सैम्पलों में द्वितीयक मैटाबोलाइट्स जैसे इैसेंसियल ऑयल तथा ओलियारेजिन की भी कम मात्रा पाई गई।

कृषि विज्ञान केंद्र

कृषि विज्ञान केंद्रों द्वारा पतिवेदित अवधि में विभिन्न विषयों पर 129 प्रशिक्षण कार्यक्रम, कई ऑन फार्म परीक्षण तथा अग्र पंक्ति निदर्शन कार्यक्रमों आयोजित किए गए। इन कार्यक्रमों से कुल 3779 व्यक्ति लाभान्वित हुए हैं। इसके अतिरिक्त, कृषि विज्ञान केन्द्रों द्वारा गैर सरकारी संगठन उदाहरणार्थ सेंटर फॉर ओवरआल डेवलपमेंट (सीओडी), विकास वालंटियर वाहिनी क्लब (वीवीवी) तथा आईएनएफएएम इत्यादि के सहयोग से भी कई कार्यक्रम चलाए गए।

रोपण सामग्रियों का उत्पादन

कालीमिर्च की जड़ कटिंग्स का न्यूक्लियस रोपण सामग्री (83000), कालीमिर्च के रूटेड लेटरल्स या पार्श्वशाखाएं (2122), हल्दी बीज प्रकन्द्र (21 टन), अदरक के बीज प्रकन्द (4.2 टन), नटमेग की कलमें (5623), इलायची की पौध (15000), इलायची सकर (1000), एवं इलायची कैप्सूल (3 किग्रा.) उपजाए गए और वितरित किए गए।

बॉयो–इंफारमेक्टिस सेंटर

रैपिड (आरएपीआईडी) जैसे डाटा बेस तथा साफ्टवेयर जो पेज (पीएजीई) डाटा , इंस्टीइंफो से यूनिक बेंड की पहचान में मदद करता है, का भारतीय कृषि अनुसंधान परिषद के बागवानी प्रभाग के अन्तर्गत सभी संस्थानों से सूचना मिलान हेतु उपयोग किया गया। संस्थान में फाइटोफ्थोरा की राष्ट्रीय रिपाजिटरी में संरक्षित फाइटोफ्थोरा संवर्द्धों पर डाटाबेस तथा कीमोइंफारमेटिक्स उपकरणों के उपयोग द्वारा हल्दी से औषधि बनाने वाले योगिकों की पहचान की गई।

Executive Summary

Black pepper

A total of 62 accessions were added to the germplasm repository. A male *Piper galeatum* with spike length 24.5 cm from Nelliampathy forest was found to be a unique collection for its unusually long spike. Characterization of pepper germplasm further revealed the close relationship among *Piper sugandhi*, *P. bababudani*, *P. schmdtii*, *P. wightii* and *P. nigrum*. Variation in the inter-microsatellite regions among pepper cultivars was found to be low. Bio-climatic analysis and prediction system (BIOCLIM) comparison of 16 wild species of South India revealed the rich diversity and 'niches' where *Piper* species occur predominantly. The highest richness grid was found to have 15-16 species while the highest diversity value found is 1.8 to 3.

Targeted gene amplification for *Phytophthora* resistance in *P. colubrinum* using degenerate primers resulted in isolation of a 252 bp sequence coding for 84 amino acids.

Putative transgenic black pepper plants containing 'osmotin' were planted out for hardening. One seedling each designated as P-24 (04-P24-1) and HP-1533 (04- HP 1533-1) showed tolerant reaction to foot rot.

Evaluation of black pepper on *P. colubrinum* rootstock (resistant to *Phytopthora capsici*) indicated that the grafts remained healthy even after seven years of planting and an average yield of 0.650 kg (dry) pepper per vine was harvested.

Characterization 81 isolates of black pepper endophytic bacteria comprised of fluorescent pseudomonads (15 strains), non-fluorescent pseudomonads (12 strains), *Serratia* sp. (2 strains), *Bacillus* spp. (42 strains), *Arthrobacter* spp. (22 strains), *Micrococcus* spp. (6 strains) and 10 unidentified strains. The species identity of *Pseudomonas fluorescens* was further confirmed by PCR amplification with specific primers.

Sequence analysis and comparison of Open Reading Frame I (ORF I) and ORF III of *Badnavirus* infecting black pepper with other known badnaviruses indicated high levels of identity with *Piper yellow mottle virus* (PYMV) followed by *Banana streak virus* (BSV). A method for simultaneous isolation of RNA and DNA from infected black pepper plants and multiplex PCR for simultaneous detection of *Cucumber mosaic virus* (CMV) and *Badnavirus* in a single reaction was standardized.

Species-specific primers were developed for the identification of *Radopholus similis* based on sequences in Internally Transcribed Spacer (ITS) gene. The primer set amplified a single band of ~400 bp in length that was specific to *R. similis*.

Imidacloprid 0.025%, lamda-cyhalothrin 0.025%, acetamiprid 0.025% and carbosulfan 0.075% were promising against root mealybug in laboratory bioassays.

The rainfall excess than normal between July to December end was beneficial to crop and would help in enhancing the yield. The rainfall excess than normal beyond December would reduce the yield of black pepper.

The P adsorption maxima was significantly reduced with the addition of FYM followed by vermicompost. On the contrary, coir pith compost

increased the rate of adsorption. Adsorption maxima, available iron and aluminium contents were significantly negatively correlated with available P in both the soils.

Granite powder was found to be a good substitute for sand in nursery mixture. Substituting sand with granite powder, a waste material obtained from stone quarries, was more economical.

The time required for drying black pepper was approximately 36, 32 and 26 h at 50° C, 55° C and 60° C respectively and open sun drying took 68 h for complete drying. Blanching accelerated the rate of drying. Berries from five varieties of black pepper were graded to 4 sizes i.e. < 3.5mm, 3.5 to 3.8mm, 3.8 to 4.8mm and > 4.8mm. More than fifty percent of the berries were of the size 3.5 to 3.8 mm. After eight months of storage, the black pepper samples stored in vacuum, showed good quality.

Essential oil constituents of organically cultivated Panniyur-1 and Karimunda showed higher values of Caryophyllene (up to 30%) in Panniyur-1 and 24% in Karimunda.

Cardamom

A total of 23 cardamom germplasm collections were made from cultivated and forests areas of Kerala during this year, which included a specific morphological marker type collected from Idukki, i.e. flowers with white labellum without any purple streaks. The other promising collections are bold capsule accessions and a wild accession from Parambikulam. A total of 416 accessions have been maintained in the field germplasm repository. Seventy two accessions (13 compound panicle and 59 Malabar accessions) were characterized for 15 quantitative characters based on IPGRI descriptor.

Characterization of export grade cardamom from India, Sri Lanka and Guatemala based on physical, biochemical parameters and molecular techniques revealed the superiority of Indian produce for physical parameters such as seed to husk ratio, weight of 100 capsules, no. of capsules in 100 g, bulk density and moisture content.

Natural reaction of 23 elite accessions to leaf blight (*Colletotrichum gloeosporioides*) and leaf blotch (*Phaeodactylium alpiniae*) was recorded. Eight high yielding accessions showed moderately resistant reaction to the diseases.

Cardamom genotypes Green gold (APG 257), Mysore-2 (APG 414), Malabar 18 (APG 434) maintained higher biomass and higher relative water content under stress. They are relatively tolerant to moisture stress. In evaluation of four selections and their cross combinations, CL-893 (APG 244) self, CL 893 OP, CCS1 x 893, GG x 893 produced more number of tillers and leaves per clump in establishment period.

Ginger

Evaluation of selected Nepal accessions of ginger revealed the superiority of Acc.578 for yield and other quality. The exotic accession of ginger, *Zingiber officinale* var. *rubens* ('Kintoki.) had yielded 1.27% fiber, 1.5% oil, 3.35% oleoresin, 52.57 % starch and 43.8 % dry recovery.

The species of *Pythium* causing rhizome rot of ginger in Kerala, Karnataka, Uttar Pradesh and Sikkim was identified, as *P. myriotylum* using PCR based method that was found to amplify 150 bp sequences in the genomic DNA of *P. myriotylum*. Isolates of *Ralstonia solanacearum* causing bacterial wilt of ginger in North Eastern State, Sikkim and Southern State, Kerala were found to be 100% similar in rep-PCR profile. Very close similarity coefficient between these two

geographically well separated distinct locations clearly indicated strain migration from one location to another.

Turmeric

924 accessions of *Curcuma* are maintained in the *ex situ* gene bank.

Molecular genetic fingerprints of sixteen *Curcuma* species using 39 RAPD primers and eight Inter Simple Sequence Repeats (ISSR) primers revealed high degree of polymorphism. Cluster analysis of the banding patterns using UPGMA algorithm placed the 16 species in seven groups

C. amada, the Indian Mango ginger was found resistant to bacterial wilt caused by *R. solanacearum*.

Apart from boring into the main pseudostem at the base, the shoot borer larvae were observed to bore into the leaf petiole to enter into the main central shoot. The earliest symptom of pest infestation on the tender shoot and leaf was identified. Mermithid nematodes and dermapterans were recorded as natural enemies of shoot borer larvae in the field at Peruvannamuzhi. Mermithid nematodes were observed throughout the crop season and the percentage of population of larvae parasitised by the nematode was higher during August and September.

Tree spices

IC Numbers for clove, nutmeg and allspice accessions were obtained from NBPGR, New Delhi. Cassia C1 (IC 370415) has been registered as INGR 05029 with NBPGR, New Delhi for its high oleoresin content (10.5%).

Using hot air drier, drying of mace took 3 ½ h at 60° C, while nut took 15 days (i.e. drying at 60° C for one day and tempering for two days, this was repeated for 15 days till a constant weight was achieved). The dry recovery of mace was 35.6% and that of nut was 58.2%. The ratio of nut to mace recovery was 5.75:1. After 180 days of storage in 300g polypropylene bags, the mace blanched for 2 min in boiling water showed better colour retention (Lycopene 49.9%) compared to 1 minute blanching (Lycopene 38.7%) and no blanching (Lycopene 9.98%).

Vanilla

A virus causing mild chlorotic mottle and streaks on leaves of vanilla was identified as a strain of *Cymbidium mosaic virus* (CymMV) based on coat protein gene sequence comparison and phylogenetic studies. The coat protein (CP) gene of the virus was cloned and sequenced. Sequence analyses confirmed the identity of the virus as a strain of CymMV. An identity of 92.3% to 97.3% was seen with different CymMV isolates infecting different orchids in India while with available partial CP sequences of CymMV isolates infecting vanilla identity ranged from 98.2 to 99.4%.

Screening of 10 tissue culture plants of *Vanilla* spp. and seedling progenies against *Phytophthora meadii* and *Fusarium oxysporum* indicated that all the seedlings were susceptible to *P. mea*dii whereas seven progenies were tolerant to *F. oxysporum*.

Paprika

Thirty-one hybrid samples and 30 germplasm samples were evaluated for colour value, oleoresin and capsaicin content. Acc 0107-7011 showed 308 ASTA units with 15.9% oleoresin and 1.02% capsaicin. MS-2 X B-2 showed 308 ASTA units with 15.7% oleoresin and 1% capsaicin.

Mycotoxin in spices

Aspergillus niger, A. parasiticus, A. flavus, Pencillium spp. and *Mucor* spp. were isolated from spices produce collected from market. These samples also possessed lower content of secondary metabolites *viz.*, essential oil and oleoresin.

KVK

The Kendra has conducted 129 training programmes, several On Farm Testing and Front Line Demonstration on various subjects during the period under report. A total of 3779 persons have benefited out of the programmes. Besides, KVK conducted activities in association with NGO's *viz.*, Centre for Overall Development (COD), The Vikas Volunteer Vahini club (VVV), *INFAM etc.*

Production of planting materials

Nucleus planting material of black pepper rooted cuttings (83,000 nos), black pepper rooted laterals (2122 nos), turmeric seed rhizomes (21 t), ginger seed rhizomes (4.2 t), nutmeg grafts 5623 nos), cardamom seedlings (15000 nos), cardamom suckers (1000 nos) and cardamom capsules (3 kg) were produced and distributed.

Bioinformatics

Databases & Softwares like 'RAPiD' that helps in identifying unique bands from PAGE data, 'InstInfo" for collation of information from all institutes under the Horticulture Division of ICAR, database on *Phytophthora* cultures conserved in the National Repository of *Phytophthora* at the institute and druggable *compounds from turmeric were identified using* chemoinformatics tools.

Present status of Spices Germplasm at IISR, Calicut

Crop	No. of accessions
Black Pepper	2300
Cardamom	439
Ginger	625
Turmeric	924
Nutmeg	484
Cinnamon	408
Garcinia	116
Clove	225
Allspice	180
Vanilla	93
Paprika	130

Introduction

History

Intensive research on spices in the country was initiated with the establishment of a Regional Station of Central Plantation Crops Research Institute (CPCRI) at Calicut, Kerala, during 1975, by the Indian Council of Agricultural Research (ICAR). This Regional Station was upgraded as National Research Centre for Spices (NRCS) in 1986 by merging with it the Cardamom Research Centre of CPCRI at Appangala, Karnataka. The NRCS was further elevated to the present Indian Institute of Spices Research (IISR) during 1995.

Location

The laboratories and administrative offices of the institute are located at Chelavoor (50 m above MSL), 11 km from Calicut (Kozhikode), Kozhikode District, Kerala, on the Calicut-Kollegal road (NH 212), in an area of 14.3 ha. The research farm is located 51 km North East of Calicut at Peruvannamuzhi (60 m above MSL), on the Peruvannamuzhi-Poozhithode road in Kozhikode District, in an area of 94.08 ha. The Cardamom Research Centre, Appangala (920 m above MSL) is located at Appangala, Kodagu District, Karnataka, on the Madikeri-Bhagamandala road, 8 km from Madikeri, in an area of 17.4 ha.

Mandate

- To extend services and technologies to conserve genetic resources of spices as well as soil, water and air of spices agroecosystems.
- To develop high yielding and high quality spice varieties and sustainable production and protection systems using traditional and non-traditional techniques and novel biotechnological approaches.
- To develop post harvest technologies of spices with emphasis on product development and product diversification for domestic and export purposes.
- To act as a centre for training in research methodology and technology upgradation of spices and to coordinate national research projects.
- To monitor the adoption of new and existing technologies to make sure that research is targeted to the needs of the farming community.
- To serve as a national centre for storage, retrieval and dissemination of technological information on spices.

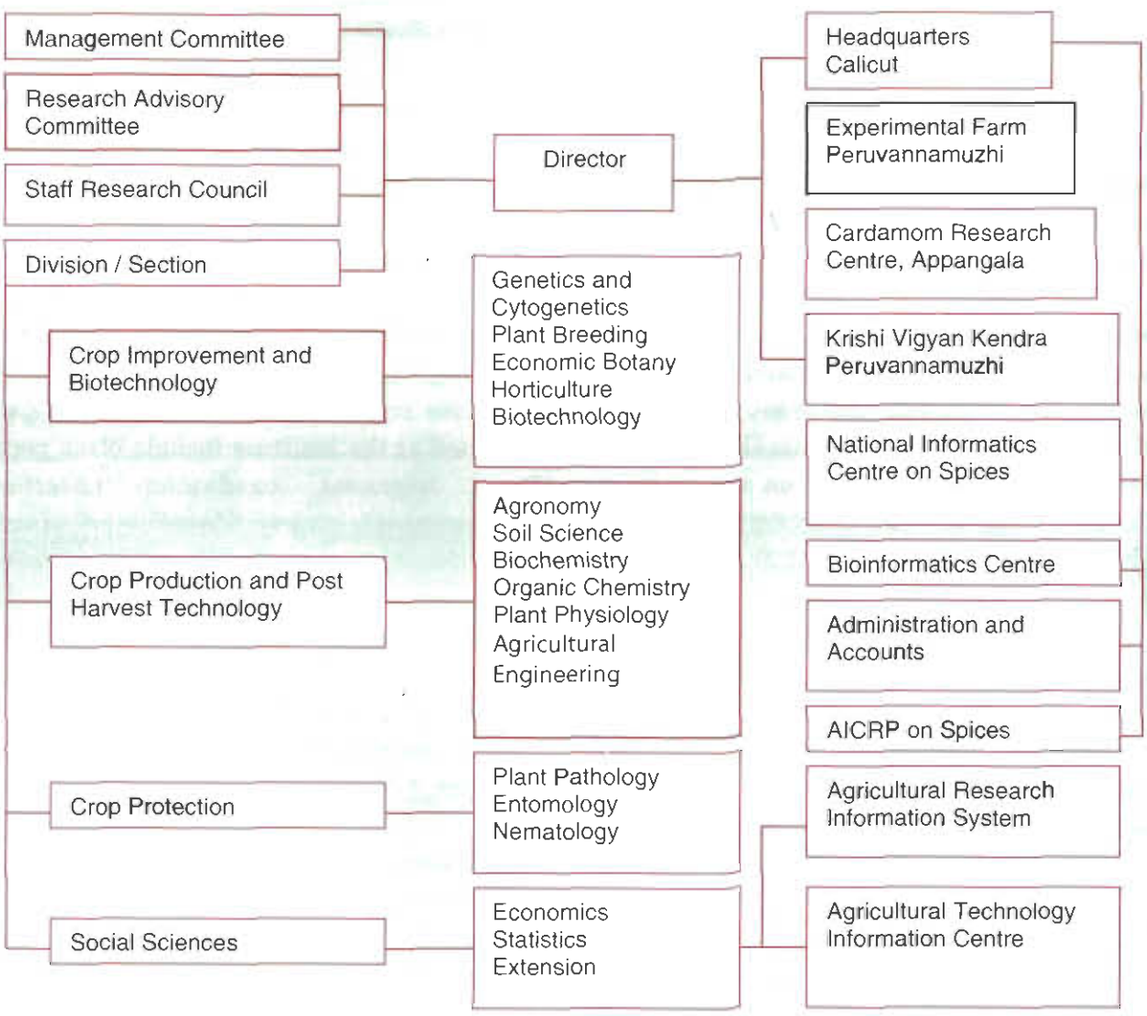
The spice crops on which research is being conducted at the institute include black pepper (*Piper nigrum*), cardamom (*Elettaria cardamomum*), ginger (*Zingiber officinale*), turmeric (*Curcuma longa*), cinnamon (*Cinnamomum verum*), cassia (*C. cassia*), clove (*Syzygium aromaticum*), nutmeg (*Myristica fragrans*), allspice (*Pimenta dioica*), Garcinia (*Garcinia gummi-gutta* and *G. indica*), vanilla (*Vanilla planifolia*) and paprika (*Capsicum annuum*).

Organization

The Director is the administrative head of the institute. The Institute Management Committee, Research Advisory Committee and Staff Research Council assist the Director in matters relating to management and research activities of the institute

Research on various aspects of the mandate crops is conducted in three divisions, namely, Division of Crop Improvement and Biotechnology, Division of Crop Production and

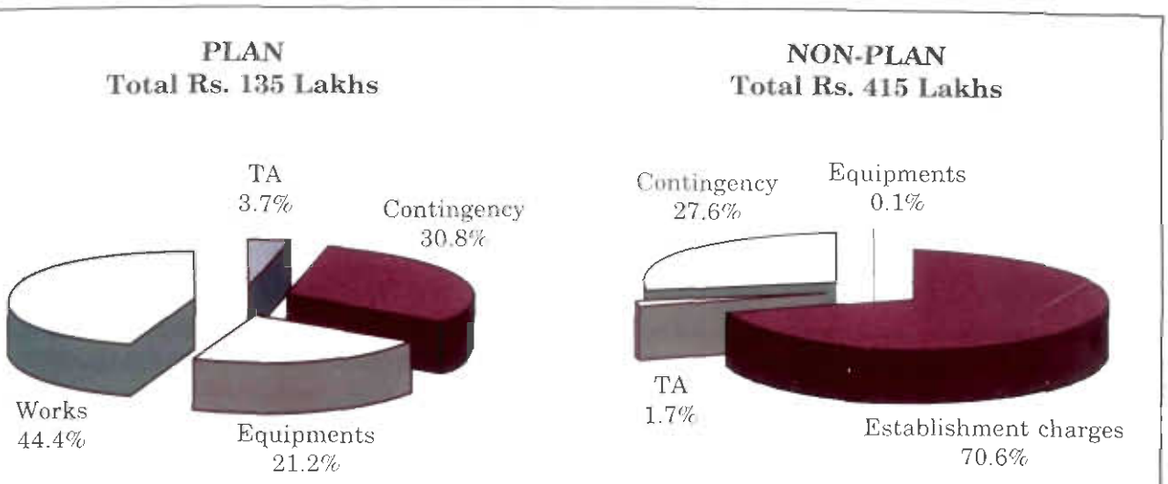
Post Harvest Technology and Division of Crop Protection and a Social Sciences Section. The other facilities available at the institute include Agricultural Technology Information Centre, Agricultural Research Information System, Bioinformatics Centre and Krishi Vigyan Kendra. The institute also functions as the headquarters of the All India Coordinated Research Project on Spices, and Indian Society for Spices. The institute has linkages with several universities, research institutes, and developmental agencies for collaborative research and developmental activities in spices.



Organization of Indian Institute of Spices Research

Budget

The total budget of the institute was Rs. 550.0 lakhs during the year, which included Rs. 135.0 lakhs under Plan and Rs.415.0 lakhs under Non Plan. In addition, Rs. 318.0 lakhs was also received as funds from external agencies.



Budget of the institute

Resource generation: Institute earned a total of Rs. 17,57,538 through sale of planting materials, biocontrol agents, training, publications and consultancy services.

Staff: The institute has a sanctioned strength of 42 scientific, 19 administrative, 36 technical and 61 supporting staff.

Staff position of the institute

Category	Sanctioned	In position Calicut (HQ)	In position Peruvannamuzhi (Farm)	In position Appangala (Regional Center)	Vacant
Scientific	42	28	2	3	9
Technical	36	18	13	5	-
Administration	19	17	-	2	-
Supporting	61	28	15	18	-
Total	**158**	**91**	**30**	**28**	**9**

Staff position of KVK

Category	Sanctioned	In position Calicut (HQ)	In position Peruvannamuzhi (Farm)	In position Appangala (Regional Center)	Vacant
Scientific	-	-	-	-	-
Technical	7	1	6	-	-
Administration	2	1	1	-	-
Supporting	2	-	2	-	-
Total	**11**	**2**	**9**	**-**	**-**

Past Achievements

Black pepper: Thousands of germplasm collections obtained through explorations were conserved for developing improved varieties for yield, quality, abiotic and biotic stresses. Several improved varieties with high yield and quality were developed and recommended for cultivation, which includes Sreekara, Subhakara, Panchami, Pournami, PLD-2, IISR-Thevam, IISR-Girimunda, IISR-Malabar Excel and IISR-Shakthi. *In vitro* and *in vivo* propagation methods were standardized. The spacing, nutrient and water requirements were standardized for different soils types of pepper growing regions. High production technologies and mixed cropping systems were developed for increasing productivity. Correlation between black pepper yield and weather parameters (weekly rainfall, maximum temperature and maximum relative humidity) was established with multiple regression models.

Major pests, pathogens, virus and nematodes affecting pepper were characterized and documented. Citrus mealybug (*Planococcus citri* Risso), commonly found associated with roots of black pepper (*Piper nigrum* L.) was shown to transmit the *Badnavirus* associated with stunted disease. Phytoplasma with phyllody symptoms was detected in black pepper using PCR. Sequence analyses showed that the gene was most closely related to members of aster yellows group (16Sr I) of phytoplasma. Integrated strategies involving cultural methods, biocontrol agents, plant products and resistant varieties were developed for the management of pests and diseases including nematodes that resulted in substantial increase in yields and pesticide free produce. Large-scale multiplication of biocontrol agents such as *Trichoderma* and *Pseudomonas* for distribution to farmers for management of disease was also under taken. These organisms were deposited in the national repository of microorganisms at IMTECH, Chandigarh for future reference. The *Trichoderma* mass production venture with 10 years life period resulted in a Net Present Value of Rs.242618 with less than 2 years of pay back period, 121% internal rate of return and 1.84 B: C ratio. Post harvest technologies for processing and production of value added product like white pepper production were standardized.

Cardamom: Molecular profiling using RAPD, ISSR and PCR-RFLP revealed two major divergent clusters *viz.*, "Kerala collections" and "Karnataka collections". *Amomum subulatum* and *A. microstephanum* were found clustered with *Elettaria cardamomum* indicating that *Amomum* is closest to cultivated cardamom. The improved varieties developed at the institute and technologies developed for increasing productivity were demonstrated through large-scale demonstration in farmers' fields. Drip irrigation and sprinkler irrigation once in 12 days recorded significantly higher number of tillers/clump, more number of leaves per tiller and more number of panicles per plant. Cardamom plot with contour staggered trenches (2m x 0.45m x 0.30m) in alternate rows recorded less runoff (43.8mm) and soil loss (148.1 kg ha^{-1}) compared to unplanted treatment (fallow), which recorded maximum runoff (216.0 mm) and soil loss (944.1 kg ha^{-1}). Investment on the technological package recommended for soil-water conservation in cardamom based cropping system in Coorg district of Karnataka yielded a net return of Rs.1,11,593 ha^{-1} against Rs. 56,186 ha^{-1} in non-adopted farms. The screening programme against leafspot caused by *Colletotrichum gloeosporioides* indicated that the

compound panicle types, CP-9 and CP-2 showed resistant reaction.

Ginger: The germplasm was enriched (756 accessions) through regular surveys and collection and an *in vitro* gene bank was established for conservation of germplasm. Three ginger varieties vis., Varada, Rejatha and Mahima were released for high yield and quality. Accessions with low/high fibre and with high oil type were identified. The critical levels of Zn were found to be 2.1 mg kg^{-1} for soil and 27 mg kg^{-1} for leaf. Post harvest technologies for processing and technologies for preparation of value added products such as salted ginger were standardized. Technique for solarization of ginger seed rhizomes (for elimination of bacterial wilt pathogen) and integrated disease management strategy for soft rot disease and shoot borer was developed. The improved varieties and technologies developed on cropping system, nutrient and water requirement, pest and disease management and post harvest processing techniques were disseminated to farmers and other agencies through publication, training programmes and demonstrations. Large-scale multiplication and distribution of elite planting material were also undertaken.

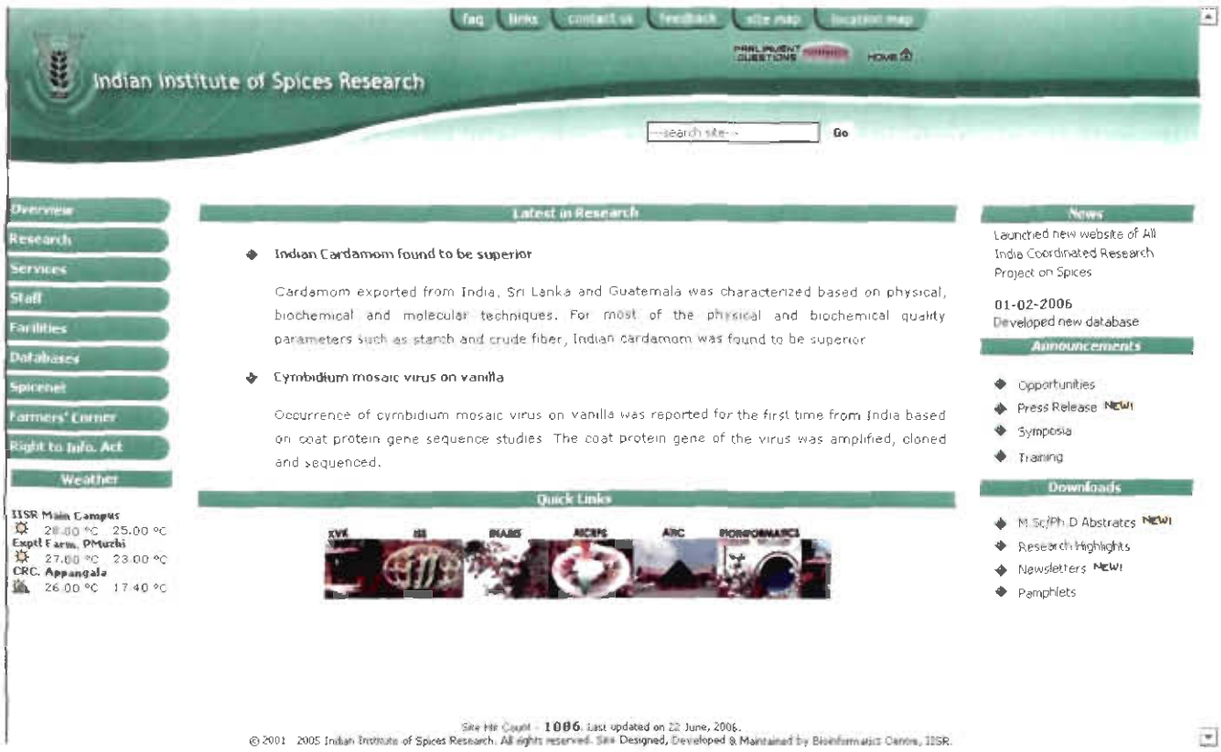
Turmeric: The germplasm added to the repository was characterized for yield, quality, resistance to pests, diseases and drought. Molecular characterization of germplasm was also initiated. Five high curcumin and high yielding varieties, Suvarna, Sudarsana, Suguna, Prabha and Prathibha were released. Two varieties *viz*., IISR-Alleppey Supreme and IISR-Kedaram were proposed for release. Accessions with high curcumin and root-knot nematode resistance were identified. Three different curcuminoids (curcumin, De Methoxy curcumin and Bis De Methoxy curcumin) could be separated from oleoresin of turmeric rhizomes by employing chromatographic techniques. A PCR based method was developed to detect adulteration of turmeric powder with wild *Curcuma* species. The optimum spacing, nutrient and water requirement were standardized for different soils. Organic farming system was developed for turmeric. Eco-friendly integrated strategy was developed for the management of shoot borer. The improved varieties and technologies were disseminated to farmers and other agencies through publications and demonstrations.

Vanilla: Several collections of vanilla made during surveys are being conserved and are being evaluated for yield and disease resistance. Successful interspecific hybridization was made between *Vanilla planifolia* and *V. aphylla*. Over 1000 seed progenies of *V. planifolia* are being established in the field to study their variability. Protocols for micro propagation through direct shoot multiplication as well as callus regeneration were standardized. Surveys revealed the causal organism involved in stem rot, root rot, bean rot and tip rot were of fungal origin and management strategies for the fungal disease developed. *Cucumber mosaic virus* (CMV) of vanilla (*Vanilla planifolia* Andrews) was characterized on the basis of biological and coat protein (CP) nucleotide sequence properties which showed that CMV infecting vanilla belongs to subgroup IB.

Tree spices: The germplasm collections of different tree spices include hundreds of nutmeg, clove, cinnamon including cassia, garcinia and allspice. The germplasm was characterized for yield and quality parameters. Two high quality cinnamon varieties, Navashree and Nithyashree and a nutmeg variety, Viswashree were released. Various improved varieties with high yield and quality were developed that had a great impact

in increasing the production and productivity of these crops in the country. Soft wood grafting of *Garcinia xanthochymus* was standardized on nine months old *G. xanthochymus* rootstocks with 90% success. Grafts have a compact plant type and bear fruits at an early age. Vegetative propagation techniques were standardized for nutmeg, cassia and cinnamon. Post harvest-processing techniques for nutmeg, mace and cinnamon were also standardized. Major pests and pathogens of tree spices were documented. The improved varieties and technologies developed on propagation and post harvest processing were disseminated to farmers and large-scale multiplication and distribution of elite planting material were carried out.

Paprika: Several accessions were added to the repository mainly through the network project on paprika. The germplasm was characterized for yield and quality. Good amount of variability was observed in capsaicin content (pungency) of selected paprika accessions, which ranged from 0.006 (EC-490) to 0.13% (ICBD-14). Accessions with high yield and colour values were also identified.



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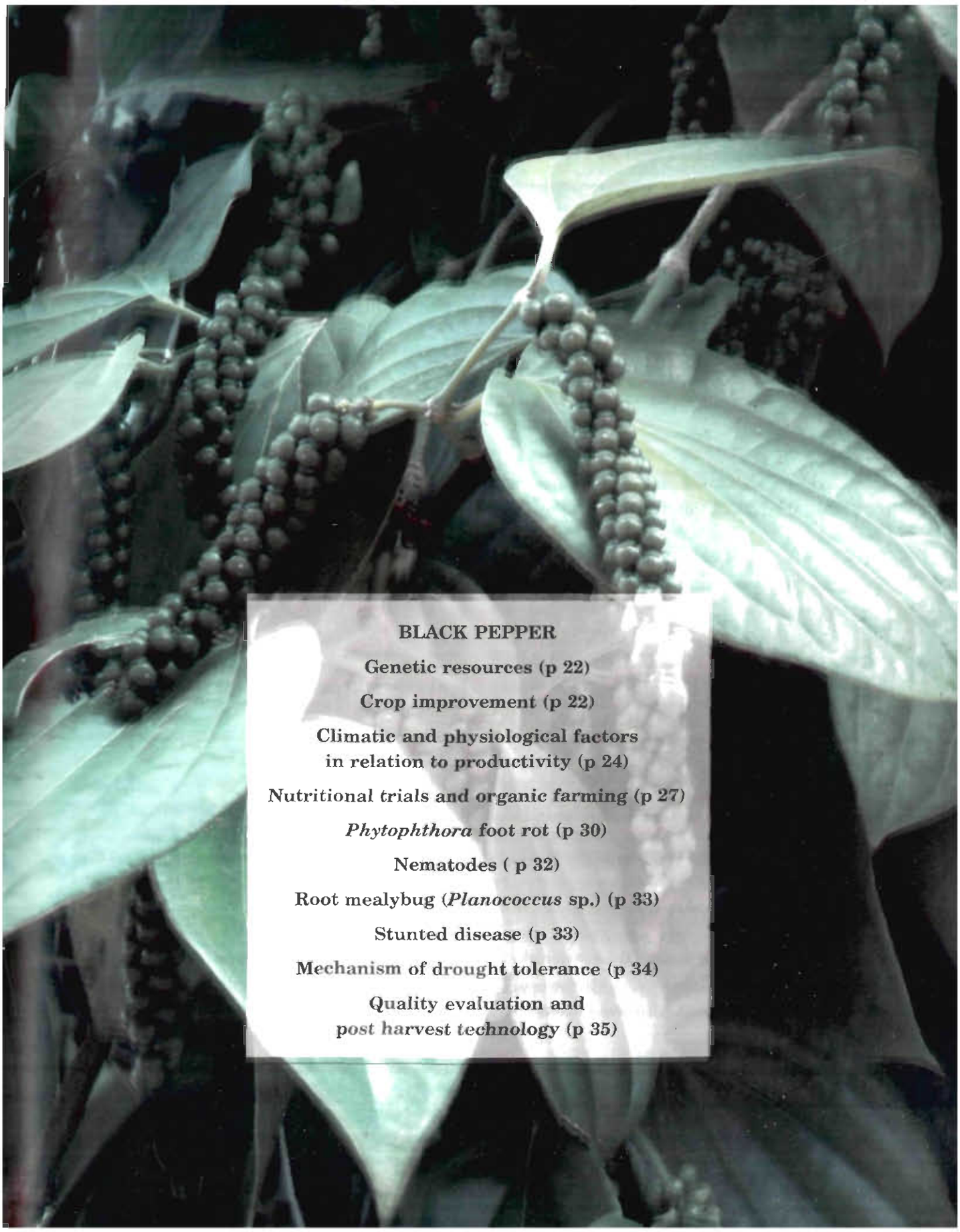


BLACK PEPPER

Black Pepper

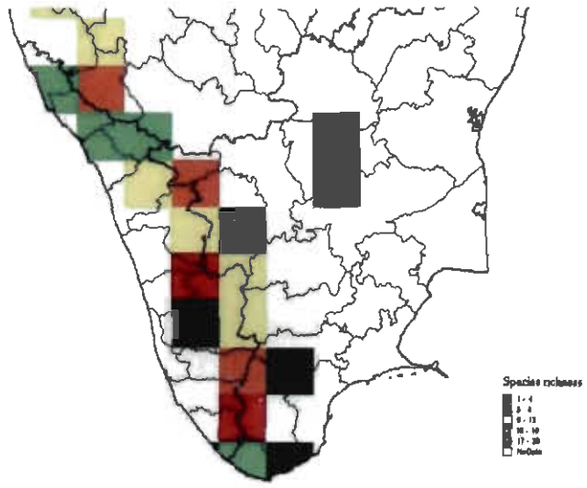
1. GENETIC RESOURCES

Collection: A total of 62 accessions were added to the germplasm repository through surveys conducted in Chimmony & Parambikulam Wild Life Sanctuary (Kerala), Nelliampathy forests (Kerala), Cherapunji (Assam), Wayanad (Kerala) and Tirupathi (Andhra Pradesh). A male *Piper galeatum* with spike length 24.5 cm from Nelliampathy forest was found to be an unique collection for its unusually long spike. Eight other local cultivars *viz.*, Karimundi, Poonjaranmunda and Balankotta from Kannur, Arakulammunda, Vellamundi, Aimpiriyan and two unnamed varieties were collected from Wayanad.

Germplasm enrichment through explorations- Local collection from Wayanad with agronomically useful traits were added to the black pepper germplasm repository

Characterization and cataloguing: Based on IPGRI descriptor 50 accessions were characterized and at present 800 accessions have been documented. Cytological studies of 20 accessions revealed that all have chromosome number 2n=52.

GIS studies: Fifteen qualitative morphological characters of 16 wild species of *Piper* from South India were studied and hierarchal cluster was plotted using SPSS software. Bio-climatic analysis and prediction system (BIOCLIM) comparison of these clusters revealed the rich diversity and 'niches' where *Piper* species occur predominantly. The highest richness grid was found to have 15-16 species while the highest diversity value was found to range from 1.8 to 3.



DIVA GIS map of southern India showing Piper *species richness.*

2. CROP IMPROVEMENT

Conventional breeding

Breeding for high yield: Accessions HP 1458, HP1255, HP 657, HP 1722, HP 986 and HP 816 were found to be promising.

Breeding for resistance to pests and pathogens: Two-year-old hybrid progenies (115) of Panniyur 1 X Subhakara and selfed progenies (150 each) of varieties Subhakara and Panniyur 1 were screened for *Phytophthora* resistance. A few resistant lines were observed from both crossed and selfed progenies, which segregated at 1 resistant: 15 susceptible. The hybrid

progenies were also giving a ratio of 9: 6: 1, which was different from the segregation in selfed progenies. Profiling of this population with three Inter Simple Sequence Repeat (ISSR) primers yielded 35 Polymorphic bands. About 20 crossed progenies of Subhakara X IISR-Shakthi and 80 selfed progenies were maintained in nursery.

Plagiotropic shoots of *Phytophthora* tolerant line HP 780 and Coll 1041 were kept for rooting. Nematode tolerant lines *viz.*, HP125, C820 and HP39 were multiplied for large-scale evaluation. Accessions 4152 and 5001 were tolerant among the fifty-one accessions (cultivars) screened for drought tolerance using physiological parameters.

Biotechnology

Transgenics with 'osmotin' gene: Five putative transgenics were multiplied by serpentine method. Another 40 transgenics are in various stages of multiplication and hardening.

Direct regeneration from *in vitro* leaf explants: Leaves from *in vitro* grown plants were more effective for regeneration than those grown in green house condition. Adventitious shoot buds were produced and further proliferation achieved on medium devoid of growth regulator. Explants started to regenerate 90 days after inoculation. The regenerated shoot buds developed rooting on basal medium without growth regulators.

Optimization of hardening procedures: Eleven thousand plants were hardened this year on solarized and fumigated potting mixture. About 95 % establishment was recorded.

Performance of tissue culture (TC) plants
Black pepper plants fortified with *Trichoderma harzianum* at recommended dose in the potting mixture at the time of hardening established better with good growth in both Panchami and Subhakara. About 300 somatic embryo derived plants were planted during the last one-year.

Hardeneing of tissue cultured black pepper plants in solarized potting mixture

Plants started producing spikes within one year after planting. Number of main shoots per plant was high in somatic embryo derived plants.

Field planting of TC plants: Ten thousand plants were distributed during this planting season and another one thousand were kept in the nursery for gap filling. Eighty-seven plots were planted so far covering an area of 23 ha. Of these approximately 12 ha are in Kerala and 11 ha is in Karnataka.

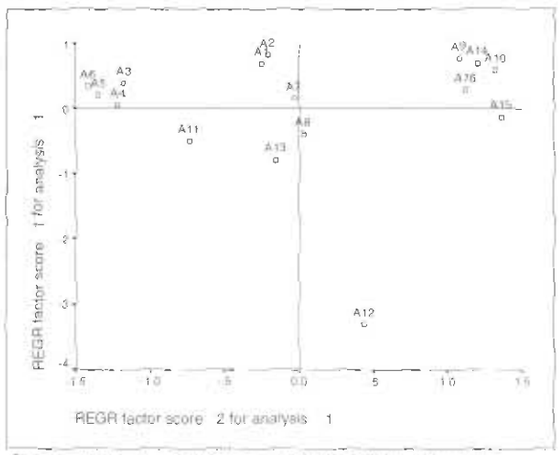
Genetic fidelity analysis of TC plants
The genetic fidelity analysis of tissue culture derived plantlets and somatic embryo derived plants showed uniform profiles using Random Amplified Polymorphic DNA (RAPD) and ISSR. This proves that this system can be used for the large-scale production of elite varieties of black pepper.

Production and supply of TC black pepper plants: About 10,000 tissue culture raised plants were multiplied. Twenty-five cultures of black

pepper and 1900 TC plants were given to Spices Board, Cochin. One hundred and fifty each of somatic embryo derived varieties of HP-1411. HP-1305 and Acc.1472 were supplied to KAU.

ISSR markers for improvement of black pepper

A total of 26 ISSR primers were designed for the amplification of genomic DNA from 16 species of *Piper* and selected cultivars. *Piper nigrum* was found to be more close to *P. sugandhi*. Longum types formed a separate group in the phylogenetic classification. *P. bababudani, P. schmdtii* and *P. wightii* were also found to be related to *P. nigrum*. Variation in the inter-microsatellite regions among cultivars was found to be low. A dendrogram and a scattergram were drawn from the scored bands using SPSS.



***Scattergram showing relationship between different species of* Piper**

A1-P. trichostachyon, A2-P. *galeatum*, A3-P. attenuatum, A4-P. argyrophyllum, A5-P. hymenophyllum, A6-P. brachystachyum, A7-P. barberi, A8-P. hapnium, A9-P. sugandhi, A10-P. nigrum (wild), A11-P. betle, A12-P. chaba, A13-P. longum, A14-P. bababudani, A15-P. schmdtii, A16-P. wightii.

Cloning of gene(s) conferring resistance to *Phytophthora* from *Piper colubrinum*

Isolation of the part (internal region) of the *Phytophthora* resistance gene sequence (252 nucleotides fragment corresponding to 84 amino acids) was achieved by targeted gene amplification of specific mRNAs using degenerate primers. SAWTED enhanced PSI-BLAST analysis of the deduced amino acid sequence of the resistance gene indicated that the sequence is close to blight resistance protein (RPI gene) from *Solanum bulbocastanum*.

3. CLIMATIC AND PHYSIOLOGICAL FACTORS IN RELATION TO PRODUCTIVITY

Crop-weather relationship: The weekly weather data *viz.*, rainfall, maximum and minimum temperature, maximum and minimum relative humidity, sunshine hours, wind speed and evaporation for six years (1992-93 to 1997-98) was obtained from Agricultural Research Station, Ambalavayal. The annual yield of Panniyur 1 black pepper cultivar for the same period of that station was collected from literature and utilized to derive crop-weather relationship. The beginning and end of annual cycle of black pepper was identified as 10th (5th - 11th March) and 9th (26th Feb – 4th March) meteorological week, respectively based on length of growing period (LGP). The nature and magnitude of black pepper-weather relationship was varied for different weather elements.

Magnitude of black pepper yield and weather relationship

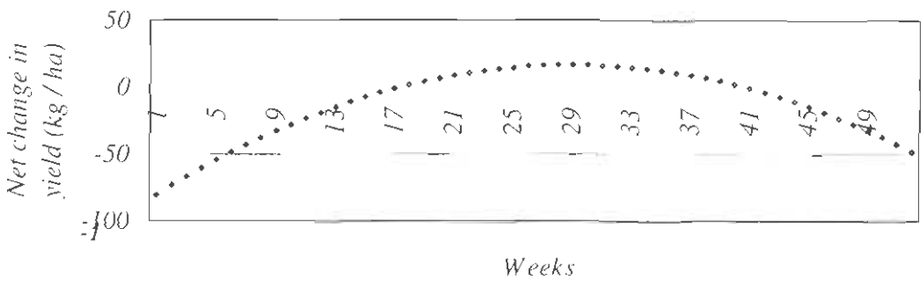
Weather element	R^2
Maximum relative humidity	0.9904
Rainfall	0.9903
Minimum temperature	0.9549
Maximum temperature	0.8951
Sunshine hour	0.8564
Wind	0.8040
Minimum relative humidity	0.4688
Evaporation	0.3913

Nature of relationship: An established statistical technique was employed to derive black pepper yield – weather relationship and a rate change in yield for additional input during annual cycle of black pepper. The nature of relationship indicates that excess rainfall during initial period of annual cycle (i.e between 5th -11th March to 25th June – 1st July) is harmful or would reduce the yield. Excess rainfall between July to December is beneficial to the crop and would help in enhancing the yield, while excess rainfall beyond December would reduce the yield.

estimates and it was found that the predicted production deviates 15% in 2002-03 and 25% in 2003-04.

Physiological and biochemical basis of productivity in black pepper

Partitioning of photosynthates: Partitioning of reducing sugars and starch was studied in different plant parts of high and low yielders to know weather metabolites are partitioned differentially to different organs. Results revealed that partitioning of reducing sugars to leaves, stem and berries did not differ, while



Effect of one mm increase in rainfall on black pepper yield

Degree-days requirement for maturity: Thermal time (Growing degree days or heat sum) for maturity of black pepper indicated that the requirement of heat sum for black pepper maturity was 3600° days.

Prediction of black pepper production: A regression model based on 11 years (1991 to 2001) data for prediction of black pepper production in Kerala was developed with monthly rainfall as predictors:

$Y = 52915.1 + 286.3769_{January} + 23.2525_{April} - 14.7527_{July} + 33.907_{September}$ ($R^2 = 0.7057$).

Black pepper production for Kerala State was predicted from this regression model for 2002-03 and 2003-04 and compared with official

partitioning of starch to berries of high yielders was slightly more than that of low yielders. Partitioning of starch to leaves and stem also did not differ between the high and low yielders.

Sucrose phosphate synthase (SPS) activity: Sucrose phosphate synthase activity was assayed during juvenile stage to assess if SPS activity could be used to distinguish between high and low yielders. The results indicated that SPS activity during juvenile stage did not differ appreciably between high and low yielders.

Isozyme assays: Isozyme assays of malate dehydrogenase (MDH) and super oxide dismutase (SOD) were carried out. MDH showed two bands (Em values of 0.06 & 0.14). For SOD,

Partitioning of starch (%) in high and low yielders

High yielder	Leaves	Stem	Berries	Low yielder	Leaves	Stem	Berries
P-1	7.26	6.95	14.85	1157	7.04	6.86	13.76
1041	6.97	6.81	13.92	840	6.97	6.71	13.20
OPKM	7.14	7.20	15.21	1120	6.84	6.24	13.35
HP813	6.52	6.76	13.74	4132	7.25	7.02	14.42
HP780	6.86	6.54	15.21	4095	6.47	6.15	14.21
HP1411	7.52	7.10	14.76	4112	6.52	6.84	13.83
1619	7.02	6.38	14.91	1607	7.16	6.97	13.47
1481	6.48	6.17	14.62	1535	6.35	6.76	13.54
4129	7.21	6.45	14.93	1467	6.66	6.71	13.12
Mean	**7.00**	**6.71**	**14.66**	**Mean**	**6.81**	**6.70**	**13.65**

five common bands could be identified (Em values - 0.06, 0.13, 0.44, 0.57, 0.77). No specific isozyme band to distinguish high and low yielders could be obtained.

Gas exchange parameters in high and low yielders: Gas exchange parameters *viz;* photosynthetic rate (A, µ moles), transpiration rate (E, m moles), stomatal conductance (g_s), leaf temperature (TL° C) and internal CO_2 concentration (Ci, ppm) were studied at two different light intensities i.e. 170-200 and 450-500 µ moles in high and low yielding black pepper accessions. All the parameters recorded higher values at higher light intensity compared to low intensity. High yielders had slightly higher photosynthetic rate but transpiration rate, stomatal conductance and leaf temperature were on par in both high and low yielders.

Climate change effects on growth and productivity: Trend analysis for the past changes in climate of pepper growing areas such as Wayanad (Ambalavayal), Calicut, Kannur (Panniyur), Idukki (Pampadumpara), Coimbatore (Valparai), Nilgiris and Kodagu has been done. Black pepper productivity trend analysis for most of these places has also been done.

Gas exchange parameters (at 450-500 µ moles of light intensity)

High yielder	A	E	g_s	TL	Low yielder	A	E	g_s	TL
Mean	3.1	1.34	0.06	33.15	Mean	2.66	1.25	0.05	33.6

A - Photosynthetic rate (i moles) g_s - Stomatal conductance
E - Transpiration rate (m moles) TL - Leaf temperature (°C)

Gas exchange parameters (at 170-200 µ moles of light intensity)

High yielder	A	E	g_s	Ci	TL	Low yielders	A	E	g_s	Ci	TL
Mean	2.50	0.86	0.04	241	32.2	Mean	2.00	0.80	0.04	251	32.2

Trend analysis in changes in climate of pepper growing areas (1984-2004)

Place	Rainfall	Tmax	Tmin	Productivity
Wayanad	Decreasing	Increasing	Increasing	Decreasing
Calicut	Decreasing	-	-	Decreasing
Kannur	Decreasing	Increasing	Increasing	Decreasing
Valparai	No trend	No trend	Decreasing	No trend
Nilgiris	Increasing	Increasing	No trend	Decreasing
Kodagu	Decreasing	-	-	Decreasing

Correlation studies showed that in Pampadumpara (Idukki), October rainfall had positive correlation with black pepper productivity while September, June and July rainfall had negative correlation. Similarly, April, September and October temperature had positive correlation while June temperature had negative correlation. In Nilgiris, Rainfall during December and January had negative correlation with black pepper productivity. Number of rainy days during May had positive influence, while rainy days during January were negatively correlated. Tmax was positively correlated with production in most of the months. In Ambalavayal, February and July rainfall and Tmin during March, January and February were positively correlated with productivity.

Influence of rainfall deficit on black pepper productivity was also studied. Rainfall during 1987 and 2002 (declared as drought years by the government) was less than normal (mean of 1984-04) for all the black pepper growing areas during these years. The black pepper productivity was also below normal (mean of 1984-04) indicating the negative influence of rainfall deficit on productivity.

Pepper productivity is generally higher in higher elevations such as Wayanad and Idukki. Relatively cool climate of these regions may influence productivity. The temperature (both Tmax and Tmin) of both Idukki and Wayanad is about 6-7° C lesser than that of Kannur or Trichur.

4. NUTRITIONAL TRIALS AND ORGANIC FARMING

Organic Farming: Black pepper, was cultivated organically by applying farmyard manure (FYM), vermi compost, ash & rock

Influence of rain on black pepper productivity

Region	Productivity (kg ha^{-1})			Rainfall deficit (%)		Reduction in yield(%)	
	Average (1984-04)	1987	2002	1987	2002	1987	2002
Wayanad	402	222	387	18.5	38.17	44.8	3.90
Kannur	241	177	147	14.9	43.43	26.6	39.0
Idukki	327	138	238	6.8	30.97	57.8	27.2
Trichur	239	158	183	-	-	33.9	23.4
Valparai	200	200	201	19.3	28.46	-	-

Pepper productivity at higher elevations

Region	Temperature (1984-04)		
	Mean Tmax (°C)	Mean Tmax (°C)	Mean yield (kg ha^{-1})
Wayanad	27.3	17.6 (9.7)	402
Idukki	27.5	15.6 (11.9)	327
Kannur	33.1	22.6 (10.5)	241
Trichur	32.1	23.4 (8.7)	239

phosphate and bio control agents such as *Trichoderma* & *Pseudomonas* sp. In black pepper, highest average fresh yield of 2.9 kg vine^{-1} was observed in organic system.

Evaluation of Sulphate of Potash (SOP) as potassium source on growth, yield and quality: The experiment was done in two locations (at Kodagu-coffee-black pepper system and at Kannur-pure black pepper system) by comparing different doses and foliar application of K sources *viz.*, MOP and SOP. The initial analysis of Kodagu soil showed that among different forms, mineral K was found to be dominant with less K in exchangeable and non-exchangeable pools. The fresh yield recorded was on par among the treatments with the highest (277 g pot^{-1}) in SOP applied at 50% recommended level, in bush pepper which recorded highest berry weight and Piperine. Oleoresin was found to be high in foliar spray of SOP.

Biofertilizers: An efficient strain of *Azospirillum* was evaluated for its N fixing ability and growth enhancement of black pepper under integrated nutrition system. Effect of *Azospirillum* on number of laterals, length of spikes, number of berries, yield, nitrogen, phosphorus and potash content in the soil, nitrogen and phosphorus content of leaves were significant. Maximum berry yield was recorded by the treatment N 50% + Mg that was on par with the treatment, application of NPK alone. Significantly higher N and K content in the soil and N content in the leaf was observed for the treatment N 50% + Mg. Initial *Azospirillum* population in the black pepper garden ranged from $28x10^4$ cfu g^{-1} of soil to $50x10^4$ cfu g^{-1} soil. *Azospirillum* population was higher in biofertilizer (*Azospirillum*) applied plot compared to uninoculated control, six month after application of inoculum. Maximum population was recorded by the treatment N 50% + Mg followed by N 50% +Z +B + Mo.

Economic evaluation of black pepper production technology developed by the institute

Economic analysis to evaluate and determine the acceptability of alternative low input technologies on black pepper was carried out using the field experiment data collected from different districts of Kerala. Results of partial budgeting and marginal analysis showed that application of NPK 70:25:135+*Azospirillum* can be recommended as the best treatment based on the criteria of MRR and could give more economic benefits of Rs. 1,17,253 ha^{-1} as net benefit. The risk analysis revealed that the combination of NPK 70:25:135+Zn with lowest index of variation as a risk free rational technology for the predominantly small and marginal pepper growers. Sensitivity analysis with price reduction of 20%, 30% and 40% also revealed NPK 70:25:135+*Azospirillum* biofertilizers as a profitable technology with high MRR.

Marginal Rate of Return for alternative low input technologies in Black Pepper

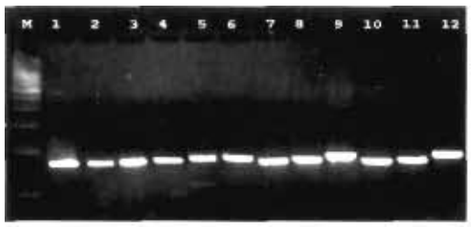
Treatments	Check (Farmer's practice)	Fertilizer (NPK-(140:0 :270)	NPK-140:50: 270)	NPK-(70-25-135+Zn)	NPK-(70-25-135+ Cowpea)	NPK-(70-25-135+ Sand 5kg)	NPK-(70-25-135+ *Azospirillum* @10^8 cfu)	NPK-(70-25-135+ Neem cake)
Total cost that vary (Rs ha^{-1})	0	34483	30269	25542	29229	28982	34558	38549
Net Benefit (Rs ha^{-1})	88333	98015	93833	104941	109148	106204	117253	95629
Whether Dominant (Yes/No)	No	Yes	Yes	No	No	No	No	Yes
Marginal Net Benefit (Rs ha^{-1})				16609	2943	1262	8106	
Marginal Variable Cost (Rs ha^{-1})				25542	247	3440	5329	
MRR	0			65	1191.8	36.7	152.1	
Rank				IV	II	III	I	

Risk analysis for alternative low-input technologies in black pepper

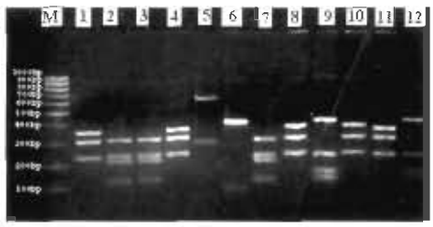
Treatments	Mean Net Benefit	Standard deviation	Index of variation	Minimum Net Benefit	Average Lowest 2
Check (Farmer's practice)	88333	10906	12.35	76409	79348
NPK-140:50:270	98016	9433	9.62	84749	89787
NPK-140:0:270	93833	18901	20.14	72170	79307
NPK-70-25-135+Zn	104942	13124	12.51	94526	94950
NPK-70-25-135+Cowpea	109148	22258	20.39	78248	87484
NPK-70-25-135+Sand 5kg	106204	16593	15.62	78495	90670
NPK-70-25-135+*Azospirillum* @10^8 cfu	117253	25228	21.52	86354	92231
NPK-70-25-135+Neem cake	95629	17355	18.15	75645	79844

5. *PHYTOPHTHORA* FOOT ROT

Characterization of *Phytophthora* isolate: The institute has assembled a repository of *Phytophthora* species/isolates infecting hosts grown under different agroclimatic conditions. A total of 260 *Phytophthora* isolates from black pepper are being maintained in the repository. Of these thirty isolates were clustered into five groups based on morphological characters. ITS-PCR based characterization using universal ITS-4 and ITS-6 primers further confirmed the morphological grouping.



ITS-PCR products of *Phytophthora* isolates using ITS 4 & ITS 6 primers



Restriction digests of ITS4 region of isolates using *Msp*1

M: 500bp ladder, Lanes 1-5: black pepper isolates of *Phytophthora*, Lane 6: Carnation isolate of *Phytophthora*, Lane 7: Tomato isolate of *Phytophthora*, Lane 8: Vanilla isolate of *Phytophthora*, Lane 9: Pineapple isolate of *Phytophthora*, Lane 10: Vanilla isolate of *Phytophthora*, Lane 11: Colocasia isolate of *Phytophthora*, Lane 12: Black pepper isolate of *Phytophthora*

Host Resistance

Evaluation of wild accessions and hybrid lines: Fourteen wild accessions were screened using stem and root inoculation methods. One of the wild accessions *viz.*, 625 showed tolerant reaction in stem inoculation, while nine other lines showed tolerance to root infections. Among the 16 hybrids evaluated, six hybrids *viz.*, HP 728, 798, 923, 998, 1299, 1602 showed tolerant reaction to root infection in the preliminary evaluation.

Evaluation of previously shortlisted open pollinated (OP) seedlings: The OP seedlings selected from the preliminary trial were subjected to second round screening. One seedling each from P 24 (04-P 24-1) and HP 1533 (04- HP 1533 -1) showed tolerance to *Phytophthora* infection in leaf, stem and root inoculation. During the year 2006, 46 OP seedlings were shortlisted after screening 80,600 OP seedlings representing 39 accessions and two cultivars.

Evaluation of cultivars and hybrids for field tolerance: Natural field tolerance of accessions was assessed by surveying the accessions planted in the cultivar management plot at IISR farm, Peruvannamuzhi. Of the 562 accessions, 88 accessions found free from foot rot infection were further evaluated by artificial inoculation of the pathogen. Two accessions (1535 & 1239) were confirmed to have tolerance to stem infection having stem lesion <5mm and Index (depth of penetration) in the rate of 1.0.

Evaluation of varietal mixtures for foot rot management: Two field experiments were conducted to study the effect of varietal mixtures on incidence of *Phytophthora* foot rot disease. In the first experiment various populations (25%, 50% and 100%) of susceptible variety Subhakara were planted with three tolerant lines *viz.*, IISR Shakti, P-339 and HP-780. In the second experiment, both tolerant and susceptible lines

were planted around the same standard. The main plot included planting of *Phytophthora* tolerant *Piper colubrinum* and susceptible Subhakara. The tolerant lines tried were P-24, P-339, HP-780, P-1534 and C-847. The survival of vines was significantly higher in *Phytophthora* tolerant lines. There was no significant difference in the survival of vines in the experiment with *Phytophthora* resistant line *P. colubrinum* and susceptible Subhakara.

Biological control

Evaluation of bio consortium: In the field trial to evaluate the effect of biocontrol consortia on *Phytophthora* foot rot and slow decline diseases of black pepper, the percentage of vines exhibiting yellowing was significantly lower in treatments involving *Pseudomonas fluorescens* isolate IISR-859 along with biocontrol consortia. In the nursery there was no significant difference between the consortia combinations. However, *Trichoderma harzianum* and biocontrol consortia were superior to control with regard to extent of root decay and yellowing.

Compatibility of biocontrol agents: Studies on *in vitro* compatibility of *Pseudomonas fluorescens* strains IISR-6, IISR-8, IISR-13, IISR-51, IISR-853 and IISR 859 revealed that only three of the isolates tested namely, IISR-8, IISR-151 and IISR-859 were compatible with *Trichoderma harzianum*, and IISR-859 alone was compatible with *Pochonia chlamydosporia* (antagonistic against nematodes).

Cultural methods

Evaluation of *Piper colubrinum* as rootstock: Black pepper plants grafted on *Piper colubrinum* rootstocks (resistant to *Phytophthora* foot rot disease) planted at various locations in Kerala performed well.

Natural plant products

Evaluation of bioactive principles: Two

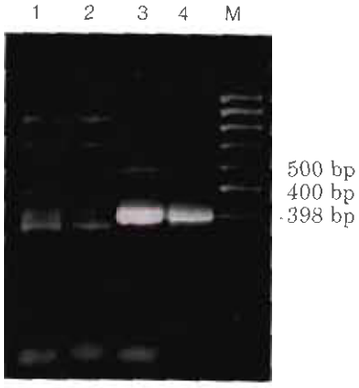
Performance of grafts of *Piper nigrum* on *Piper colubrinum*

Location	Standard type	Age of the vine (years)	Number of grafts	Yield (Dry pepper) (kg plot^{-1})	Remarks
1. IISR Farm Peruvannamuzhi	Arecanut	3	84	5.4	Formation of plagiotropic shoot was poor
2. Farmers plot Peruvannamuzhi	*Macarango peltata*, Jack Tree	7	409	231	Low yield is due to lack of irrigation during summer
3. Kamana, Wayanad	Arecanut	4	450	150	Plants affected by viral diseases
4. Muthireri, Wayanad	*Erythrina lithosperma*	3	35	25	Mixed with arecanut
5. Elivali, Kottayam	Concrete poles	3	150	34	Low yield is due to lack of irrigation during summer

chalcones were isolated from active fractions of *Chromolaena odorata* leaves earlier. In order to test the fungitoxicity of these compounds against *P. capsici*, fractionation of the methanol extract was repeated. Column chromatographic separation of methanol extract using hexane-ethyl acetate and ethyl acetate-methanol yielded eight fractions. The effect of these fractions was tested on mycelial growth of *P. capsici* and two fractions with inhibitory activity were identified.

6. NEMATODES

Etiology: Two *R. similis* specific primers were designed using Bioinformatics tools and custom made for the first time. On evaluation in the laboratory, these primers specifically amplified rDNA of *R. similis* and resulted in an amplified product of 398 bp. The amplified product was cloned and sequenced. The ITS sequence of the Indian isolate of *R.similis* showed >99% similarity with sequences of other *R.similis* isolates.



Amplification of *Radopholus similis* genomic DNA using species specific primer.
Lane 1 and lane 2 *M .incognita*., Lane 3 and 4 *R. similis* and M 100 bp ladder marker.

Characterization of endophytic bacteria: Morphological and biochemical characterization of additional 36 isolates of bacterial endophytes were completed. Of the total 201 isolates, 109 were grouped into nine clusters comprising of fluorescent pseudomonads (15 isolates), non-fluorescent pseudomonads (12 isolates), *Serratia* spp. (2 isolates), *Bacillus* spp. (42 isolates), *Arthrobacter* spp. (22 isolates), *Micrococcus* spp. (6 isolates) and 10 unidentified isolates. The species identity of *Pseudomonas fluorescens* was further confirmed by PCR amplification with specific primers. Isolates producing hydrogen cyanide (10 isolates), chitinase (8 isolates) and protease (21 isolates) were identified through biochemical assays.

Evaluation of endophytic bacteria: Fifty-nine isolates of bacterial endophytes were evaluated in the greenhouse for suppression of nematodes. Out of this, 14 short-listed ones were tested in black pepper nurseries for nematode suppression and colonization in black pepper roots. Significant growth promotion was not observed with any of the isolates. However, the isolates BP10, BP20, BP 25, BP 35, BP 46, BP 70, BP 76 and Tc 10 reduced *Radopholus similis* population in black pepper roots significantly.

Host Resistance

Preliminary screening of 13 (7 hybrids, 4 wild accessions and 3 released varieties) black pepper germplasm accessions against *R. similis* has been carried out and all were susceptible to the nematode. After two years of planting, all the R. similis-resistant lines viz. Hp 39, Acc. 820 (IC No. 316481), Acc. 1047 (IC No. 316602) and Acc. 1204 (IC No. 316690) were free from nematode infestation. Among these, Acc. 820 and HP 39 have recorded an average yield (dry) of 300 and 286.7 g, respectively. However, among the five short-listed root-knot nematode resistant black pepper lines only two accessions, Acc.812 (IC No. 316475) and Acc. 1090 (IC No. 316635) were healthy and free from root-knot nematode infestation. The biochemical profiling of these lines showed very high caryophyllene content in Acc. 1090 and HP 39.

7. ROOT MEALYBUG (*Planococcus* sp.)

Evaluation of natural products and insecticides: Eleven insecticides were evaluated in laboratory bioassays for their efficacy against root mealybug, among which imidacloprid, acetamiprid, lamda-cyhalothrin (0.025% each) and carbosulfan (0.075%) were promising, causing above 90% mortality in one month after treatment. The promising insecticides were also evaluated in the field among which imidachloprid 0.025% and acetamiprid 0.025% were more effective. Natural products such as custard apple seed extract, neem leaf extract and tobacco extract that were promising in laboratory bioassays conducted earlier are being evaluated in the field for their efficacy in the management of root mealybug.

Evaluation of biocontrol agents: No major natural enemy of root mealybug was recorded in the field. Eight microbial pathogens including four commercial products were evaluated in laboratory bioassays for their efficacy against root mealybug among which *Metarrhizium anisopliae* was the most promising causing 34% mortality within one month after treatment.

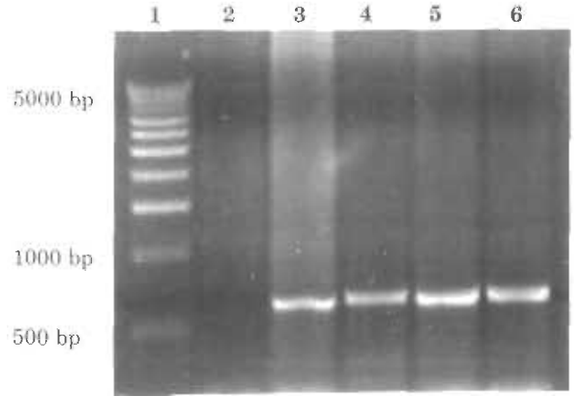
'Pollu' Beetle Resistance in black pepper

Screening of 98 cultivars and 110 hybrids of black pepper available in the Germplasm Conservatory against pollu beetle (*Longitarsus nigripennis*) revealed that all the accessions except one of the hybrids were susceptible. The percentage of berries infested in the susceptible accessions ranged from 8.8 to 35.8 in cultivars and 0.4 to 37.0 in hybrids.

8. STUNTED DISEASE

Mosaic, bright yellow mottling along veins, reduction in leaf size and internode length and stunting were the symptoms observed on diseased vines. All cultivars and improved varieties including hybrids were susceptible to the disease under natural conditions. Vines of all ages trained on different types of standards were found affected by the disease. Two viruses *viz.*, *Cucumber mosaic virus* (CMV) and a *Badnavirus* were identified to be involved in the disease. Of these, both CMV and *Badnavirus* were purified and virus specific antiserum produced in rabbits. DAS-ELISA was standardized for the detection of both viruses in diseased samples. The coat protein gene of CMV was cloned and sequenced. Sequence comparisons with other CMV isolates showed that CMV infecting black pepper belongs to CMV subgroup-IB and were more close to other CMV isolates occurring in India.

In the current year, total DNA extracted from *Badnavirus* infected black pepper leaves was used as template in PCR to amplify its genome. Out of the four primer pairs tested, one pair representing ORF-I of badnavirus yielded a fragment of 750 bp consistently. The PCR product was purified, cloned and sequenced. Sequence analysis and comparison with other known badnavirus showed high levels of identity

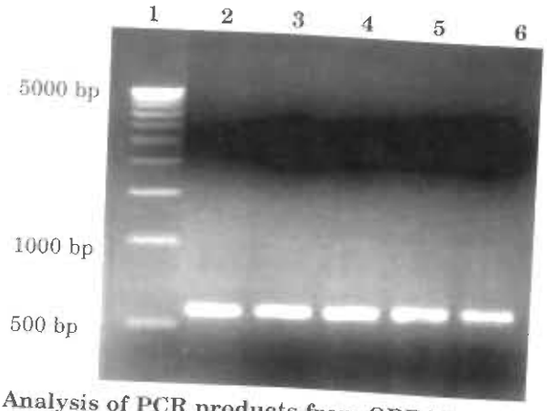


Analysis of PCR products from ORF I region of Piper yellow mottle virus *infecting black pepper*

Lane 1: 500 bp DNA ladder, Lane 2 Healthy black pepper, Lane 3-6 infected black pepper

with *Piper yellow mottle virus* (PYMV) indicating close relationship of badnavirus infecting black pepper in India with PYMV known to infect black pepper in other South East Asian countries.

Similarly, a 600 bp corresponding to ORF III of badnavirus infecting black pepper was amplified through PCR, cloned and its nucleotide sequence determined. Sequence comparison and phylogenetic studies showed close relationship with other mealybug transmitted badnavirus. Thus based on the sequence analysis of ORF I and III, it is concluded that *Badnavirus* infecting black pepper in India is a strain of PYMV.



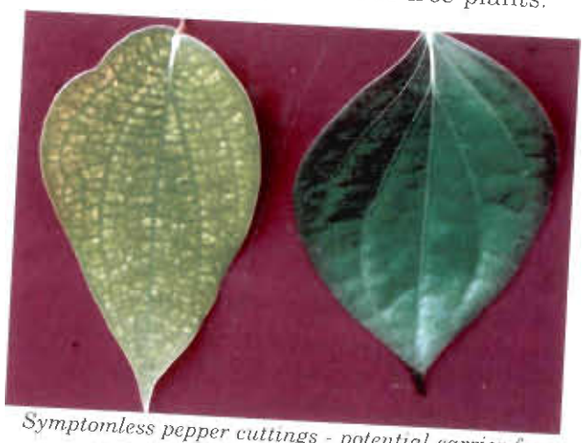
Analysis of PCR products from ORF III region *Piper yellow mottle virus* infecting black pepper

Lanc 1. 500 bp DNA ladder, Lanes 2-6 infected black pepper samples

In order to detect the virus in field samples including nursery plants, RT-PCR and PCR was optimized for the detection of CMV and PYMV infecting black pepper plants. A procedure for simultaneous isolation of RNA and DNA from infected black pepper plant and multiplex PCR for simultaneous amplification of CMV and PYMV in a single reaction was standardized.

Results of ELISA to know the distribution of viruses during different seasons, showed varying concentration of both the viruses during different months. The concentration of both the viruses was found to be higher during months of October to February. Further, distribution of both the viruses also showed variation within different parts of plants, maximum being in young leaves.

A DAS-ELISA based procedure was standardized for indexing CMV and PYMV in black pepper mother vines. Of the 2186 mother vines indexed, 713 were found infected with virus. Of the 713 ELISA positive plants, about 50% of plants did not show any visible external symptoms suggesting that symptoms cannot be used as criteria for identifying infected plants. Sensitive methods such as ELISA or PCR are essential to identify the virus-free plants.



Symptomless pepper cuttings - potential carrier for viruses

9. MECHANISM OF DROUGHT TOLERANCE

Screening for drought tolerance: Screening of black pepper germplasm (75 accessions) for drought tolerance revealed that accessions 5001 and 4152 were relatively tolerant.

Isozyme and protein profiles: The following tolerant and susceptible accessions, identified previously, were used for isozyme assays and protein profiles.

Tolerant accessions: 931, 1495, 892, 807, 4057, 4095, 1622, 1114, 1343, 4177, 1368, 4072, 1390,

4216, 4226, 1315, 1248, 1585, 1216, 1198, 1228, 1218, 1277

Susceptible accessions: 1312, 1311, 1296, 1320, 1362, 1093, 1095, 1363, 1491, 1330, HP348, 350

Super oxide dismutase (SOD): A total of 8 bands were noticed. Em values varied from 0.04 to 0.76. Five bands were common in all the accessions (Em values 0.04, 0.11, 0.40, 0.53, 0.73). Other bands (Em values 0.60, 0.67 & 0.76), not common to all the accessions were also seen. However no specific band representing tolerance could be identified.

Peroxidase: Two bands with Em values 0.03 and 0.09 were noticed. Tolerant and susceptible accessions had a similar banding pattern

Catalase: Single band was obtained both in tolerant and susceptible accessions.

Protein profile: Nine bands were observed with Em values of 0.17, 0.3, 0.43, 0.61, 0.71, 0.74, 0.79 & 0.64 and 0.76 (minor bands). No specific pattern for tolerance or susceptibility could be observed

Gas exchange parameters: Gas exchange parameters such as photosynthetic rate (A, μ moles), transpiration rate (E, m moles), g_s (stomatal conductance), leaf temperature (T ° C) etc. were measured during control, three and six days after stress induction. Photosynthetic rate, transpiration rate and stomatal conductance decreased while leaf temperature increased with stress intensity.

Gas exchange parameters

Acc	A	E	g_s	Ci	T
Control					
Mean	1.91	1.11	0.07	316	30.4
Three days after stress					
Mean	1.32	0.53	0.026	255	34.0
Six days after stress					
Mean	0.60	0.24	0.004		37.0

The rate of decrease in transpiration rate and stomatal conductance was much higher than the rate of decrease in photosynthesis during stress in all the accessions.

10. QUALITY EVALUATION AND POST HARVEST TECHNOLOGY

Quality Evaluation: Five black pepper samples grown at Munnar were evaluated for oil, oleoresin, piperine and oil profile. HP-105, HP-728 and C-1041 contained 4% oil. Oleoresin ranged from 7.8 – 10.5% and piperine 1.6 – 2.9%. The oil of HP-34 contained 18.5% caryophyllene followed by HP-105 with 15% caryophyllene.

Sabinene, Myrcene and Limonene content were high in the essential oil while caryophyllene was below 12%.

Essential oil constituents of organically cultivated Panniyur-1 and Karimunda showed upto 30% caryophyllene in Panniyur-1 while Karimunda showed upto 24% caryophyllene in oil. Oil, oleoresin and piperine did not show much variation. The study indicated variation in caryophyllene content within a cultivar.

Grading of black pepper varieties: Five varieties of black pepper were graded using TNAU model cleaner cum grader. Cleaned black pepper samples of 15 kg each were used for the above study. The samples were graded to 4 sizes i.e < 3.5mm, 3.5 to 3.8mm, 3.8 to 4.8mm and > 4.8mm. Percentage of various grades of pepper obtained in each variety is given below.

Evaluation of Black Pepper from Munnar

Sample	Oil (%)	Oleoresin (%)	*Piperine* (%)	Caryophyllene in oil (%)
HP-34	2.8	9.3	2.6	18.5
HP-105	4.0	10.5	2.9	15.0
HP-728	4.4	7.8	2.9	9.2
HP-813	2.4	9.2	2.1	8.0
C-1041	4.4	8.6	1.6	9.7
Arivikad (local)	2.8	8.0	1.6	7.5

Evaluation of organically cultivated Black Pepper

Sample	Oil (%)	Oleoresin (%)	*Piperine* (%)	Caryophyllene in oil (%)
Panniyur-I				
Organic	3.0	9.3	3.0	23-30
IPNM	3.1	11.4	3.5	31.9
Karimunda				
Organic	3.6	9.3	3.8	15-24
IPNM	3.5	11.7	4.0	25.0

Grading of black pepper

Variety	Size(mm) (% of berries)			
	< 3.5	3.8	4.8	> 4.8
Panniyur-1	8.67	65.17	25.76	0.40
Panniyur-II	9.51	64.48	25.58	0.44
Panniyur-V	17.43	65.53	16.84	0.30
Subhakara	13.95	51.89	33.29	0.86
Sreekara	20.12	57.94	21.66	0.29

For all the five varieties graded, more than 50% of the berries were of the size 3.5 to 3.8 mm.

Storage studies: Black pepper was stored in polypropylene (PP) bags of 300 g at four atmospheres i.e. 100% vaccum, 100% nitrogen, 90% nitrogen and 10% vaccum and in normal atmosphere. After eight months of storage, when analyzed the black pepper samples stored in vacuum, showed comparable quality with original sample.

Preparation of white pepper through fermentation

Eight among the 51 bacteria evaluated were found to be useful for production of white pepper from black and green pepper berries. All the eight bacteria resulted in more than 95%

conversion, within five days. These isolates could convert the black and green pepper at a concentration of 10^9 cfu ml^{-1} at 35°C. Apparently matured green berries were used for microbial conversion into white pepper. The white berries from green berries were creamy in colour but sizeable quantities of wrinkled berries were found among the white pepper indicating their immaturity.

Nursery Management

Black pepper is commonly propagated through rooting of cuttings using potting mixture consisting of soil, sand, and farmyard manure in 2:1:1 proportion. Substituting sand with granite powder, a waste material obtained from stone quarries, is found to be more convenient method of black pepper propagation. Rate of leaf production (4.6), leaf area (136.8 cm^2), and biomass (3.9g) of black pepper rooted cuttings were higher for combinations of soil (S), granite powder (G) and farmyard manure (F) (SGF 2:1:1), followed by (SGF 1:1:1), soil, granite powder and coir pith compost (CPC) (SG CPC 1:1:1) and soil, granite powder, *Azospirillum* and phosphobacteria (SG, A+P 1:1:1). Production cost of rooted cuttings were less for SGF 2:1:1 and SGF 1:1:1 compared to control.

CARDAMOM

Cardamom

1. GENETIC RESOURCES

Collection: Two germplasm explorations in cultivated and wild areas of Idukki, Chimmony, Nelliampathy and Palakkad regions of Kerala yielded a total of 23 germplasms. The collection comprised of a specific morphological marker type with white labellum (the normal flower being white labellum with purple streaks), high yielding bold capsule type, lower elevation adapted types and accession with purple pigmentation of pseudostem. The present *ex-situ* gene bank consists of 439 collections, hybrids and disease resistant selections.

Seventy-two accessions, which include 13

Normal cardamom accession: Flower with white labellum and purple streaks

Unique cardamom accession: Flower with white labellum

Evaluation of 'Malabar' types under CYT I

Entries	Plant height (cm)	Tillers per plant	Panicles per plant	Capsules per plant	Wet yield per plant (g)	Dry recovery(%)	Dry yield (kg ha^{-1})
MA 11	320.5	44.0	49.7	2949.3	2149.8	21.3	1142.1
MA 18	315.3	59.7	65.0	3219.7	2897.1	20.0	1448.6
MA 28	330.3	40.7	56.7	2890.0	2297.6	18.9	1085.6
CP 7	280.2	44.3	52.0	2990.7	2024.3	21.4	1083.0
CP 9	310.0	51.3	49.7	2797.7	2422.2	20.0	1211.1
RR 1(S)	300.6	52.0	64.0	3799.7	2811.3	18.8	1317.8
SAM	280.3	46.7	89.3	3997.0	3105.7	20.0	1552.8
Mean	302.5	42.6	52.7	2323.7	1743.3	-	867.0
SEd	26.15	5.01	10.11	621.00	511.12	-	222.23
CV (%)	13.56	16.38	22.09	33.73	34.88	-	41.01
CD (p=0.005)	49.20	9.95	19.66	1299.18	1067	-	397.33

compound panicle types and 59 Malabar types, have been characterized for 18 characters based on IPGRI descriptor. Among the compound panicle types, highest fruit set (44.1%) and yield (3541.5 g plant^{-1}) were recorded in the accession APG 250. Among the Malabar types highest variability was observed for yield [Coefficient of variation (CV) 44.4%] followed by length of the panicle upto first raceme (CV-40.6%). The longest panicle was recorded for the accession APG 292 and highest oil content was recorded in the accession APG 257. The number of fruits ranged from 15.4 to 61.1% and maximum was recorded in the accession APG 407.

2. CROP IMPROVEMENT

Considerable extent of heterosis for yield and yield components has been demonstrated in cardamom and being a vegetatively propagated crop, heterosis can be fixed at F_1 generation itself. Based on preliminary evaluation, 59 selections and 11 hybrids were short-listed for Comparative Yield Trials (CYT). Morphological, yield and quality characters have been recorded in CYT I, II, III and IV. The genotypes with significantly high yield were short-listed and planted for clonal multiplication.

Among the 16 accessions, highest yield was recorded in the accession SAM followed by MA 18 with 1552 and 1448 kg ha^{-1} respectively. The yield level was significantly higher than local checks (RR 1, CCS 1) and Green Gold. The accession MA 28 performed consistently well over the last two years

Promising Malabar selection - M 28

Promising hybrid - NHY 35

Evaluation of hybrids and OP's under CYT II

Entries	Plant height (cm)	Tillers per plant	Panicles per plant	Capsules per plant	Wet yield per plant (g)	Dry recovery(%)	Dry yield (kg ha^{-1})
HY 3	325.5	50.0	60.7	2317.7	2102.5	20.0	1051.8
NHY 14	323.1	38.3	47.0	2345.3	2169.7	22.0	1193.4
NHY 35	297.1	31.7	51.7	3142.7	2840.2	21.1	1498.2
Mean	267.77	35.23	44.42	1441.72	1278.45	-	629.96
SEd	27.52	5.15	10.81	529.86	475.85	-	236.34
CV (%)	12.59	17.89	29.80	45.01	45.57	-	45.95
CD (p=0.005)	55.23	10.33	21.69	1063.25	954.86	-	394.26

In CYT II, among the 18 hybrids and 4 open pollinated progenies three hybrids *viz.*, NHY 35, NHY 14 and HY 3 out yielded checks. The hybrid between *katte* resistant and high yielding accession, NHY 35 recorded significantly high yield of 1498 kg ha^{-1} and the yield level is consistent over the years.

Evaluation of 'Vazhukka' selections in CYT IV

The purpose of CYT IV was to know the suitability of Idukki land races such as Green gold, Wonder cardamom and Palakuzhi selections in higher elevations of Karnataka. The performance of Vazhukka selections was also

Promising Vazhukka selection - VA1

tested. Among the three land races, Palakuzhi selection performed well with mean dry yield of 1550 kg ha^{-1}. Among the Vazhukka selections, AMB 2 out yielded other selections and checks by recording 1779 kg ha^{-1}.

To get desirable recombinants having high yield, superior quality and *katte* resistance hybridization was carried out between two mosaic resistant selections *viz.*, APG-306 & APG-310 with the popular high yielding land race Green gold (APG-259). The crosses were effected in four combinations both direct and reciprocal, which resulted in four hybrids.

3. DISEASE MANAGEMENT

Resistance

Studies on genetics of resistance to mosaic (*katte*) disease: Back crossing was carried out in two promising hybrids (NHY 35 and NHY 3) with respective resistant and susceptible parents to study the genetics of *katte* disease. Two F_1 hybrids were also selfed to study the progenies. The seedling progenies were raised in polybags for screening against the disease.

Screening against mosaic virus: Sixteen promising accessions were screened in green house conditions and only one accession (NHY 17) expressed mosaic symptom in the initial screening.

Screening against foliar diseases: Natural infection of leaf blight and leaf blotch were recorded from 70 accessions which were under evaluation in CYT I to IV.

Evaluation of bio-consortium

The bio-consortium of rhizobacteria was applied to the root zone of 5-month old cardamom seedlings and challenged with the pathogens *Phytophthora capsici* and *Pythium vexans* after 15 days. Significantly less root rot and mortality were recorded with *Trichoderma harzianum* (MTCC 1578) alone followed by bioconsortium (IISR-6, IISR-13, IISR-51, IISR-151, IISR-853 & IISR-859) and chemical drenching with COC (0.2%).

4. MECHANISM OF DROUGHT TOLERANCE

The six genotypes *viz.*, Green gold, Mysore-2, APG 277, Malabar-18, Compound Panicle 7 and Hybrid 36 were screened for drought tolerance. Morphological and physiological parameters

were recorded. Chlorophyll florescence was reduced under water stress, whereas relative water content recorded less reduction. Green gold, Mysore-2, Malabar-18 and Hybrid-36 maintained relatively higher biomass compared to CP-7.

Green gold, CCS-1, Acc. 893 and RR1-reciprocal cross i.e. 16 crosses and four open pollinated progeny were planted in field for further evaluation to moisture stress. They recorded significant variation for plant height, number of tillers per clump, number of leaves per clump at end of one half year. 893 OP, 893 self, CCS-1 self, GG x 893; CCS-1 x 893 recorded better growth parameters compared to other genotypes.

5. QUALITY EVALUATION

GI appellation using molecular, morphological and quality profiling techniques: Physical quality parameters such as weight of 100 capsules, number of capsules in 100 g, seed husk ratio, bulk density (gL^{-1}), weight of splits (in 100g), colour intensity, circumference, length of capsules and the biochemical parameters such as total carbohydrates, starch, reducing sugar, protein, total free amino acids, phenols, crude fiber, ash, acid insoluble ash, volatile oil and moisture content were documented. The comparative analysis of export grade cardamom from India, Sri Lanka and Guatemala based on physical and biochemical parameters and molecular techniques revealed the superiority of Indian produce for the physical parameters such as seed to husk ratio, weight of 100 capsules, number of capsules in 100g, bulk density and moisture content. GC profile of the oil revealed high 1, 8-cineole and α- terpinyl acetate in the Indian cardamom.

Evaluation of promising accessions: Among the seventy one germplasm samples analyzed, NHY-15, RR-1 x MB-3, MA-7, VA-1, and WC contained more than 6% oil and NHY-14, MB-3, NHY-18 and OP-28 possessed more than 40% α- Terpinyl acetate in the oil.

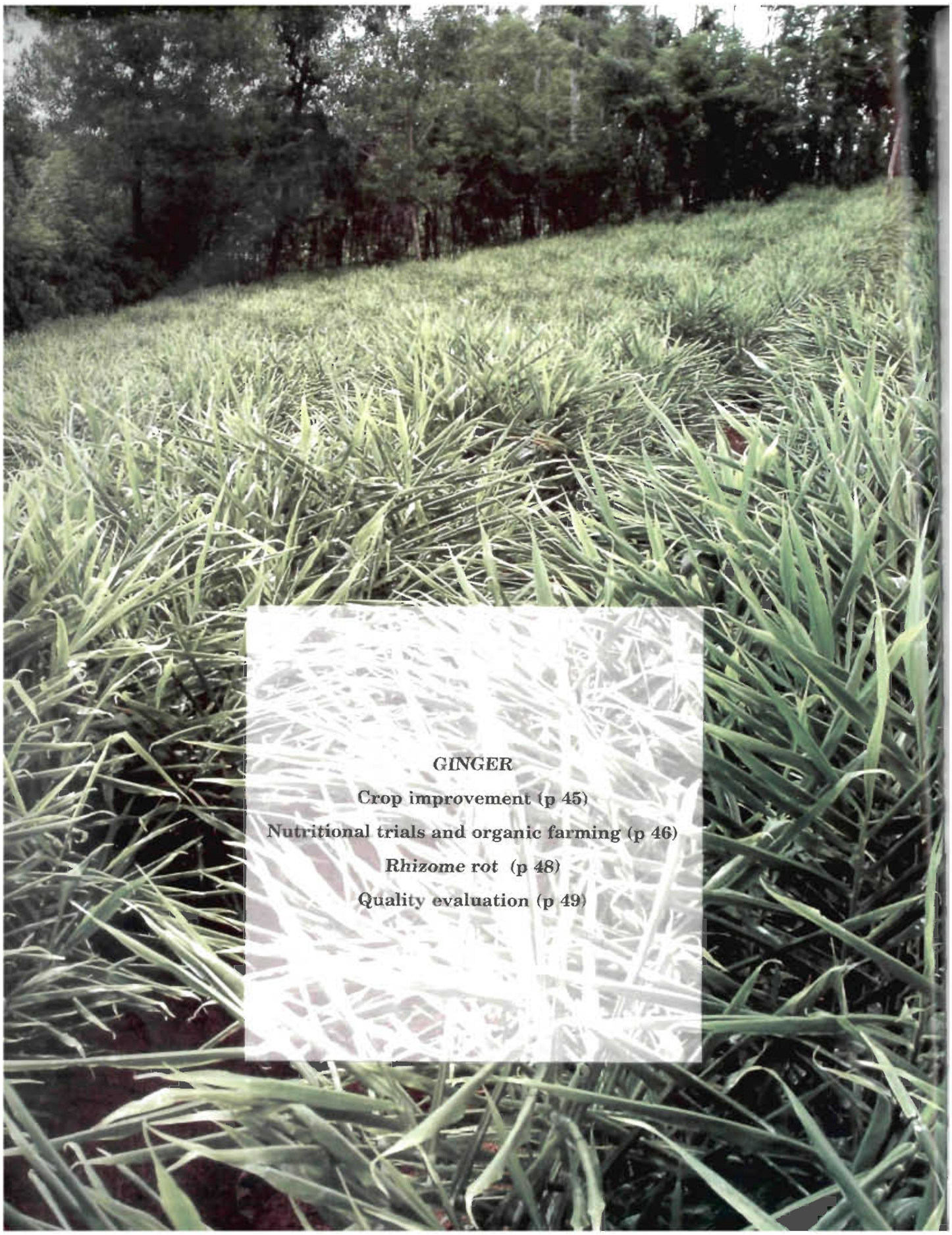
Accessions	Oil	1,8 Cineole	α-Terpinyl acetate
NHY-15	6.5	32.0	38.0
RR-1 x MB-3	6.5	28.0	39.0
VA-1	6.5	26.0	39.0
WC	6.5	28.8	39.2
NHY-14	5.0	29.5	43.0
NHY-18	5.0	29.2	43.7
MB-3	6.0	30.0	42.6
NHY-32	5.0	27.8	41.3

Comparative physical and biochemical quality parameters of Indian, Guatemalan and Sri Lankan cardamom

Parameter	Indian cardamom	Sri Lankan cardamom	Guatemalan cardamom
Weight of 100 capsules (g)	24.26 ± 0.43	12.18 ± 0.27	18.23 ± 0.27
No. of capsules in 100g	334	807	554
Seed husk ratio	3:1	1.7:1	2.1:1
Bulk density (g l^{-1})	384.64 ± 6.33	338.08 ± 3.45	286 ± 7.24
Weight of splits (in 100g)	21.46 ± 0.49	6.8 ± 0.30	Nil
Colour intensity	23 -13 to 24 -8	24-13 to 24-7	24-10
Circumference of the capsules (cm)	2.46 ± 0.02	2.08 ± 0.02	2.13 ± 0.01
Length of capsules (cm)	1.89 ± 0.12	1.60 ± 0.06	1.95 ± 0.07
Moisture (%)	5.08	15.74	18.84
Essential oil (%)	10	5	14
Starch (%)	39.26	29.4	29.52
Carbohydrate (%)	40.16	35.25	31.75
Reducing sugar (%)	3.14	4.18	3.17
Phenols (%)	3.26	4.75	3.88
Protein (%)	1.03	1.05	1.42
Crude fiber (%)	16.3	12.2	12.5
Ash (%)	7.45	8.4	8.6
Acid insoluble ash (%)	1.76	1.07	1.23

GC-profile of volatile oil of cardamom

Constituent (Area %)	Indian cardamom	Sri Lankan cardamom	Guatemalan cardamom
Pinene	1.95	1.43	1.93
Sabinene + Myrcene	7.11	5.62	7.00
Limonene	3.60	3.67	3.63
1,8 Cineole	32.55	27.89	31.39
α- Terpinene	2.31	2.32	1.90
Linalyl acetate	0.79	1.81	3.31
Geraniol	2.00	2.94	2.10
α- Terpinyl acetate	41.20	37.93	34.92



GINGER

Ginger

1. CROP IMPROVEMENT

Production of nucleus planting material: Nucleus planting material of Varada (1640 kg), Mahima (1418.5 kg) and Rejatha (1273 kg) were produced

Cataloguing: Fifty ginger accessions were field planted for cataloguing the growth parameters of ginger.

Character	Mean	Range	CV(%)
Plant height (cm)	53.7	40.4-67.4	20
Leaf no./main tiller	20.4	14-27	14
Tillers/plant	6.9	3-12	12.5
Leaf length (cm)	24.5	21.6-27.6	12
Leaf width (cm)	3.1	2.56-4.01	9.5
Clump weight (kg)	0.3	0.12-0.56	28
Internode length (cm)	0.8	0.1-1.06	13
Yield	8.7	3-13	34

Yield evaluation: The mean yield of selected Nepal collections ranged from 11.0 kg to 13.1 kg of fresh rhizomes per $3m^2$ (Bed), which was on par with Varada (10.4 kg). The dry recovery was 20 to 24.8% and the crude fibre ranged from 1.7 to 2.9%. The difference among the accessions for essential oil and oleoresin was not high. Among the accessions, Acc. 578 performed well with a yield of 13.1 kg with 1.0% crude fibre and 3.5% oleoresin. Among the 13 high oil and 7 low fibre ginger accessions, Acc. 162 performed well with a yield of 10.5 kg bed^{-1} giving 23.8% dry recovery with high oil content (2.0%), low fibre (3.4%) and oleoresin content (4.5%).

***In vitro* pollen germination:** Comparison of different media such as Brewbaker and Kwack (1963), Pillai *et al* (1978) and Dhamayanthi *et al* (2003), using pollen of cultivar Varada indicated that the one recommended by Pillai *et al* (1978)

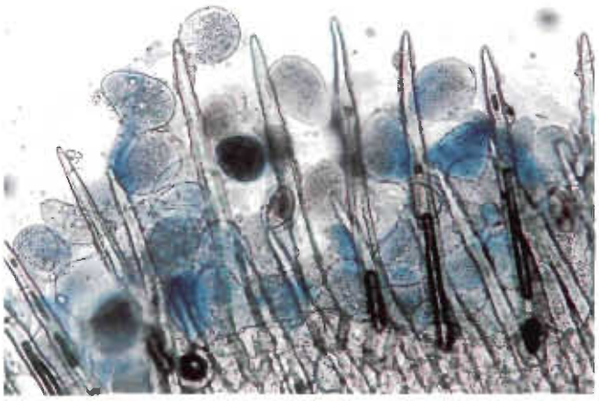
Mean yield ($3m^2$ bed) and quality of selected ginger accessions and control

Acc. No	Mean fresh yield (kg)	Dry recovery (kg)	E.oil (kg)	Crude fiber (kg)	Oleoresin (kg)
552	12.1	21.8	1.0	2.4	3.8
553	12.8	20.0	1.0	2.9	3.5
573	10.0	22.4	1.0	2.2	3.2
574	11.6	22.9	1.0	1.7	3.2
578	13.2	21.7	1.0	2.8	3.5
581	12.2	20.9	1.0	2.2	3.3
589	11.6	21.1	1.0	2.3	3.2
591	11.9	24.8	1.0	2.2	3.4
592	10.8	21.2	1.3	1.9	3.4
593	12.9	20.7	1.3	2.5	3.2
597	10.6	21.9	1.0	2.5	3.3
598	11.0	21.3	1.0	2.0	3.5
Varada (control)	10.4	21.4	-		
CD			Non significant		

Mean yield per bed and quality of high oil type ginger accessions

Acc. No	Mean fresh yield (kg bed^{-1})	Dry recovery (%)	E.oil (%)	Crude fiber (%)	Oleoresin (%)
50	9.25	18.3	1.7	3.0	4.8
57	9.25	20.0	1.7	3.7	5.5
95	8.5	23.2	1.0	2.5	3.0
99	7.5	21.7	1.3	4.4	4.8
156	6.62	23.0	1.7	3.1	5.0
162	10.5	23.8	2.0	3.4	4.5
197	9.13	20.6	1.7	1.5	4.2
209	8.62	20.6	-	-	-
217	12.25	23.0	1.0	2.0	3.0
225	9.63	20.0	2.0	3.4	4.5
228	9.87	25.0	1.0	3.0	4.5
411	9.87	21.2	1.7	1.5	4.2
420	9.0	21.7	1.0	3.8	3.8
CD			Non significant		

A view of in vitro *pollen germination in ginger showing sterile pollen and ungerminated fertile pollen(40X)*



Germination of Curcuma longa *pollen grains on stigmatic papillae of* Zingiber officinale *(40X)*

gives higher percentage of pollen germination (5.3%) *in vitro* at 26.5°C.

***In vivo* pollen germination:** *In vivo* pollen germination was tested by placing the inflorescence (before opening of the flower) in a conical flask filled with water. After performing pollination the system was kept in a BOD incubator at 26.5° C. After 20 h the pistil was stained with Cotton blue in Lacto phenol to observe *in vivo* germination of pollen. No pollen germination was observed *in vivo* in cv. Varada as well as Maran. Pollen of *Curcuma* species was found to germinate on the stigma of ginger at low frequency.

2. NUTRITIONAL TRIALS AND ORGANIC FARMING

Optimum nutrient ratios for yield: Highly significant positive correlation of leaf P/Zn ratio and a significant negative correlation of soil P/

Zn ratio with rhizome yield were further confirmed through trials. A step wise regression analysis showed that leaf P/Zn is most influencing factor on rhizome yield (R^2=0.337**) followed by soil P/Zn. A linear regression equation for rhizome yield prediction was developed.

Rhizome Yield (t ha^{-1}) = 13.538 + 0.0635 (L P/Zn) – 0.277 (S P/Zn) (R^2= 0.353**)

	L P/Zn	S P/Zn
L P/Zn	-	-0.450**
Rhizome Yield	0.563**	-0.415**

** Significant at P=0.01

Nutrient requirement for targeted production

Based on the fixed yield targets and initial soil availability of major nutrients, nutrient contribution from soil, nutrient contribution from fertilizer and nutrient contribution from control soil were calculated from the earlier data and fertilizer doses to obtain yield targets of 10, 15, 20 and 25 kg bed^{-1} was calculated and validated. The overall yield recorded was less. However, a deviation of 13.0% to -25.3% in ginger yield over the fixed target was noticed. Through targeted nutrient application, 57% and 46% increased yield over recommended dose could be achieved in Mahima and Rejatha, respectively with reduced fertilizer application.

Organic Farming

The mean yield recorded in varieties Varada, Rejatha and Mahima was 18 kg bed^{-1}, that was 24.5% and 68% higher over chemical and integrated farming respectively. Foliar infection with *Phyllosticta* sp. was the major constraint noticed. Soil nutrient buildup was observed to be high in organic and integrated managements compared to conventional system. FYM + NC + vermi / coirpith compost application recorded higher yield on par with FYM application alone

Yield target achieved in ginger

Yield target (kg bed^{-1})	Mahima		Rejatha	
	Yield (kg bed^{-1})	Deviation (%)	Yield (kg bed^{-1})	Deviation (%)
10	10.1	1.0	11.1	13.0
15	11.2	-25.3	13.8	-8.0
20	16.0	-20.0	15.1	-24.3
Recommended dose	10.2	-	10.3	-

High quality ginger accessions

Accessions	Oil (% v/w)	Oleoresin (% w/w)	Fibre (% w/w)
277	2.3	5.9	2.4
62	2.3	5.9	3.0
369	2.0	4.6	5.0
399	2.0	5.9	4.5
374	2.0	5.5	3.2
537 (Kozhikkalan)	2.0	5.7	3.2
HO-225	2.0	4.5	3.4
HO-162	2.0	4.6	4.9

in ginger. All the PGPR combinations applied were equally effective in controlling rhizome rot and produced yield on par to chemical control.

3. RHIZOME ROT

Etiology

Etiology of soft rot: Species of *Pythium* causing soft rot of ginger in Kerala, Karnataka, UP and Sikkim was identified as *P. myriotylum*. The pathogenicity trial further confirmed that this species was highly aggressive on ginger. PCR based method was found suitable for identification of *P. myriotylum*. Primers specific for *P. myriotylum* were found to amplify 150 bp sequences in the genomic DNA of *P. myriotylum*.

Etiology of bacterial wilt pathogen in north-eastern states and its relationship with strains in southern states: Isolates of *R. solanacearum* causing bacterial wilt of ginger in North Eastern States, Sikkim and Kerala were found to be 100% similar in REP, ERIC and BOX PCR profile. Very close similarity coefficient between these two geographically well separated locations clearly indicated the strain migration from one location to another. They belong to Biovar 3 or Biovar 4 and caused wilt in 5-7 days of inoculation

Resistance against *Pythium*

Forty-three ginger accessions short-listed during the preliminary screening were subjected to second round screening. Accession no. 32, 97, 98, 246, 554 and 588 were found tolerant to *P. myriotylum*.

Resistance against *Ralstonia solanacearum*

Ginger strain of *R. solanacearum* was found to infect turmeric, cardamom, *Curcuma aromatica, C. zedoaria, Kaempferia* sp., *Zingiber zerumbet* and tomato but not *C. amada*. Mango ginger (*C. amada*) was found unaffected by the ginger bacterial wilt pathogen *R. solanacearum*. Interestingly the plant wilted when the pathogen was inoculated into pseudostem after making a pinprick indicating that the bacterium could not make entry into the plant system through roots. Besides *R. solanacearum* was found to survive on soil, roots, and rhizome of mango ginger without causing any yield reduction.

Integrated management

Integrated management strategies involving rhizome solarization and bacteriazation were evaluated in the field at Peruvannamuzhi for the management of bacterial wilt and rhizome rot diseases in ginger. However, the incidence of both the diseases was negligible in the field. There was no significant difference for germination and yield for heat-treated and untreated rhizomes. Among the bacterial consortium, yield from G3 was significantly higher (7.3 kg $3m^2$ bed^{-1}) when compared to other treatments.

Micro-climatic parameters recorded during rhizome solarization: Data on temperature, light intensity and CO_2

Parameter	Ambient (atmosphere)	Inside the polythene bag
Temperature (°C)	34	47
CO_2 (ppm)	370-380	1800-1850
Light Intensity (micromoles/m^2/s)	1900-2100	1600-1720

concentration was recorded within the polythene sheet (200 micron) used to cover the rhizomes using Photosynthesis System. Higher CO_2 concentration, higher temperature and slightly lesser light intensity were recorded within the polythene sheet when compared to ambient atmosphere.

Nematodes

Four accessions out of 20 newly screened lines were resistant to root-knot nematode. Resistance of 11 other ginger accessions shortlisted during last year *viz.* Acc. 23, 75, 104, 106, 110, 111, 141, 194, 251, 357 and 376 were confirmed by repeated inoculations.

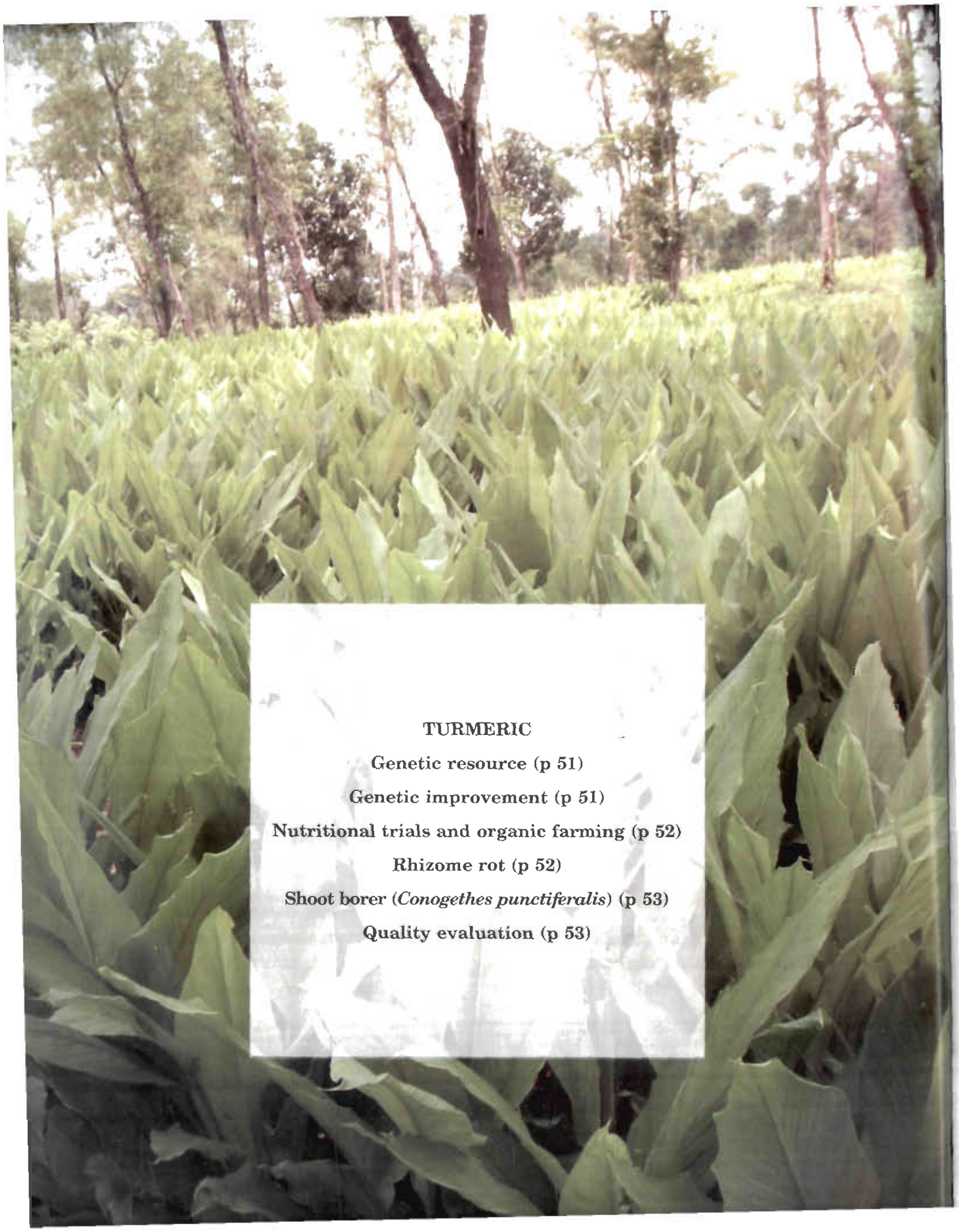
4. QUALITY EVALUATION

Twelve Nepal collections, 49 germplasm collections, 15 low fibre types and 12 high oil types were evaluated for oil, oleoresin and crude fibre. Acc-277, 399, 408, 537 (Kozhikkalan) and Acc-246 (Sabarimala) showed more than 5.5% oleoresin. Many accessions with fibre content below 3% were identified. Biochemical characterization of volatile oil of a Japanese variety of ginger 'Kintoki' has been done.

GC-MS of ginger oil

RT	Area (%)	Compound
11.57	5.3	Z-citral
12.16	1.14	Geraniol
12.82	8.16	Citral
20.93	7.81	AR-curcumene
21.59	19.11	α-Zingiberene
21.99	7.57	β-Bisabolene
22.13	6.66	α-Farnesene
22.61	10.28	β-Sesquiphellandrene

Analysis of ginger oil: GC-MS analysis of ginger oil from Peruvannamuzhi on GC MS analysis indicated the presence of following major compounds. Citral-a-5.3%, citral-b-8.1%, ar-curcumene-7.8%, α- zingiberene-19.1%, β-bisabolene-7.5%, α- farnesene- 6.6% and β-sesquiphellandrene-10.2%.



TURMERIC

Turmeric

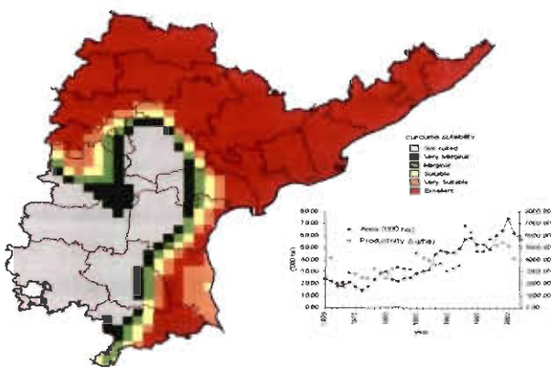
1. GENETIC RESOURCE

Production of nucleus planting material

Kedaram (1345 kg), Alleppey Supreme (1161 kg), Prathibha (1000 kg), Prabha (950 kg), *C. aromatica* (152 kg) *C. caesia* (32 kg) were the nucleus planting materials produced during the year.

GIS studies

With the help of suitability maps and area productivity graphs, the status of turmeric cultivation in the important turmeric growing states was studied and it was found that site suitability is the key factor determining the productivity of this crop.



GIS studies in Turmeric

Suitability map of turmeric and area & productivity graph of Andhra Pradesh

The suitability map indicates that most part of Andhra Pradesh is suitable for turmeric cultivation, except for a small patch in the central and western Andhra Pradesh. It is interesting to note that during 1995-2000, the area under turmeric cultivation increased but the production level remained unchanged at 4000-5000 kg ha^{-1}. When analysed at district level it was found that districts such as Kurnool, Mehaboobnagar and Anantapur have large areas under turmeric cultivation but the productivity is low. This is due to less suitable growing conditions as predicted in the analysis. However, districts such as Nizamuddin, Guntur, Nellore, Vishakapattanam and Medak are highly suitable.

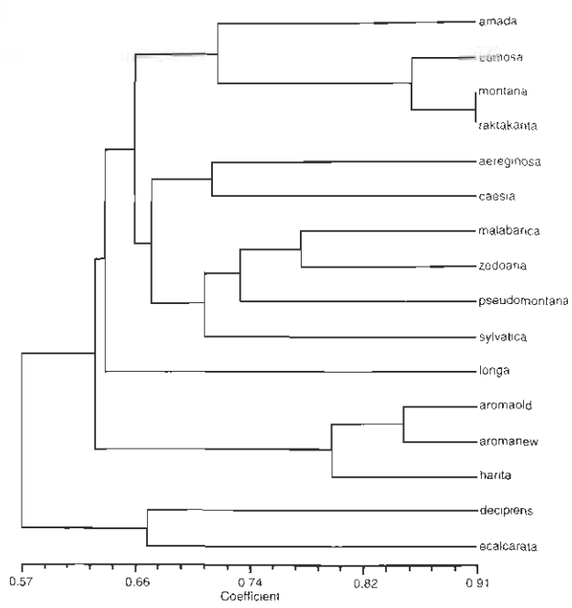
Maintenance and cytological analysis of seedling progenies

Two hundred and fifty seedling progenies of different turmeric accessions were maintained. Cytological analysis of seven seedling progenies of accession 138 revealed variation in chromosome number *viz.*, 138/1-78, 138/27- 84, 138/19- 84, 138/12- 84, 138/32 –78, 138/14-84, 138/1-78. Cytological analysis of seven seedling progenies of turmeric accession 138 revealed variation in chromosome numbers as 2n=78 (3 accessions) and 84 (4 accessions).

2. GENETIC IMPROVEMENT

Molecular characterization of *Curcuma* sp.

Molecular genetic profile of 16 *Curcuma* species. was developed using ISSR and RAPD primers. Thirty-nine RAPD primers yielded 376 bands of which 352 were polymorphic while out of the 91 bands generated by 8 ISSR primers, 87 were polymorphic. Dendrogram was constructed based on the unweighted pair group method using arithmetic averages. Cluster analysis of data using UPGMA algorithm placed 16 species in seven groups that are somewhat congruent with the classification based on conventional taxonomic units.



Cluster analysis of 16 Curcuma *species based on the molecular data generated by ISSR/RAPD markers*

3. NUTRITIONAL TRIALS AND ORGANIC FARMING

Nutrient requirement for targeted production: The realized yield showed 4.7% to -42.4% deviations from the fixed target. Through targeted nutrient application, 66% and 25% increased yield over recommended dose could be achieved in Prabha and Alleppey Supreme, respectively.

Efficacy of organic amendments in nutrient release and its uptake in soil: Efficiency of organic amendments in reducing the P fixation capacity of Peruvannamuzhi and Pulpally soil series were studied under lab conditions. The P adsorption maxima was reduced with the addition of FYM followed by vermicompost. Contrarily coir pith compost increased the rate of adsorption. Adsorption maxima, available iron and aluminium contents were significantly negatively correlated with available P in both the soils.

Organic Farming: Turmeric var. Alleppey Supreme and Prathibha recorded a mean yield of 11.75 kg bed^{-1} under organic cultivation with a reduction of 19% rhizome yield as compared to the integrated systems, but showed 13.4% higher yield over conventional (chemical) farming. Soil nutrient buildup was observed to be high in organic and integrated managements as compared to conventional system. FYM + NC + vermi/coir pith compost application recorded higher yield which was on par with FYM application alone in both ginger and turmeric. All the PGPR combinations applied were equally effective in controlling rhizome rot of ginger and turmeric and produced yield on par to chemical control.

4. RHIZOME ROT

Etiology: Rhizome rot affected turmeric collected from four states *viz*, Kerala, Karnataka, Tamil Nadu and Andhra Pradesh yielded predominantly the isolates of *Pythium* with stray incidence of *Fusarium*.

Evaluation of rhizobacteria: Management strategies involving application of bioconsortium of rhizobacteria (isolated from soil) were evaluated in the field for the management of rhizome rot. However, no incidence of the disease was observed in the field. Among the bacterial consortium, G3-G6 yielded significantly higher (10.6–11.6 kg $3m^2$ bed^{-1}) when compared to untreated control (6.5 kg $3m^2$ bed^{-1}).

Evaluation of endophytic bacteria: Putative endophytic bacteria isolated from turmeric rhizomes were evaluated in the field against rhizome rot. However, no incidence of the disease was observed in the field. Among the rhizobacterial treatments, the yield was significantly higher (14.5 kg $3m^2$ bed^{-1}) in beds

treated with TEB1+2+3 when compared to control (11.5 kg $3m^2$ bed^{-1}).

Nematodes

ance: Seven out of 35 accessions were ıt in the preliminary screening and five ıortlisted accessions *viz*, Acc. 57, 62, 150, 199 also showed tolerance in the repeated ng trials. Acc. 82 and Acc. 146 were to control (Prathibha).

ɔT BORER (*Conogethes punctiferalis*)

ure of damage: The nature and ıptoms of damage caused by shoot borer turmeric was studied in the greenhouse ıd field. Early symptoms of pest infestation ere identified. Apart from boring into the main pseudostem at the base, the larvae also bored into the leaf petiole to enter into the main central shoot. The crop loss caused by shoot borer on turmeric under various categories of infestation was determined. The crop loss was 72 and 79 g per clump when 25–50% of shoots and 50–75% of shoots, respectively, were damaged by the pest.

Distribution: The pattern of distribution of shoot borer in a turmeric field during various seasons was studied by determining various dispersion indices. The pattern of distribution was random initially up to September and became more aggregated during October, November and December. The seasonal population of shoot borer was recorded on turmeric in the field at fortnightly intervals. The symptoms of pest infestation were first observed during August (0.3% shoots infested) and were high during October to November (8.6%).

Natural enemies: Collections of shoot borer larvae were made at regular intervals to document the natural enemies of shoot borer on turmeric in the field. Mermithid nematodes and dermapterans were recorded as natural enemies and the former was observed throughout the crop season and the percentage of population of shoot borer larvae parasitised by the nematode was higher during August (77.8%) and September (65.4%).

6. QUALITY EVALUATION

Characterization of turmeric germplasm for curcuminoids: Curcuminoids were determined in the released varieties of turmeric *viz.*, Alleppey, Prabha, Prathibha, Suguna and Sudarsana. Variations were observed for curcumin I (1.6-3.39%), Curcumin II (0.39-1.08%)and Curcumin III (0.48-1.10%) among the varieties. Prabha and Prathibha showed lower content of curcumin I as compared to the other three varieties. Curcumin II showed a varied pattern, with highest values in Sudarsana. Regarding curcumin III, highest content was seen in Sudarsana and Suguna, with values ranging from 0.48 – 1.14%.

Chemical composition of high quality turmeric accessions

Accessions	Oil	Oleoresin (%)	Curcumin
50	9.0	21.8	7.2
35	9.0	20.8	3.4
1	8.4	20.2	3.2
47	8.3	18.1	3.3
62	8.3	19.5	3.5
21	7.6	20.3	3.1
2	8.6	11.1	2.0
Alleppey Supreme	3.0	13.2	6.2
Kedaram	4.0	16.0	7.5
Prabha	3.6	14.8	6.7

Seventy-two germplasm samples were evaluated for oil, oleoresin and curcumin content. Accession 50 contained 7.2% curcumin with 21% oleoresin. Accessions with more than 20% oleoresin are: 1, 25, 35, 21 and 50. Accessions with high oil (>8%) are; 62, 1, 47, 35, 39, 48, 20, 15, 32, 10, 2, 50 and 23.

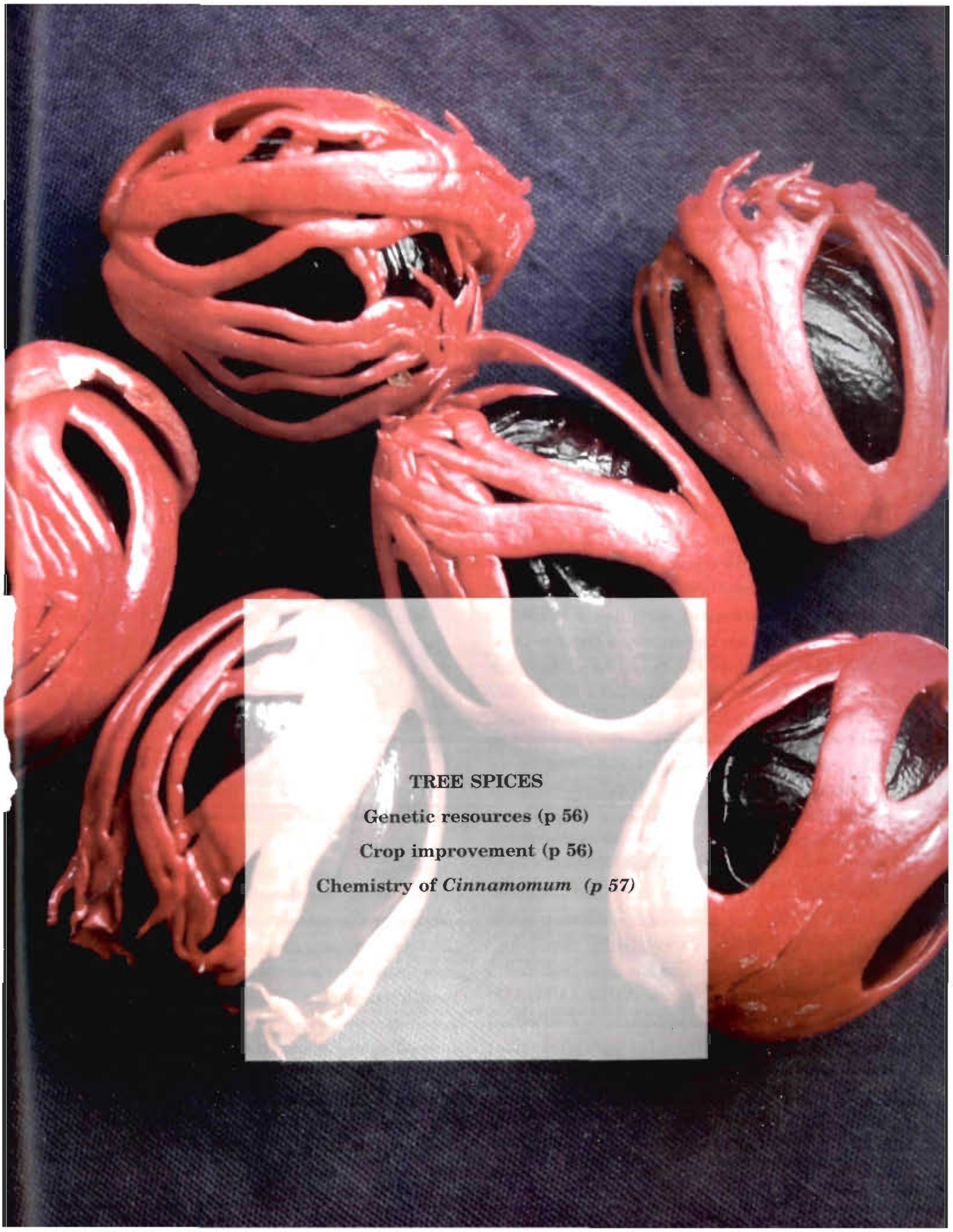
Major constituents in turmeric rhizome oil

ar-curcumene-1.5%, α- zingiberene- 1.45%, β-sesquiphellandrene- 1.6%, ar- turmerone-28.47%, β- tumerone- 9.2%, ar-tumerone- 3.1% and α- Tumerone- 22.17%.

GC-MS of turmeric oil

RT	Area %	Compound
4.19	1.32	α-Phellandrene
20.82	1.54	ar-Curcumene
21.34	1.45	α-Zingiberene
22.40	1.62	β-Sesquiphellandrene
28.37	28.4	ar-Turmerone
28.45	8.9	β-Tumerone
28.7	3.12	ar-Tumerone
29.67	22.17	α-Tumerone

RT: Retention time (min)



TREE SPICES

Tree Spices

1. GENETIC RESOURCES

Eleven accessions of *Garcinia gummigutta* and one accession of *G. molella* were collected from Kakkadumpoyil, Kakkayam, Wayanad, (Pakshippara, Sugandhagiri), Nelliampathy, Pakuthipalam and Parambikkulam. An unidentified *Syzygium* sp. was collected from Mowsmai, Cherapunji.

2. CROP IMPROVEMENT

Cassia

Evaluation of cassia is being done at Peruvannamuzhi and Appangala farms of IISR. At Peruvannamuzhi the elite lines A_2, C_1, D_1, D_3 were evaluated for three years and the pooled data did not reveal any significant differences between the accessions for number of shoots, fresh weight of bark/plant, dry weight of bark/plant and percentage of bark recovery. The range in values respectively were 2.9 to 4.8 for number of shoots, 325.2 to 395.1 g. for fresh bark weight, 89.5 to 111.2 g for dry bark weight and 21.2 to 24.7 for percentage bark recovery. When 15 accessions were evaluated at Appangala, D_3, a collection from Srikundara estate, Valpari was found to be the best.

Nutmeg

A total of 102 accessions were evaluated, out of which five accessions were found promising. Among these, A11/25 was the best (952 fruits plant^{-1}). Other accessions are A4/12, A4/11, A11/10, A11/29 (600 to 700 fruits plant^{-1}). Evaluation of clones of elite lines for morphological characters indicated that A4/22 was the best with height of 252 cm and maximum number of branches of 33.

Garcinia

Three accessions of *G. gummigutta* planted in the year 2000 flowered after five years, whereas one seedling of *G. xanthochymus* flowered after eight years of planting.

Seedlings of *G. hombroniana* flowered after four years. Two are male and two are female. Flowers are single or in pairs at the tip of branchlets in the axil of leaves. The average growth measurements of these trees were 393.9 cm in height, 323.3 cm (EW) canopy width and 280 cm (NS), girth of 23.7 cm and 21 tiers of primary branches, which were 42 per tree.

Fruits of G. hombroniana

The fruits of *G. hombroniana* are round about 5 cm in width & red in colour and with a disc like stigma attached to it. The interior of the fruit is segmented and most segment contain one flat seed. The pulp is yellowish and has a sour taste.

Garcinia spp: An unidentified collection from Mizoram flowered in October and December 2005 in two flushes producing red flowers, which were males.

Evaluation of nutmeg grafts for productivity

In the field trial on nutmeg, the performance of nutmeg on *M. malabarica* continued to be better than other rootstocks. The scion had an influence on the shape of the canopy as evident by the growth of the graft. A9-69 had an upright growth when compared to A9-4, which had more of a spreading canopy. Parameters like photosynthetic rate, transpiration rate, stomatal conductance and stomatal resistance were recorded in field-grown grafts. All parameters were more in A9-4 grafts on the three different rootstocks when compared to A9-69 grafts.

Evaluation of clove grafts for dwarfness

The scions exhibited reversal of the dwarfing nature on ordinary clove rootstock seedlings. The mean internodal length on the newly produced scion portion of the graft increased by 1.66 cm showing the effect of rootstock on scion. When dwarf clove was approach grafted on dwarf clove, the resultant grafts exhibited dwarfness (mean internodal length-0.38 cm). Similarly ordinary clove when approach grafted on dwarf clove, rootstock the mean internodal length of scion was reduced from 1.8 cm to 0.73 cm. This indicated that rootstock had a definite influence on the scion. The dwarf clove seedlings have been planted in the field.

The Zanzibar clove graft on *S. heynianum* expressed compactness of canopy. Grafting Zanzibar clove on *S. caryophyllatum* was successful when *S. heynianum* was used as interstock and three such grafts were raised with good sprouting and growth. Earlier attempts to graft clove with an extremely dwarf species *S. zeylanicum* were not successful and grafting of this species with *S. heynianum* is being done to induce dwarfness through double rootstock method. Dwarf clove plants are preferred for high density planting and for easy harvest.

Multiplication of Zanzibar clove and clonal rootstock of clove

The Zanzibar clove and *S. heynianum* are being multiplied clonally through vegetative means and tissue culture to get sufficient uniform rootstocks for grafting clove. Eleven Zanzibar grafts on clove rootstock have been prepared. All the grafts are being raised and maintained in big poly bags in the nursery. Clonal multiplication of *S. heynianum* through tissue culture was attempted. In *S. heynianum* multiple shoots were induced from nodal explants. Callus induction was observed from stem and leaf explants on WPM supplemented with 2BA + 0.5 NAA. The callus was white and compact. Rooting was observed on ¼ WPM and ¼ SH medium from stem explants along with bud break.

Standardization of grafting *Garcinia indica* and *G. gummiguttaa* on *G. cowa* as rootstock

One hundred seedlings of *G. cowa* have been grafted on *G. indica* with 30% success.

Molecular characterization in nutmeg

A cheap and less time consuming method was developed for isolation of PCR amplifiable DNA in nutmeg without RNase and phenol chloroform treatment. Forty-five random decamer primers were screened and 15 primers that gave good amplification were selected for further characterization. Single primers yielded better polymorphism than combinations of random primers.

3. CHEMISTRY OF *CINNAMOMUM*

Leaf oil content and composition: One hundred accessions of *Cinnamomum* germplasm were evaluated for leaf oil content. The oil content varied from 0.11% to 3.65% (v/w). In *C.*

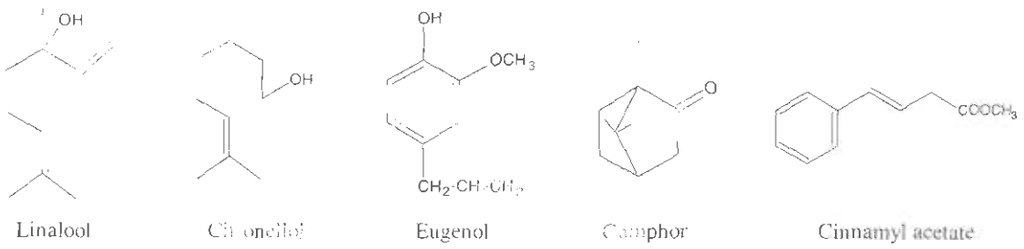
verum accessions the major constituent of leaf volatile oil, *viz.*, eugenol ranged from 67% to 88%. The chief component of volatile oil of leaves of *C. camphora, C. tamala*, *C. malabatrum* and *C. citriodora* was identified as camphor, eugenol, linalool and citronellol respectively. A chemotype of *C. cassia* with cinnamyl acetate as major component in the leaf oil was identified.

Bark oil and oleoresin contents

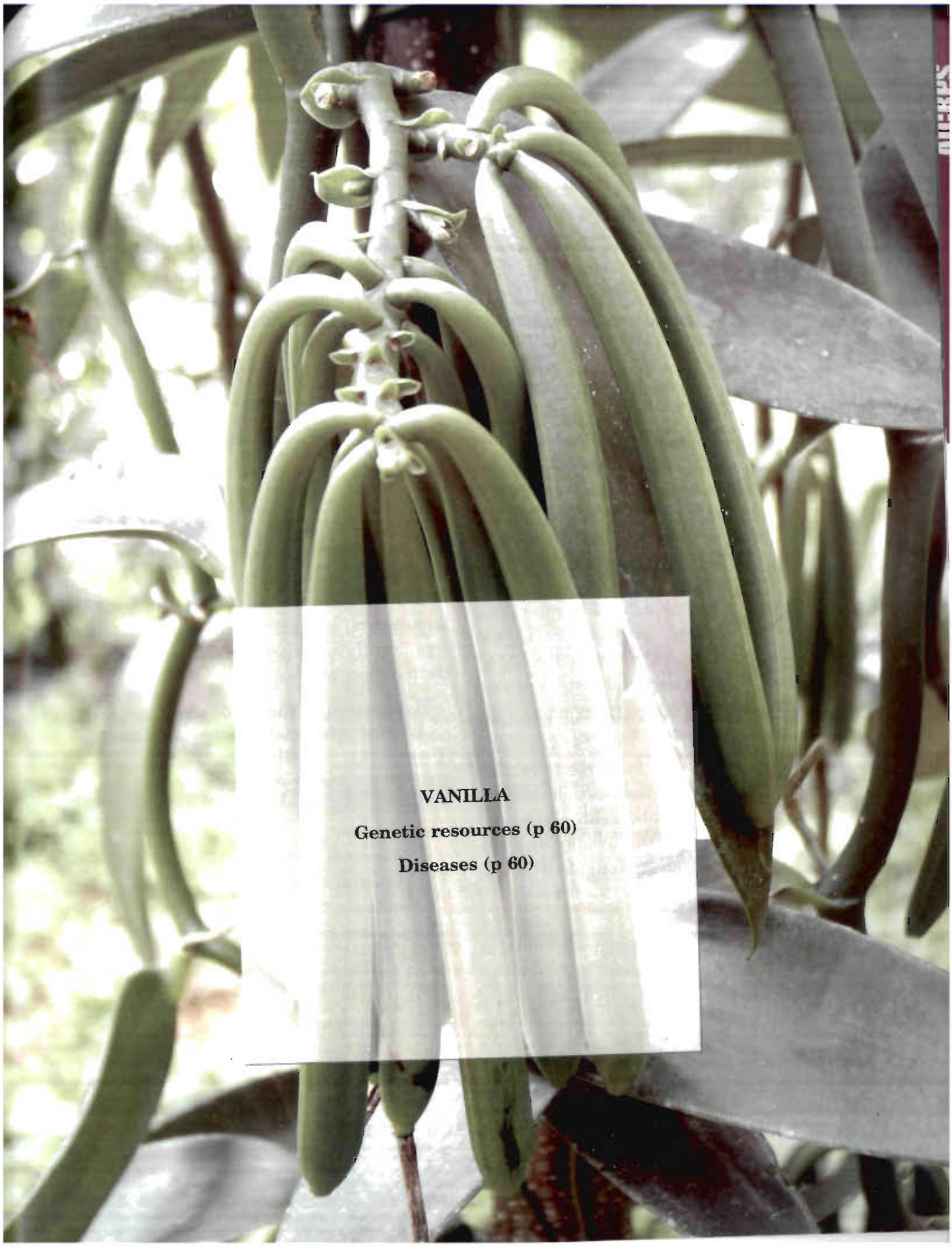
Seventy accessions of *C. verum* were analysed for bark oil and oleoresin contents. The bark oil content in these accessions ranged between 0.4% and 2.4% whereas bark oleoresin content varied from 8% to 17%. Accession No. 3, 73 and 147 recorded high volatile oil (>2 %) and oleoresin (>12 %) contents. The bark oil contained 60 - 70% cinnamaldehyde.

Leaf oil constituents of five *Cinnamomum* species

Species	Principal constituents(%)
C. verum	Eugenol (67-88), t- Caryophyllene (3.08), Eugenyl acetate (1.23)
C. *tamala*	Eugenol (32.05); β- Myrcene (10.75); α- Elemene (6.03); 1,8- Cineole (4.29); p- Cymene (4.14); Spathulenol (4.08); a- Terpineol (3.9)t- Caryophyllene (2.71); Terpinen-4-ol (1.09)
C. *camphora*	Camphor (59.92), α- Terpineol (3.23), α- Pinene (2.94), β- Myrcene (2.74), t- Caryophyllene (2.74), Camphene (1.58), β- Pinene (1.45)
C. citriodorum	Citronellol (42.41), Citronellal (11.0), Geraniol (6.94), Camphor (2.87)
C. malabatrum	Linalool (33.44), t- Caryophyllene (3.78), Isoeugenol (3.02), Nerolidol (2.82)



Chemical structure of principal constituents of Cinnamomum *species*



VANILLA

Genetic resources (p 60)

Diseases (p 60)

Vanilla

1. GENETIC RESOURCES

Vanilla germplasm collection consisted of 9 clonal accessions from NBPGR, Thrissur and two from farmer's plot (Kadampuzha). Cytological analysis of *V. planifolia* revealed that the frequent chromosome number is 2n=28.

Accession of wild vanilla species from A&N Islands produced flowers of different colours in different branches of the same plant. Acc.4704A & 4706 produced purplish pink and light pink flowers while Acc.4709 produced purplish pink and pure white flowers in different branches. Acc.4705, 4707, 4708 and 4710 continued to produce purplish pink flowers and 4704 B produced pure white flowers as in previous years. Forty-four cultivar collections were planted for field evaluation.

2. DISEASES

Etiology of root and stem rot disease: *Fusarium oxysporum* f sp. *vanillae* was found associated with root and stem rot of vanilla. Among the six pathogenic isolates collected, two (F4 and F13) were found to be highly pathogenic. Symptom appeared on the 5th day and the inoculated stem and roots were completely rotten on the 8th day.

The survey for fungal diseases of vanilla in Wynad region was conducted in sixteen plantations. Root rot and wilting was found to be the major production constraints in the plantations. Two of the plantations were totally destroyed due to stem rot and yellowing where as in other plantations the infection ranged from 5-100%.

Host Resistance

V. planifolia, V. andamanica 1 (5), *V. andamanica* 2 (6), *V. andamanica* 3, *V. andamanica* 3 (7), *V. andamanica* 4, *V. andamanica* 4 (8), *V. aphylla,* V-4 *and V 24,* were screened against *Phytophthora meadii* and *Fusarium oxysporum f sp. vanillae.* All the plants were found susceptible to *Phytophthora* infection whereas only V4, V24, *V. andamanica* (4) and *V.andamanica* 4 (8) were found susceptible to *Fusarium* infection.

Disease management

Experiments were conducted in the greenhouse to study the effect of fungicides and organic products for the management of tip rot, basal rot/root rot and inter node rot infestations in vanilla. The trials indicated that all the treatments, except carbendazim 0.1% were significantly superior over control in reducing the incidence of the diseases.

Evaluation of fungicides and natural products for management of vanilla diseases

Treatment	Disease incidence(%)
Carbendazim + Mancozeb 0.2%	5.9
Carbendazim 0.2%	4.6
Carbendazim 0.1%	23.2
Thiophanate methyl 0.2%	10.7
Carbendazim + Mancozeb 0.2% + Neem oil 0.5%	6.4
Mancozeb 0.25%	9.3
Phytomin 0.3%	7.8
Phytoguard 0.5%	5.7
Control	43.0
CD (P=0.05)	20.1

Five biocontrol consortia were evaluated in the greenhouse for management of vanilla diseases. The incidence of disease was the lowest in the treatment involving consortia of IISR-6, 8, 13, 51,151 and 853 that was on par with all treatments of biocontrol consortia except IISR-6, 8, 13, 51, 151 + 859.

Effect of biocontrol consortia on root rot of vanilla caused by *Fusarium oxysporum*

Treatment	Disease incidence(%)
IISR-6, 8, 13, 51, 151 + PB21C	22.2
IISR-6, 8, 13, 51, 151 + P1AR6	22.2
IISR-6, 8, 13, 51, 151 + 853	16.6
IISR-6, 8, 13, 51, 151 + 859	38.9
IISR-6, 8, 13, 51, 151 + PB21C + PB21C + 853 + 859	22.2
Trichoderma harzianum	33.3
Chemical control (COC 0.2%)	38.9
Medium alone	44.4
Absolute control	44.4
CD (P=0.05)	18.5

Viral diseases of vanilla

Stem necrosis disease

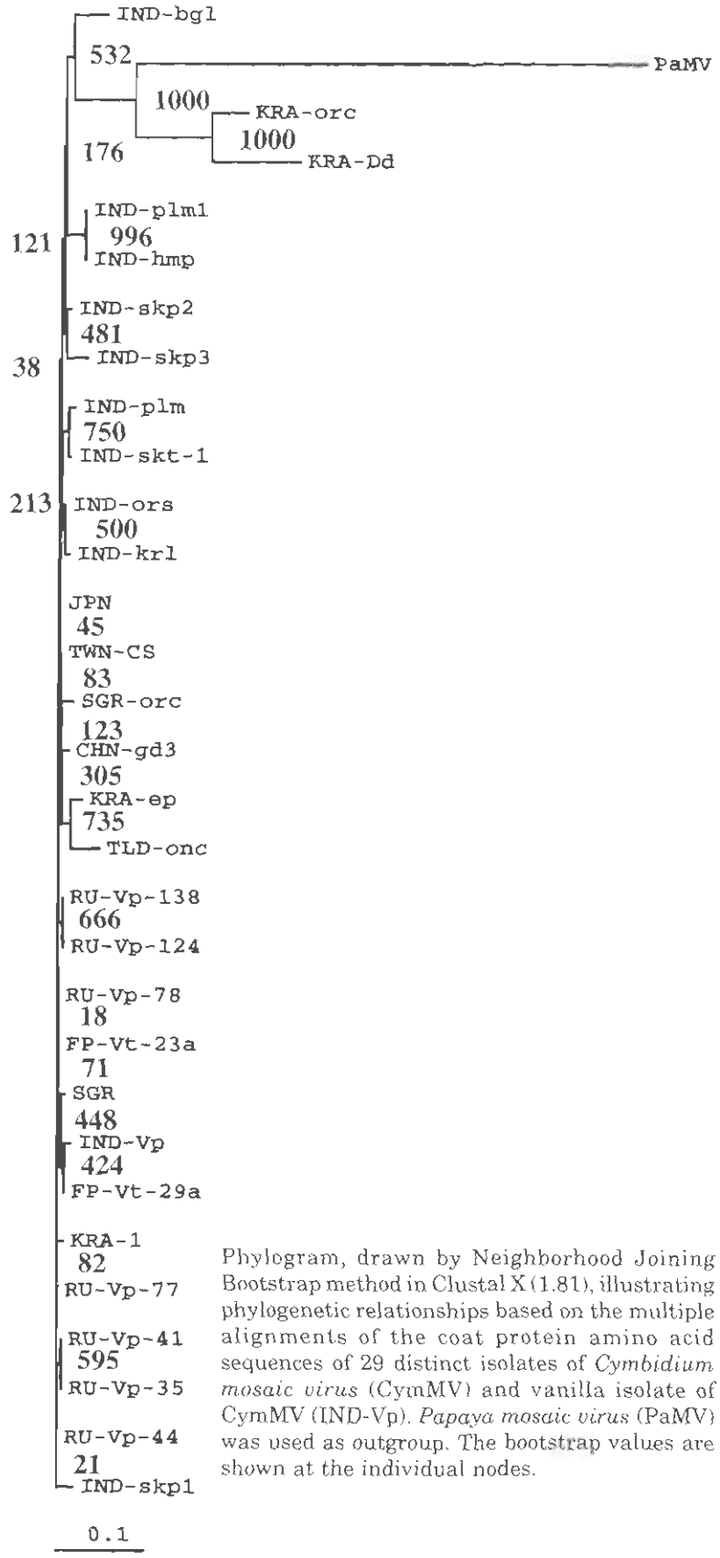
The stem necrosis disease is characterized by the appearance of brown necrotic patches on the stem region with shriveled appearance. The affected stem shows distinct necrotic lesions of varying length (few mm to several cm). The disease initially starts as a necrotic spot on the stem and slowly gets enlarged and encircles the stem. In an affected plant, necrosis may be seen only at one or few regions on the stem. Rest of the stem region looks apparently healthy without any visual symptoms. A few of the necrosis affected plants also show mosaic symptoms on leaves. The causal virus was efficiently sap transmitted to *Chenopodium amaranticolor*. The inoculated leaves produced chlorotic local lesions within 3-5 days of inoculation. The virus was also transmitted to plant members belonging to Cucurbitaceae, Fabaceae and Solanaceae. *N. benthamiana* was found to be a good host for propagation of the virus.

***Occurrence of Cymbidium mosaic* virus**

A virus causing mild chlorotic mottle and streaks on leaves of vanilla was identified as a strain of *Cymbidium mosaic virus* (CymMV) based on coat protein gene sequence comparison and phylogenetic studies. The diseased vanilla plants showing different kinds of symptoms collected from different regions of Karnataka and Kerala were subjected to reverse transcription (RT) PCR using primers designed for coat protein (CP) gene of *Cymbidium mosaic virus* (CymMV). A ~650 bp RT-PCR amplified fragment was consistently seen in only those plants of vanilla showing mild chlorotic mottle or streaks on leaves. The amplicon obtained from one infected vanilla plant was cloned and sequenced. Sequenced region contained a single open reading frame of 672 nucleotides potentially coding for 223 amino acids. Sequence analyses confirmed the identity of the virus as a strain of CymMV. The CP gene

Symptoms of CymMV in vanila

of the virus showed the greatest identity with a CymMV isolate from Singapore (99.1%). An identity of 92.3 to 97.3% was seen with different CymMV isolates from India while with available partial CP sequences of CymMV isolates infecting vanilla, identity ranged from 98.2 to 99.4%. Phylogenetic analyses confirmed the results of sequence alignment and showed no clear cut clustering of isolates either based on host they infect or geographical origin.



Phylogram, drawn by Neighborhood Joining Bootstrap method in Clustal X (1.81), illustrating phylogenetic relationships based on the multiple alignments of the coat protein amino acid sequences of 29 distinct isolates of *Cymbidium mosaic virus* (CymMV) and vanilla isolate of CymMV (IND-Vp). *Papaya mosaic virus* (PaMV) was used as outgroup. The bootstrap values are shown at the individual nodes.

PAPRIKA

Genetic resources (p 64)

Quality analysis (p 64)

Paprika

1. GENETIC RESOURCES

Fifty-seven indigenous and 11 exotic paprika accessions were added to the germplasm repository from IIVR, Varanasi (U.P.), UAS, Dharwad (Karnataka) and Agricultural Research Station, Guntur (A.P.). The newly collected germplasm was purified in insect-proof greenhouse. Five promising lines were distributed to three AICRPS centres for evaluation.

2. QUALITY ANALYSIS

Besides the routine analysis of the germplasm samples, chilli samples supplied by Lam, Guntur (A.P), UAS, Dharwad (Karnataka) and IIVR, Varanasi were evaluated for colour value (ASTA units), oleoresin and capsaicin content.

The colour value of selected lines ranged from 110 to 354 ASTA units, the highest being with ICBD-19 (354 ASTA units) followed by ICBD-11 (348 ASTA units), ICBD-3 (286 ASTA units) and ICBD-21 (282 ASTA units) and the lowest with ICBD-24 (110 ASTA units).

Guntur samples showed very low colour value (<100 units) and very low capsaicin content. Among the 14 Dharwad samples, KTPL-19 possessed colour value of 241 ASTA units with undetectable capsaicin. Other samples also showed low capsaicin as well as low colour value. Among the 31 hybrid samples from Varanasi, MS-2 x B-2 possessed highest colour value of 308 ASTA units. Samples A1 perennial, A1 x Taiwan2 and A1 x Kalyanpur Chanchal showed oleoresin content above 18%. Many other hybrid samples had colour value above 200ASTA units. Only A1 x SP-4C had less capsaicin content. Acc 0107-7011 showed 308 ASTA units with 15.9% oleoresin and 1.02% capsaicin. Acc.IC119321, Taiwan-2, EC-268216, IIHR-21, Co-5692, B-2 and BC-4 showed above 18% oleoresin. Low capsaicin samples are B-2, EC-497635, C0-5692, Pant-C1 and PBC-535.

Soil quality under spice based cropping systems

Soil quality under black pepper based cropping systems

Soils were collected from various spice based sites *viz.*, chemical, INM and organic farming sites under black pepper, chemical, INM and organic farming sites under ginger, and turmeric, cardamom based sites *viz.*, cardamom + nutmeg, cardamom + all spice, cardamom + cinnamon, cardamom + coffee, cardamom + arecanut, cardamom alone etc and soils under different standards (tree supports) of black pepper. The soils were then analysed for various physico-chemical and biochemical parameters.

Samples were also taken from sites under contrasting management in black pepper *viz.*, organic, chemical and INM sites. Soil pH was slightly acidic (5.27-5.46), organic C levels were relatively higher in the organic and IPNM sites (2.27 and 2.05% respectively). Similar observations were made with respect to available N and P levels. Contrarily, available K levels were lowest in the organic sites (146 mg kg^{-1}) compared to chemical (245 mg kg^{-1}) and INM (264 mg kg^{-1}) sites. Among the micronutrients, DTPA Zn, Cu and Fe levels were consistently greater in the organic (6.2, 9.2 and 42 mg kg^{-1} respectively) and INM (3.2, 4.2, 42 mg kg^{-1} respectively) sites compared to the chemically managed sites (1.8, 1.1, 38 mg kg^{-1} respectively). DTPA Mn levels did not vary considerable between sites and ranged from 4.5-6.0 mg kg^{-1}. With regard to enzyme activities all the enzymes showed relatively greater activities in the organic and INM sites compared to chemically managed sites.

Soil sampling was also done from various standards (tree supports) of black pepper. Soil pH varied in a narrow range of 4.40-5.00. Organic carbon levels varied from 3.06% (*Erythrina*) to 2.48 (*Ailanthus*). Available N, Bray P and available K did not differ significantly between the standards. DTPA Zn was relatively higher under garuga and least under *Erythrina*. Similar results were observed with respect to Cu, Fe and Mn. Among the biochemical parameters, the activities of various enzymes did not differ significantly between various standards.

Sites under cardamom based cropping systems

Soil samples were collected from various cardamom based sites viz., Cardamom + Clove, Cardamom + Nutmeg, Cardamom + Coffee, Cardamom + Cinnamon, Cardamom + Allspice, cardamom alone etc. Soil pH varied from 4.8-5.2 and organic C from 1.8-2.6%. Available N ranged from 121-148 mg kg^{-1}, Bray P from 2.1-3.8 mg kg^{-1}, and available K from 212-338 mg kg^{-1}. Among the micronutrients, available Cu ranged from 4.5-13.0 mg kg^{-1}, available Fe from 17.5-48.4 mg kg^{-1}, available Mn from 2.9-8.9 mg kg^{-1}. Available Zn was found to be the most limiting nutrient ranging from 0.75-1.04 mg kg^{-1}. The soils were also analysed for various biochemical parameters involved in nutrient cycling. The variations in acid phosphatase, phosphodiesterase, invertase, cellulase, BAA- protease and dehydrogenase activities were not consistent between the various cardamom-based sites.

Soil quality in ginger based cropping systems

Soil samples were collected from organic, chemical and INM sites under ginger and analyzed for various parameters. Soil pH differed little between the sites and ranged between 5.13-5.35. Organic C was highest in the organic sites

(2.15%) followed by INM (1.94%) and chemically managed (1.33%) sites. Available N (range 154-171 mg kg^{-1}), Bray P (range 2.0-3.2 mg kg^{-1}) and available K (221-270 mg kg^{-1}) did not differ significantly between the sites. DTPA Zn and Cu levels were lower at all the sites, with organic sites registering relatively higher levels (1.7 and 1.4 mg kg^{-1}), followed by chemical (1.4 and 1.1 mg kg^{-1}) and INM (0.94 and 1.4 mg kg^{-1}) sites. DTPA Mn levels were relatively greater under IPNM (6.2 mg kg^{-1}) and organic (6.1) sites compared to chemically managed site (4.0 mg kg^{-1}).

Among the biochemical parameters, phosphodiesterase (3.2 µmol p nitophenol g^{-1} h^{-1}), invertase (6.2 µmol glucose g^{-1} h^{-1}), cellulase (1.1 µmol glucose g^{-1} h^{-1}), BAA- protease (6.4 µmol NH_3 g^{-1} h^{-1}), arylsulphatase (0.46 µmol p-nitrophenol g^{-1} h^{-1}) and dehydrogenase (212 µmol TPF g^{-1} h^{-1}) activities were higher in organic sites, while acid phosphatase (43.2 µmol p-nitrophenol g^{-1} h^{-1}) and urease (7.9 µmol NH_3 g^{-1} h^{-1}) activities were higher in INM sites.

Soil quality in turmeric based cropping systems

Soil samples were collected from organic, chemical and INM sites under turmeric and analyzed for various parameters. Soil pH differed little between the sites and ranged between 5.23-5.62. Organic C was highest in the INM sites (1.71%) followed by organic (1.54%) and chemically managed (1.28%) sites. Available N did not vary significantly between sites and ranged from. Contrarily, Bray P levels were significantly higher in chemical treatment (6.7 mg kg^{-1}), followed by organic (4.9 mg kg^{-1}), while it was lowest in INM site (1.9 mg kg^{-1}). Available K levels were also highest in chemical sites (302 mg kg^{-1}) followed by INM site (270 mg kg^{-1}) and it was lowest under organic sites (219 mg kg^{-1}). DTPA Zn, Cu, Fe and M levels, however, did not vary significantly between sites and ranged between 0.86-1.2 mg kg^{-1}, 1.2-2.5 mg kg^{-1}, 30-31 mg kg^{-1} and 7.0-8.6 mg kg^{-1} respectively.

Among the biochemical parameters, acid phosphatase (42.7 µmol p-nitrophenol g^{-1} h^{-1}), phosphodiesterase (3.4 µmol p-nitrophenol g^{-1} h^{-1}), invertase (9.9 µmol glucose g^{-1} h^{-1}), cellulase (0.9 µmol glucose g^{-1} h^{-1}), BAA- protease (5.9 µmol NH_3 g^{-1} h^{-1}) and dehydrogenase (222 µmol TPF g^{-1} h^{-1}) activities were higher in organic sites, while urease (8.6 µmol NH_3 g^{-1} h^{-1}) and arylsulphatase (0.49 µmol p-nitrophenol g^{-1} h^{-1}) activities were higher in INM and chemically managed sites respectively.

All India Coordinated Research Project on Spices

1. GENETIC RESOURCES

Genetic resources at the AICRPS centers consist of 612 accessions of black pepper, 273 of cardamom, 603 in ginger, 1332 in turmeric, 202 in tree spices and 3961 in seed spices. In total eighty-six lines for yield and 36 lines for quality attributes were identified through CVT/CYT/IET/germplasm evaluation.

2. BLACK PEPPER

Foot rot in black pepper: Planting of black pepper cuttings in solarized soil fortified with *Trichoderma harzianum* @ 1g kg^{-1} soil and VAM inoculum @ 100 cc/kg soil was found ideal for production of healthy rooted cuttings at Chintapalle and Pampadumpara centers. Application of Metalaxyl Gold MZ (2.5 g l^{-1}) and *T. harzianum* was effective for controlling foot rot disease in the field at Panniyur centre. However at Mudigere centre, spraying and drenching with Bordeaux mixture (1%) during May/June and July-August was most effective. At high altitude areas, maximum reduction of anthracnose disease in black pepper could be achieved by spraying carbendazim + Mancozeb 0.1% as foliar spray or carbendazim 0.1% or Bordeaux mixture 1% thrice (Pampadumpara Centre) and at Mudigere Centre, the same results could be achieved by three sprays of 1% Bordeaux mixture during the last week of May, July and August.

Supplementing biofertilizers *Azospirillum* (50g) and phosphobacteria (50g) separately in combination with recommended inorganic fertilizer enhanced the yield of black pepper, cardamom, ginger and turmeric. Addition of traditional nutrient sources like burnt earth (10kg) and wood ash (2.0kg) along with Farm Yard Manure (10kg) was promising in increasing black pepper yield (6.4kg^{-1} vine).

3. CARDAMOM

Root grub management: In Cardamom, root grub can be checked effectively by drenching with Imidacloprid (0.75 ml l^{-1}) or chlorpyrifos (0.07%) and maximum yield (412 g $plant^{-1}$) and highest B:C ratio (1:1.65) could be realized.

4. GINGER AND TURMERIC

Rhizome rot management in ginger and turmeric: Rhizome rot of ginger was controlled by treating the seed rhizomes with hot water at 51°C for 10 minutes and *T. harzianum* mixed with neem cake for 30 minutes. However, in turmeric, maximum reduction of rhizome rot was obtained by seed and soil application of *T. viride* and *Pseudomonas fluorescens* @ 12.5 kg and 25.0 kg ha^{-1}, as basal and top dressing, respectively along with recommended application of NPK and FYM.

Recommended dose of fertilizers registered maximum yield of 17.87 t ha^{-1} in ginger and 26.02t ha^{-1} in turmeric at Raigarh and 18.65 t ha^{-1} in ginger and 18.29 t ha^{-1} in turmeric at Pottangi and 25.03t ha^{-1} in turmeric at Pundibari centre, while application of FYM 10kg+ Pongamia oil cake+Neem oil cake+Sterameal + Rock phosphate + wood ash, 250g recorded higher yield of 23.67 t ha^{-1} in ginger at Dholi centre. Application of zinc sulphate @ 25.0 kg ha^{-1} produced maximum ginger yield (20.27 t ha^{-1}) at Dholi centre.

5. SEED SPICES

Wilt management in Coriander: In coriander, minimum wilt incidence with maximum yield (818

kg ha^{-1}) was recorded with the *T. harzianum* applied as seed treatment as well as soil application. In cumin, Mancozeb spray @ 0.25% at 40, 50, 60 and 70 days after sowing resulted in maximum yield with less of wilt diseases.

Nutrient Requirement in seed spices: In coriander, micronutrient spray *viz.*, $ZnSO_4$ + $FeSO_4$ + $CuSO_4$ + $MnSO_4$ (each at 0.5%) recorded the higher yield (940 kg ha^{-1}). Application of 100% inorganic N + *Azospirillum* @ 1.5 kg ha^{-1} + 5 t FYM/ ha resulted in maximum seed yield in coriander (3.45 t ha^{-1}), cumin (323 kg ha^{-1}) and fennel (1.16 t ha^{-1}), whereas 100% inorganic N alone gave the highest yield (1.256 t ha^{-1}) in fenugreek at Jobner Centre. However, maximum yield was obtained in coriander, fennel and fenugreek with the application of 10t ha^{-1} of FYM + 1.5 kg ha^{-1} of *Azospirillum* as seed treatment at Kumarganj (U.P.) conditions. At Coimbatore (T.N.) conditions, application of FYM 5t ha^{-1} + *Azospirillum* 1.5 kg ha^{-1} as seed treatment along with inorganic N 50% and 100%, produced the highest yield in coriander (738 kg ha^{-1}) and fenugreek (685 kg ha^{-1}), respectively. In coriander, spray of bioregulator, Triacontanol @ 0.5%, thrice at 40, 60 and 80 days after sowing significantly increased the yield (1.46 t ha^{-1}) at Dholi conditions, while highest yield (1.50 t ha^{-1}) was achieved with spraying of Triacontanol @ 1.0%, thrice at 40, 60 and 80 days after sowing at Kumarganj conditions. However, maximum yield of 1.01 t ha^{-1} was obtained with spraying of NAA 10 ppm, twice at 40 and 60 days after sowing at Guntur conditions.

For more information Logon to www.aicrps.res.in

Krishi Vigyan Kendra

Training programmes: The Kendra has conducted 129 training programmes on various subjects during the period under report. A total of 3779 persons have benefited out of the programmes. The details of the training programmes are furnished below. Besides, KVK conducted activities in association with NGO's *viz.*, Centre for Overall Development (COD), The Vikas Volunteer Vahini club (VVV), INFAM etc. collaboration with the Government Community Polytechnic College, West Hill, Calicut. A total of 62 unemployed rural youth have benefited out of the trainings. After completing the above programme they have associated with Chakkittapara Service Co-operative Bank and have started a spawn production unit with the financial assistance from the bank.

Training programmes conducted during the year 2005-'06

Category	No. of courses	No. of participants			No. of SC/ST participants
		Male	Female	Total	
Practising farmers	108	2228	1093	3321	305
Rural youth	14	143	120	263	42
Extension functionaries	7	128	67	195	10
Total	**129**	**2499**	**1280**	**3779**	**357**

Discipline-wise training programmes conducted

Category	No. of courses	No. of participants			No. of SC/ST participants
		Male	Female	Total	
Crop Production	75	1428	564	1992	158
Horticulture	13	103	128	231	7
Animal Science	37	938	523	1461	163
Home Science	1	-	21	21	9
Agrl.-engineering	2	23	14	37	17
Others	1	7	30	37	3
Total	**129**	**2499**	**1280**	**3779**	**357**

Long duration vocational training programmes: The Kendra conducted three long duration vocational training programmes for rural youth on 'Repair and maintenance of farm implements', Spawn production' and 'Tailoring'. The programmes were of two to three months duration. The programmes were organised in

Revolving Fund Programme: Under this programme, planting materials of various crops were produced and made available to public at affordable price. Various seedlings of plants such as anthurium, mangosteen, Indian gooseberry, clove, allspice, teak, neem, coconut; pathimukam, arecanut and grafts such as bush

pepper, jack, jasmine, rambootan, mangosteen, sapota, cashew, garcinia, mango, guava layer and Rooted cuttings of vanilla, rose apple, cinnamon were distributed. The centre has also supplied medicinal plants such as *Stevia, Costus sp, Jatropha* sp. and biofertilizer, *Azolla*. During the period an amount of Rs.4.82 lakhs was realised through sale of planting materials, mushroom spawn, *Trichoderma*, chicks and the activities of Plant & Animal Health Centre.

Kisan Mela and exhibitions: KVK regularly participated in exhibitions and seminars within and outside the district in association with the host institute. During the period under report, KVK participated in the following exhibitions/ Kisan Melas.

1. At Vazhayoor, SAFI Campus, Malappuram organised by SAFI from 26.8.05 to 27.8.05.
2. At Devagiri College campus, Calicut in connection with Platinum Jubilee celebration of Devagiri College from 7.11.05 to 11.11.05.
3. At Calicut in connection with Calicut Flower Show 2006 from 6.1.06 to 11.1.06.
4. At Calicut in connection with Fruits & Flower show 2006 from 7.2.06 to 12.2.06.

IISR Stall at Calicut flower show 2006

Place of visit	Date (s)	No. of participants
Rubber Board, Kottayam	12.05.05 & 13.05.05	30
Govt. Goat Farm, Kommeri, Kannur	02.07.05	19
Govt. Goat Farm, Kommeri, Kannur	07.12.05	29
KAU, Thrissur	15.12.05, 20.02.06	25
KAU, Thrissur		42

Farmers' study tour: Five study tours were arranged for the farmers during the period. The details are given below:

Seminars organised: The Kendra conducted 5 district level seminars on Intellectual Property Rights, Seed Act and Organic farming. A total of 343 participants were benefited

Demonstration units: *Demonstrations on* homestead gardening, poultry and quail unit, cultivation of medicinal plants, guava, sapota, vanilla and Production of improved varieties in black pepper, arecanut seed garden, cashew, mango, nutmeg scion bank and mushroom spawn production, were conducted.

FLD Programme

Introduction of HYV of fodder grass *viz.* Hybrid Napier Co-3 as a component in homesteads: The programme was implemented in 15 farmers' field during June 2005 in Chakkittapara and Changaroath Panchayat. There was an average yield of 185 t ha^{-1} of green fodder for Co-3 in the homestead compared to 102 t ha^{-1} for guinea grass. The demonstration proved that raising 10 cents of Co-3, as an irrigated intercrop is enough to feed a cow. Feeding with 25-30 kg of green high quality fodder grass can save a minimum of ½ kilogram of concentrate feed/day with an average increase of 0.3% SNF and 1.2 litre of milk day^{-1}.

High density planting of tissue culture Banana var. *Nendran*: Average yield obtained per plant was 10.0 kg in demonstration. The total income from was Rs.19, 824 (B: C ratio-2.67) while it was Rs.16, 476 (B: C ratio-2.64) for local check. The demonstration proved that high density planting of Nendran gives better income from unit area compared to conventional planting.

Introduction of a short duration variety of Oyster mushroom viz. *Ananthan*: Short duration variety, *Ananthan* yielded in 33 days when compared to *P. sajor-caju* which required 40 days. The short duration has reduced the cost of production. *Ananthan* had a better B: C ratio (3.55) compared to *P. sajor caju* (3.19). Besides, the sporocarp of Ananthan was found to be larger, tougher fleshed and pure white in colour compared to *P. sajor-caju* resulting in better acceptability.

Demonstration of Broad Breasted large white turkey for meat purpose in backyard system: In this demonstration it was revealed that, the average body weight in the case of male was 9.25 kg, whereas in the case of female it was 5.4 kg at 9 months of age. The average egg production was 39 eggs at 9 months of age and attained the ASM at 29 weeks.

Rearing improved variety of Japanese quail with space, feed and light management: In case of MLQ3 variety, the egg production recorded was 131 eggs/bird in 192 days and attained ASM in 53 days. The B: C ratio recorded was 2.1, whereas in local check the B: C ratio was 1.9.

Introduction of Malabari x Jamunapari crossbred goat with optimal feeding and deworming practices: In case of Malabari x Jamunapari cross bred goat the body weight recorded was 19.4 kg at 8 months of age whereas in case of local check it was 13.4 kg.

Successful OFT Programmes

Integrated management of stem bleeding in coconut: The programme was implemented in 5 plots in Changaroath Panchayat in 2005. In addition to the chemical treatments with Tridemorph, Bordeaux paste, coal tar etc.

Trichoderma also was applied @100g palm ' with 5 kg neem cake along with liming. Fifty palms were treated and no fresh bleeding patches were noticed. However, the effect of treatments will be confirmed in the next summer.

Management of feeding problems in pig rearing: In this trial it was revealed that the body weight of pigs by KVK intervention was 145 kg at 9 months of age and the profit was Rs.4015/pig where as the profit was Rs.3010/- and Rs.1585/- per pig respectively in farmer's and recommended practice.

Management of Dairy animals during summer by supplementing *Azolla*: The milk production was sustained during summer while feeding *Azolla*. Lactometer reading of 31 and fat percentage of 4.5 were recorded by feeding *Azolla*.

Mass production of Azolla

For details Logon to www.iisr.org/kvk

Agricultural Technology Information Centre

The major activities carried out by the center are

- Production and distribution of quality planting material
- Production and distribution of printed literature
- Farm advisory services including crop diagnostic services
- Information dissemination through multimedia, video and interactive databases
- Providing audio visual aid support to the institute activities
- Organising technology dissemination services like exhibitions, seminars to farmers and other users

i. Technology inputs and Advisory services

The technology inputs distributed from the centre include good quality-planting material of improved varieties of spices, bio control agents, vermicompost, fresh whole spices and scientific publications including extension literature. During the year 2005-06 planting material worth Rs 49,751 was distributed from the centre. The proceeds from sale of publications amounts to Rs 32, 274. Six hundred and seventy one farmers who visited the centre were benefited from advisory services. This includes 329 farmers from within Calicut district, 217 farmers from outside Calicut district, but within Kerala state and 125 farmers from outside the state. Six hundred and ninety eight students from various educational institutions visited the centre. An amount of Rs 5259 was realized through soil and manure sample analysis. *Trichoderma* formulation for Rs 18,745 and *Pseudomonas* formulations worth Rs 25,938 were distributed to farmers.

From the secondary data recorded on the visit of farmers to the institute the pattern of advisory services delivered by the institute was detailed using frequency scores.

ii. Pattern of advisory services

Purpose of visit	Frequency score
Planting material	132
Scientific information	485
Bio inputs	47
Diagnostic services	13
Publications	34

iii. Extension Services

Out Reach: Seed rhizomes of ginger varieties Varada, Rejatha and Mahima and turmeric varieties Prabha and Prathibha were supplied to a group of framers in Wai Taluk of Satara district, Maharashtra and demonstration plots established. The varieties performed better compared to local ones and the varieties became popular in the region.

Participated in two national fairs, Pride of India Expo organized in connection with the 93d Indian Science Congress at Hyderabad during 3-7 January 2006 and North east Agri expo 2006 held at Dimapur under the Central Sector Scheme for Technology Mission on integrated development of horticulture in NE states during 27-31 March 2006.

iv. Local programmes

1. The centre participated in following seminars/ exhibitions
2. Trade fair organized by CODDISSIA at Coimbatore during 11-16th August 2005

Performance of improved varieties of turmeric in Satara district, Maharashtra

3. Farmers meet at Vazhayoor, Malappuram organized by SAFI, Malappuram during 26-27 August 2005.
4. St Josephs college golden jubilee trade fair, Calicut during 7-11 November 2005
5. Calicut flower show organized during 6-11 January 2006.
6. Calicut fruit and flower show organized during 7-12 February 2006

v. Training for Development

The partnership services offered by the institute include Training, Consultancy and Contract research. The Institute offers training programme on demand from various agencies targeted for field extension functionaries of line departments and research workers of other ICAR Institutes and State agricultural Universities (SAU). The modules for these training programmes are prepared based on technologies developed by the institute and research achievements. The topics covered included spices production technology, nursery, pest and disease management in major spices, post harvest technology and computer and statistical applications in research and development. The details of training programme organized during the year 2005-06 are furnished below.

- Training programme on Good Agricultural Practices for rural youth sponsored by ICRI, Myladumpara was organized during 4th-6th April 2005.
- Orientation training programme for newly appointed Apprentice staff on 3 October 2005
- Training on computer applications for

Apprentice staff during 10-14th October 2005

- Training course on Spices production technology for the officers of NE states sponsored by the Spices Board during 28-30th November 2005
- Training programme on Good Agricultural Practices for rural youth sponsored by ICRI, Myladumpara was organized during 31January to 2 February2006

All the training programmes organized at the institute was evaluated to assess the effectiveness of the training using the following evaluation schedule

- Pre-training knowledge test
- Post-training knowledge test
- Gain in knowledge due to training- Paired t- test
- Training effectiveness index- 4-point *continuum scale: Organizational* effectiveness of training.
- Feed back by trainees

Technology Mission for Integrated Development of Horticulture for North eastern states including Sikkim

Releases were made by the Department of Agriculture and Cooperation, Government of India to the Indian Institute of Spices Research under the Central Sector Scheme for Technology Mission for Integrated Development of Horticulture for NE sates including Sikkim. The identified component was training on Spices production management for the NE states and release made was to the tune of Rs 9.0 lakhs for the financial year ending March 2006. Accordingly, a training programme on Organic cultivation and Value addition in major spices was organized at Diamapur, Nagaland in which 69 farmers/ extension functionaries participated.

Shri. Nyeiwang Konyak, Honourable Parliamentary Secretary, inaugurating Workshop on Spices at Dimapur, Nagaland

Education and Training

POSTGRADUATE STUDIES

Ph.D

Neema Antony, Investigations on the biosynthesis of curcumin in turmeric (*Curcuma longa*), University of Calicut

Vimala Jose, Studies on genetic variability in open pollinated progenies of vanilla, University of Calicut

Praveen, K., Variability in somaclones of turmeric (*Curcuma longa* L.), University of Calicut

Rubina M.R., The effect of organic fertilizers on soil quality, nutrient availability and quality of black pepper, University of Calicut

M.Sc projects

Twelve students from various universities undertook their M.Sc project work in Biotechnology, Biochemistry, Microbiology and Plant Pathology under the guidance of the scientists of the institute.

Post M.Sc Training

Four post M.Sc candidates under went hands-on training in various techniques of Microbiology and Biotechnology.

Training / workshops organized by the Institute

Summer training programme on *'Techniques in Biochemistry and Biotechnology'* for M.Sc students, May 05 to June 04, 2005. Thirty eight students from various universities attended the training

Bioinformatics and Biotechnology-Tools and Applications, September 19-October 08, 2005, There were nine participants.

Training on web site development was also conducted for institutes under Horticulture Division of ICAR. Representatives of three institutes have participated.

Production Management in ginger, turmeric, tree spices under Technology mission NE states –Off campus. Seven extension officers attended, March 2005.

Good Agricultural Practices sponsored by Spices Board Institute Course: 16 rural youth attended in April 2005 and 21 youth in February 2006.

Organic cultivation and post harvest technology in major spices- Technology mission NE states- off campus, 67 extension officers attended, October 2005.

Spices Production Technique. Institute course, eight officers of NE states attended, November 2005.

Workshop on Biodiversity and Bio-resources Conservation Awareness held on 21st January 06, organized jointly by National Biodiversity Authority, Chennai and IISR, Calicut.

TRAINING /WORKSHOPS ATTENDED BY STAFF

Name	Training/Workshop	Institute	Duration
A Kumar, V Srinivasan, T E Sheeja, KN Shiva, A I Bhat	Capacity building programme for Indian agricultural research, extension, development organizations in globalised economy	NAARM, Hyderabad	29-30 April, 2005
B Krishnamoorthy	Awareness programme on IPR	IARI, New Delhi	May 11-12, 2005
K N Babu A I Bhat	Safety assessment of genetically modified foods	MSSRF, Chennai	May 27-28, 2005
P Rajeev	Information Technology in Agriculture	NAARM, Hyderabad	June 1-21, 2005
E Jayashree	Unit and bulk packaging systems for food, pharmaceuticals, cosmetics and consumer goods	Indian Institute of Packaging, Bangalore	June 9-10, 2005
S Devasahayam	Laboratory Accreditation under ISO 17025:1999 Standard	CDC, New Delhi	June 29-30, 2005
N K Leela	Innovative HPLC and analytical solutions	Waters (India) Pvt Ltd, Trivandrum	July 29, 2005
T K Jacob A Kumar	Biotechnology and Bioinformatics: Applications to Agricultural Research	IISR, Calicut	September 17 to October 08, 2005
R Dinesh, K Kandiannan P Rajeev	Workshop on Organic farming and Post Harvest Technology	Dimapur, Nagaland	18-21 October 2005.
N K Leela	Trends in the versatile technique of HPLC	Amritha Institute of Medical Sciences and Research Centre, Kochi	November 4-5, 2005
D Prasath	Trade oriented exploitation of horticulture in humid tropics- opportunities and challenges	KAU, Vellanikara	December 01-21, 2005
A Kumar	IPR and WTO	ASCI, Hyderabad	Dec 5 -10, 2005
E Jayashree	Process Engineering and product Innovation	Association of Food Scientists and Technologists (India), Bangalore	December 09-10, 2005

TK Vinod I Jijil	Workshop on XML Databases	Kerala Education Grid, IIITMK, Techno park, Trivandrum	December 10-11, 2005
S J Eapen	E -publishing	IIM, Kozhikode	December 12-14, 2005
A I Bhat	Indo-US workshop on Molecular Plant Virology	DBT, New Delhi.	February 11-12 2006
S Balaji S Praseetha	National seminar cum Workshop on Bioinformatics	Indian Institute of Science, Bangalore	1-2 March 2006
K M Prakash	Soil, Water and plant analysis	IISR, Calicut	20.3.06 to 23.3.06
S Hamza	Effective Technical Assistance in Management of Agricultural Research	NAARM, Hyderabad	24-30 March 2006

CONSULTANCY PROCESSING CELL

During the year, the consultancy processing cell took up various activities of which sample analysis (which includes analysis of chemical and organic fertilizers, plant and soil samples for nutrients, analysis of commercial samples for *Trichoderma*, *Pseudomonas*, *Azospirillum*, Phosphobacteria, analysis of samples for biochemical constituents etc.) is the major one. Other activities included sale of technology for large scale multiplication of *Trichoderma* and *Pseudomonas*, sale of cultures, contract research, field visits based on planter's requests and organizing training programmes.

During 2005-06, the total receipts through consultancy is Rs. 13.79 lakhs. The major share (approximately 60 %) is from analysis of samples for nutrients, biocontrol agents, biochemical constituents etc. and consultancy services. The share through contract research is 23%, sale of technology 11 % and training programme 6 %. The technology for large scale multiplication of *Pseudomonas* was commercialized during the year and the same was sold to 3-4 entrepreneurs. Two training programmes, one, Summer training course on Bioinformatics and Biotechnology for M.Sc. Students and the other on Efficient use of soil and plant analysis lab for KVK personnel were organized through consultancy processing cell.

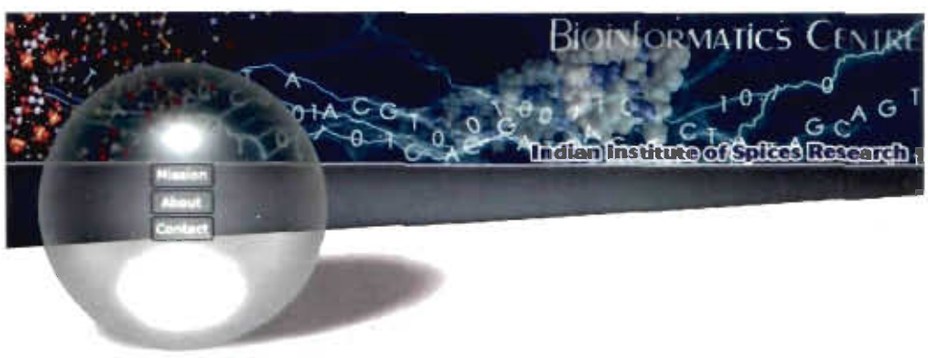
Bioinformatics Centre

Databases & Softwares: Following software were developed.

- 'RAPiD' that helps in identifying unique bands from PAGE data was developed.
- The software 'Instinfo' was developed using Visual Basic 6.0 for collation of information from all institutes under the Horticulture Division of ICAR.
- The databases developed during the year include a new database on *Phytophthora* cultures conserved in the National Repository of *Phytophthora* at the institute and 'SpicePat', searchable database on patents related to spices.
- Some druggable leads from turmeric, other than the popular curcumin were identified using chemoinformatics tools. Species-specific primers were designed for identifying plant growth promoting rhizobacteria (PGPR), *Bacillus* and *Pseudomonas* spp., and plant parasitic nematodes (*Radopholus* and *Pratylenchus* spp.) based on rDNA sequence analysis.

Other services

- A 21 days training programme entitled 'Biotechnology & Bioinformatics – applications in Agricultural Research' has been organized during 19 October to 8 November 2005.
- To improve the internet connectivity a new leased line connection of 1 Mbps speed was finalized. New hardwares like one HCL server and four Pentium IV computers were also added.
- Computational and Information support to various R&D projects of the institute.
- Maintenance and updating of the institute website www.iisr.org. It is rated as one of the best sites under ICAR.
- Designing and developing customized databases and software.
- Sustaining the intranet 'SPICENET' and the email facility 'Spicemail', E journals etc.
- Providing round the clock access to Internet, Bioinformatics tools through the facility called E-Lab.
- *Designing, development and hosting of websites*
- E-publishing – online journals, institute repositories etc.



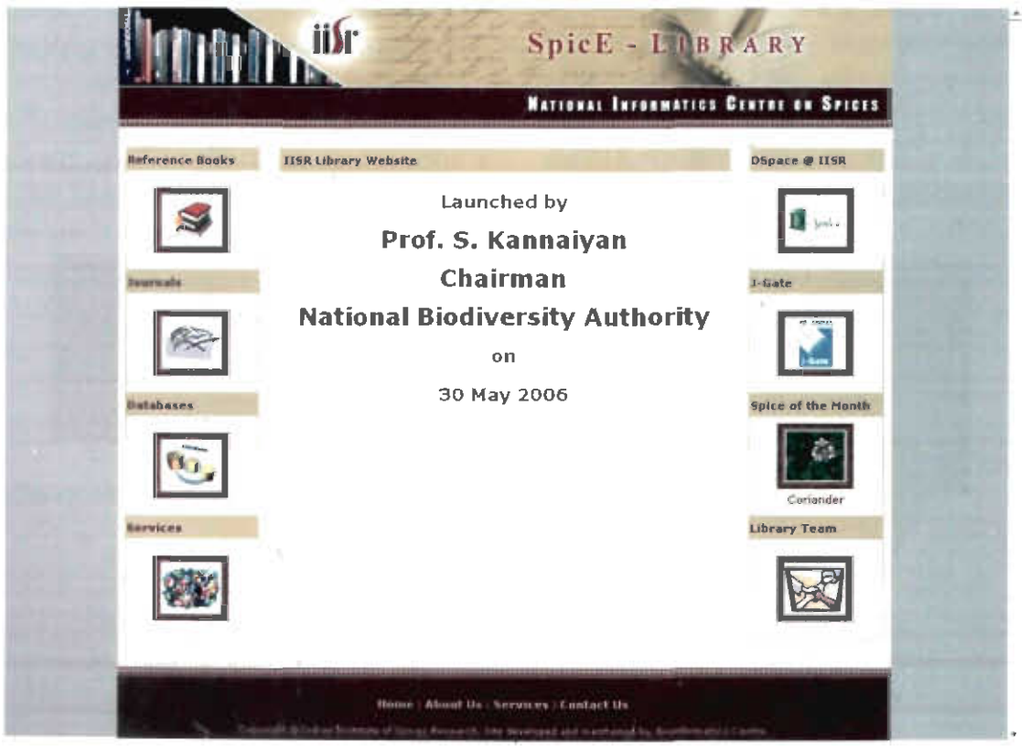
Bridging the gap between the wet-lab and in-silico analysis

Logon to www.iisr.org/bioinfo for more information

Library

The library of the institute was set up to provide support to research activities of the institute and to function as a national information storage, retrieval and dissemination system for spices and related areas. At present, it has a collection of 4076 books, 2651 bound volumes, 2292 reprints, 825 technical reports 121 theses and 127 project reports. The library is subscribing to 35 foreign journals including three online journals and 84 Indian Journals in addition to 2 CAB CD databases. During the reporting period the library started subscribing J Gate (Agricultural and Biological sciences), which is the best e-journal portal of India. The additions during the year include 105 books, 17 reprints, 27 technical reports, 8 theses and 51 project reports.

The library continued to provide bibliographic services (published in the Journal of Spices and Aromatic Crops) and database services apart from publishing "Agri-Science Tit Bits" at quarterly intervals. Sharing of resources between the libraries of Central Plantation Crops Research Institute, Kasaragod, National Research Centre for Cashew, Puttur and IISR, Calicut, was continued. Access to online journals and content page service was provided through Institute website to respective users. During 2005-06, 1799 internal users and 1134 external users utilized the library facilities. Internet facility is provided in the library for literature search, web search, checking E- mails etc. Reference Manager software is used in the library for management of references. Hands-on training is given on information retrieval and documentation to the participants of various training programmes organized by the institute.



For more information Logon to www.spices.org/library

Agricultural Research Information System (ARIS)

As a regular endeavor of ARIS in developing computer awareness, ARIS continued training programme this year also, Besides, Local Area Network was restructured augmenting accessibility of end users providing additional nodes and also bringing all desks in the administration and accounts section within the network.

ARIS took a leading role in developing a software for office automation. Office automation software is a fully integrated system which automates multifarious functions of IISR that helps in the management of day to day operations and decision making process. System will take care of Document flow, Personnel and Administration Financial Accounting, Stores, Purchase and distribution, Contracting, Tour management, File Tracking system, Intranet Messaging etc.

ARIS maintains and updates on a regular basis information on all the staffs of the Institute by accessing and editing PERMISNET. It serves as a service centre for various purposes like internet browsing, statistical analysis of data, documenting and multimedia programmes developed on various activities of the Institute. e-formats were developed in relation to periodical reports to be transmitted to Council. It also provides presentation facility to scientists at SRC, RAC, Seminars etc.

Office automation: An initiative towards paperless office

Publications

1. Bhadramurthy, V., Retheesh, S.T., Bhat, A.I., Madhubala, R., Hareesh, P.S. and Pant, R.P. 2005. Development of ELISA based technique for the detection of a putative badnavirus infecting black pepper (*Piper nigrum* L.). *Indian Phytopathology*. 58: 314-318.
2. Bhat, A.I., Madhubala, R., Hareesh, P.S. and Anandaraj, M. 2006. Detection and characterization of the phytoplasma associated with a phyllody disease of black pepper (*Piper nigrum* L.) in India. *Scientia Horticulturae* 107: 200-204.
3. Bhat, A.I., Bhadramurthy, V., Siju, S. and Hareesh, P.S. 2006. Detection and identification of *Cymbidium mosaic virus*-infecting vanilla (*Vanilla planifolia* Andrews) in India based on coat protein gene sequence relationships. *Journal of Plant Biochemistry & Biotechnology*, 15: 33-37.
4. Bhat, A.I., Devasahayam, S., Hareesh, P.S., Preethi, N. and Thomas, T. 2005. *Planococcus citri* (Risso)-an additional mealybug vector of *Badnavirus* infecting black pepper (*Piper nigrum* L.) in India. *Entomon* 30: 85-90.
5. Bhat, A.I., Devasahayam, S., Venugopal, M.N. and Suseela Bhai, R. 2005. Distribution and incidence of viral diseases of black pepper in Karnataka and Kerala, India. *Journal of Plantation Crops* 33: 59-64.
6. Diby P., Sarma, YR., Srinivasan V. and Anandaraj M. 2005. *Pseudomonas fluorescence* mediated vigour in black pepper (*Piper nigrum* L) under green house condition. *Annals of Microbiology* 55:171-174.
7. Diby P., Anandaraj, M., Kumar, A. and Sarma, Y. R. 2005. Antagonistic mechanisms of fluorescent pseudomonads against *Phytophthora capsici* Leonian in black pepper (*Piper nigrum* Linn.) *Journal of Spices and Aromatic Crops* 14: 94-101
8. Diby P., Jisha P. J., Sarma Y. R. and Anandaraj M. 2005. Rhizospheric *Pseudomonas fluorescens* as rejuvenating and root proliferating agents in Black Pepper. *Journal of Biological Control*. 14: 122-129.
9. Diby P., Saju, K. A., Jisha, P. J., Sarma, Y. R., Kumar A., and Anandaraj M. 2005. Mycolytic enzymes produced by *Pseudomonas fluorescens* and *Trichoderma* spp against Phytophthora capsici, the foot rot pathogen of black pepper (*Piper nigrum* Linn.). *Annals of Microbiology*. 55: 129-133.
10. Hamza, S. and Sadanandan, A.K. 2005. Effect of sources and method of application of Zinc on yield and quality of black pepper (*Piper nigrum* L.). *Journal of Spices and Aromatic Crops* 14:117-121.
11. Hamza, S. and Sadanandan, A.K. 2005. Response of black pepper (*Piper nigrum* L) to molybdenum nutrition. *Indian Journal of Agricultural Sciences*, 75: 294 -95.
12. Hamza, S. and Sadanandan, A. K. 2005. Soil amendments and molybdenum on yield and quality of black pepper (*Piper nigrum* L). *Indian Journal of Agricultural Sciences* 75:735-737.
13. Hareesh, P. S., Madhubala, R. and Bhat, A.I. 2006. Characterization of *Cucumber mosaic virus* Infecting Indian long pepper (*Piper longum* L.) and Betel vine (*Piper betle* L.) in India. *Indian Journal of Biotechnology*, 5: 89-93.
14. John Zachariah, T., Krishnamoorthy B., Rema, J. and Mathew P. A. 2005. Oil constituents in bud and pedicel of clove (*Syzygium aromaticum*). *Indian Perfumer* 49: 313-316.
15. John Zachariah, T., Mathew, P.A. and Gopinath P. 2005. Chemical quality of berries from black pepper varieties grafted on *Piper colubrinum*. *Journal of Medicinal and Aromatic Plant Sciences* 27: 39-42.
16. Johnson, K. G., Varma, S.R., Ganga, G., Anandaraj, M. and Parthasarathy, V.A. 2005. A method for isolation and reverse transcription of high quality RNA from *Piper* species. *Journal of Spices and Aromatic Crops* 14: 10-14.
17. Kandiannan, K., Thankamani, C.K., Korikanthimath, V.S., Mathew, P.A. 2005. Performance of Java Long Pepper (*Piper chaba* Hunter non Blume Syn. *P. retrofractum* Vahl.) intercropped with arecanut. *Journal of*

Plantation Crops 33: 77-78.

18. Leela, N. K and Pillai, P. M. 2005. Chemical constituents of *Humboldtia vahliana*. *Journal of Medicinal and Aromatic Plant Sciences* 27:49-50.
19. Madhubala, R., Bhadramurthy, V., Bhat, A.I., Hareesh, P.S., Retheesh, S.T. and Bhai, R.S. 2005. Occurrence of *Cucumber mosaic virus* on Vanilla (*Vanilla planifolia* Andrews) in *India*. *Journal of Biosciences*. 30: 339-350.
20. Nirmal Babu K., Minoo D., Geetha SP., Ravindran P.N. and Peter K.V. 2005. Advances in Biotechnology of Spices and Herbs. *Indian Journal of Botanical Research 1*: 155-214.
21. Rema, J., Leela, N. K., Krishnamoorthy, B. and Mathew, P.A. 2005. Chemical composition of *Cinnamomum tamala* essential oil-a review. *Journal of Medicinal and Aromatic Plant Sciences*, 27: 515-519.
22. Saji, K.V., Sasikumar, B., Johnson George, K. and Parthasarathy, V.A. 2005. Sex change in *Piper thomsoni* Hook (*Piperaceae*). *Journal of Spices and Aromatic Crops*. 14:39-41.
23. Sasikumar, B., Johnson George, K., Saji, K.V. and John Zachariah, T. 2005. Two new high yielding, high curcumin turmeric (*Curcuma longa* L.) varieties-'IISR Kedaram' and 'IISR Alleppey Supreme". *Journal of Spices and Aromatic Crops*. 14: 71-74.
24. Srinivasan, V., Hamza, S. and Sadanandan A.K. 2005. Evaluation of composted coir pith with chemical and biofertilizers on nutrient availability, yield and quality of black pepper (*Piper nigrum* L.) *Journal of Spices and Aromatic Crops*, 14: 15-20.
25. Suseela Bhai R., Kishore, V.K., Kumar, A., Anandaraj, M. and Eapen, S. J. 2005 Screening of rhizobacterial isolates against soft rot disease of ginger (*Zingiber officinale* Rosc) *Journal of Spices and Aromatic Crops* 14: 130-136
26. Suseela Bhai, R. and Sarma. Y. R .2005 Characterization of *Phytophthora* de Bary inciting Capsule Rot / Azhukal and leaf blight disease of cardamom (*Elettaria cardamomum* Maton) *Journal of Plantation Crops* 33: 193-203
27. Thankamani, C.K., Madan, M.S., Sivaraman, K. and Kandiannan, K. 2005. Utilization of composted coir pith for growth and yield of turmeric. *Agricultural Science Digest*. 25: 99-102.
28. Thankamani, C.K., Sreekala, K. and Anandaraj. M. 2005. Effect of *Pseudomonas fluorescens* (IISR6) and *Trichoderma harzianum* on growth of black pepper varieties in the nursery. *Journal of Spices and Aromatic crops*.14: 112-116.

Technical Bulletin

1. Sharma, Y.P., Kumar, A., Yadav, D.S., Sasikumar,B., Tripathi, A. K., Anandaraj. M., Sanwal, S.K. and Parthasarathy, V.A. 2006. Production and Marketing of Ginger- Tech. Bull. no.24, ICAR Research Complex for North Eastern Hilly region, Barapani.and Indian Institute of Spices Research, Calicut. pp28.

2. Parthasarathy, U., Bhat, A.I., Sushamadevi, C.K. Sheriff, P. A. (eds) 2005. Abstracts of M.Sc and Ph.D Dissertations on spice crops. Tech. Bull. 8, Indian Institute of Spices Research, Calicut, p97.

Awards

Dr. JS Pruthi Award for the best research paper in Journal of Spices and Aromatic Crops. Sasikumar, B., Haridas P., Johnson George K., Saji K.V., John Zachariah T, Ravindran P.N., Nirmal Babu K., Krishnamoorthy B., Mathew P.A. and Parthasarathy, V.A. 2005. IISR Thevam, IISR Malabar Excel and IISR Girimunda, three new black pepper clones. *Journal of Spices and Aromatic Crops* 13(1): 1-5.

Visit abroad

Krishnamoorthy, B, Mathew, P. A

Visited Grenada as experts in nutmeg agronomy for the Diagnostic Mission for revitalization of nutmeg industry in Grenada, organized by the Commonwealth Secretariat, London, 2-18 June 2005.

List of Projects

Mega Project-1: Collection, conservation, characterization and cataloguing of germplasm of spice crops for yield and other economically important characters. [Project Leader: P. A. Mathew]

1. Gen. I (813): Collection, conservation, cataloguing and evaluation of black pepper germplasm [1972-2008] [K. V. Saji, Johnson K. George and R. Ramakrishnan Nair and Utpala Parthasarathy]
2. *Gen. IX (813): Collection, conservation*, cataloguing and evaluation of cardamom germplasm [1976-2007] [D. Prasath and M.N. Venugopal]
3. Gen. II (813): Collection, conservation, cataloguing and evaluation of germplasm of ginger and turmeric [1976-2007] [B. Sasikumar, Johnson K. George, K. V. Saji and R. Ramakrishnan Nair]
4. Gen. XIV (813): Characterization of turmeric germplasm for curcuminoids [2004-2007][B. Chempakam and N. K. Leela]
5. Gen. VI (813): Collection, conservation, cataloguing and evaluation of germplasm of tree spices [1976-2007] [B. Krishnamoorthy, J. Rema, P. A. Mathew, D. Prasath and N.K. Leela]
6. Gen. XIII (813): Maintenance, enhancement and characterization of genetic variability in vanilla (*Vanilla planifolia* Andrews) (2005-2010) [R. Ramakrishnan Nair and P. A. Mathew]
7. Hort. III (813): Collection, characterization, evaluation and maintenance of paprika and paprika alike chillies [2004-2009] [KN Shiva, T.J. Zachariah and V.A. Parthasarathy]

Mega Project-2: Breeding improved varieties of spice crops for yield, quality, drought and resistance to pests and diseases [Project Leader: B. Krishnamoorthy]

1. Gen.VII.1 (813): Breeding black pepper for high yield, quality, drought and resistance to pests [1977-2007] [B. Sasikumar, Johnson K. George, K. V. Saji, T. John Zachariah and K. S. Krishnamurthy]
2. Gen.X. (813): Breeding cardamom for high yield and resistance to 'katte' disease. [1976-2007] [D. Prasath and M. N. Venugopal]
3. Gen.XV. (813): Investigations on the reasons and solutions for the absence of seed set in ginger (*Zingiber officinale* Rosc.) [2005-2008] [R Ramakrishnan Nair]
4. Biotech. IV (813): Biotechnological approaches for crop improvement in black pepper [1995-2005] [K. Nirmal Babu and M. Anandaraj]
5. Biotech. VII (813): ISSR markers for black pepper improvement [2004-2007] [Johnson K. George and B. Sasikumar]
6. Biotech. VIII (813): Molecular characterization and *in vitro* propagation in *Myristica* sp.[2005-2008] [Sheeja T.E and B. Krishnamoorthy]
7. Hort. IV (813): Rootstock-scion interactions in tree spices [1998-2008] [J. Rema, P. A. Mathew and K. S. Krishnamurthy]

Mega Project-3: System approach for sustainable production of spices [Project Leader: K. Kandiannan]

1. SSC IV(813): Nutrient Budgeting For

Improved Varieties of Spices [2005-2010] [V. Srinivasan, R. Dinesh, C.K. Thankamani, K. Kandiannan, S.J. Anke Gowda and S. Hamza]

2. Agr. XXI (813): Efficacy of biofertilizer on nutritional management of black pepper [2000-2007][C. K. Thankamani and K. S. Krishnamurthy]
3. Agr. XXII (813): Biometeorological investigations and modeling in black pepper *[2003-2006]* [K. Kandiannan and Utpala Parthasarathy]
4. SSC. III (813): Assessment of quality of soils under spices based cropping systems [2005-2008] [R. Dinesh, V. Srinivasan, T.E. Sheeja and S. Hamza]

Mega Project-4: Production physiology of spice crops [Project Leader: B. Chempakam]

1. Phy. VII (813): Physiological and biochemical basis for productivity in black pepper [2003-2008][K. S. Krishnamurthy and B. Chempakam]
2. Phy. VIII(813): Mechanism of drought tolerance in cardamom and black pepper [2005-2008] [S.J. Anke Gowda and K.S. Krishnamurthy]

Mega Project-5: Value addition and post* harvest processing of spices [Project *Leader: T. John Zachariah]

1. PHT. III (813): Studies on drying and storage parameters in black pepper, ginger, turmeric and nutmeg [2004-2007] [E. Jayashree and T. John Zachariah]
2. PHT. IV (813): Evaluation for physical and biochemical quality of spices. [2005-2009] [T. John Zachariah, N.K. Leela and K.N. Shiva]

Mega Project-6: Production of planting materials of improved varieties of spice crops [Project Leader: C. K. Thankamani]

1. Agr. XX (813): Production of planting materials of improved varieties of spice crops [1972-2007] [C. K. Thankamani, P. A. Mathew, K. Kandiannan and S. J. Ankegowda]

Mega Project-7: Identification, characterization and development of diagnostics against pests, pathogens nematodes of spice crops [Project Leader: M. N. Venugopal]

1. Path. XV (813): Investigations on diseases of vanilla [2003-2008] [A. Ishwara Bhat, R. Suseela Bhai and M. N. Venugopal]
2. Nema. III (813): Investigations on nematodes associated with spices [1992-2005] [Santhosh J. Eapen]

Mega Project-8: Conventional and molecular approaches for developing pest, pathogen and nematode resistance in spice crops [Project Leader: M. Anandaraj]

1. Crop Prot. 1.1 (813): Screening germplasm of spice crops for reaction to diseases [1978-2006 [R. Suseela Bhai, M. Anandaraj, M. N. Venugopal and K. V. Saji]
2. Crop Prot. 1.3 (813): Screening germplasm of spice crops for reaction to nematodes [1978-2006] [Santhosh J. Eapen and K. V. Saji]
3. Crop Prot. 1.2 (813): Screening germplasm of spice crops for reaction to insect pests [1978-2006 [K. M. Abdullah Koya, S. Devasahayam, T. K. Jacob, K. V. Saji and B. Sasikumar].

Mega Project-9: Developing integrated pest and disease management strategies in spice crops [Project Leader: S. Devasahayam]

1. Path. II.3 (813): Disease management in *Phytophthora* foot rot affected black pepper plantations [1988-2006] [M. Anandaraj, V. Srinivasan and C. K. Thankamani]
2. Hort. II (813) : Utilization of *Piper colubrinum* Link and *P. arboreum* as rootstocks in the management of foot rot disease of black pepper [1996-2006] [P. A. Mathew, T. John Zachariah and J. Rema]
3. Path XVI (813):Etiology and management of rhizome rot complex in ginger and turmeric [2004-2009] [A. Kumar, R. Suseela Bhai, S.J. Eapen and K.N. Shiva]
4. Org. Chem. II (813): Characterization of bioactive compounds with pesticide properties [2002-2005] [N. K. Leela]
5. Biocontrol II. (813): Development of consortium of bioinoculants for management of pests, diseases and nematodes in spices [2004-2008] [M. Anandaraj, M. N. Venugopal, S. Devasahayam, R. Suseela Bhai, K. M. Abdulla Koya, Santhosh J. Eapen and A. Kumar]
6. Ent XII (813): Bioecology and integrated management of shoot borer *Conogethes punctiferalis* Guen. infesting turmeric [2005–2009] [S. Devasahayam, T. K. Jacob, and K. M. Abdulla Koya]

Mega Project-10: Economics, statistics and modeling [Project Leader: M. S. Madan]

1. Econ. III (813) : Remote sensing and GIS in evaluating the impact on socio-ecological changes on spices production in [2003-2008] Western Ghats region [M. S. Madan and Utpala Parthasarathy]

Mega Project-11: Extension and training [Project Leader: P. Rajeev]

1. Ext. IV (813): Training of research and extension workers [1971-2007][P. Rajeev and T. K. Jacob]
2. Ext. VI (813): Agricultural Technology Information Centre. [2004-2007] [P. Rajeev]

Mega project-12: Developing customized software and expert systems on spices [Project Leader: K. N. Kurup]

1. Stat. I (813): Development of databases and software [2004-2007] [K. N. Kurup, Santhosh. J. Eapen, P. Rajeev, and K. Jayaraj]

EXTERNALLY FUNDED PROJECTS

ICAR

1. ICAR- CIB 1: Strengthening the cause of Geographical Indication of major spices using molecular, morphological and quality profiling techniques. [2004-2007] [B. Sasikumar and T. John Zachariah]
2. ICAR-CIB 2: Cloning of *Phytophthora* resistance and defense genes from *Piper colubrinum* [2004-2007] [Johnson George K and M. Anandaraj]
3. ICAR–CPPHT- 1: Network Project on Organic Farming [2004-2007] [V.Srinivasan, C. K. Thankamani, A. Kumar and T. John Zachariah].
4. ICAR- CPPHT-2: Impact, Adaptation and *Mitigation of Climate Change Effects on* Growth and Productivity of Plantation Crops with Special Reference to Coconut and Black pepper. [2004 –2007] [Co-PIs- K.S. Krishnamurthy, K. Kandiannan and B.Chempakam, Main Centre- CPCRI,

Kasaragod, Sub Centre- IISR, Calicut]

5. ICAR – CPPHT- 3: Development of chilli (*Capsicum annuum* L.) hybrids for paprika (oleoresin) production [2004-2007] [T. John Zachariah and K.N. Shiva]
6. ICAR-CPPHT- 4 Chemical characterization of *Cinnamomum* germplasm [2005-2008] [N K Leela and J. Rema.]
7. ICAR- CPPHT- 5: Prevention and management of Mycotoxin contamination in commercially important Agricultural commodities [2005-2008] [B.Chempakam, M. Anandaraj, T. John Zachariah, N.K. Leela and E. Jayashree]
8. ICAR–CP1: Identification and development of diagnostics for the viruses causing stunted disease in black pepper [2003-2006] [A. Ishwara Bhat and R. Suseela Bhai]
9. ICAR- CP 2: Molecular characterization and maintenance of National Repository of *Phytophthora* [2004-2007] [M. Anandaraj, R. Suseela Bhai, A.I. Bhat]
10. ICAR – CP 3: Bioecology and integrated management of root mealybug (*Planococcus* sp.) infesting black pepper [2003-2006] [S. Devasahayam, K. M. Abdulla Koya and M. Anandaraj]
11. ICAR-Ext-1: Central Sector Scheme: Technology mission for integrated development of NE states including Sikkim [2005-2006] [P.Rajeev].

DBT

1. DBT- CIB 1: On farm evaluation of tissue culture derived black pepper plants [2002-2006] [K. Nirmal Babu, M. Anandaraj, V. Srinivasan and Ramakrishnan Nair]
2. DBT- CIB 2: Determination of purity of powdered market samples of major spices using PCR techniques, protein profiling and /or HPLC techniques. [2004-2007] [B. Sasikumar and B.Chempakam]
3. DBT- CP 1 (813): Molecular characterization of viruses causing stunted disease in black pepper and development of PCR based methodology for their detection [2003-2006] [A. Ishwara Bhat and R. Suseela Bhai]
4. DBT- CP 2: Endophytic bacteria for biological system management of *Radopholus similis*, the key nematode pest of black pepper (*Piper nigrum* L.) [2003-2006] [Santhosh J. Eapen, R. Ramakrishnan Nair and A. Kumar]
5. DBT- SS 1: Distributed Information Sub-Centre (Bioinformatics Centre) [2000-2007][S.J. Eapen]

OTHERS

1. IPL - CPPHT 1: Evaluation of Sulphate of Potash (SOP) as Potassium Source on Growth, Yield and Quality of Black pepper [2004-2007] [K. Kandiannan and V. Srinivasan.

2. Kerala State Council for Science, Technology and Environment project: Production of white pepper through fermentation technology (KSCSTE-CPPHT-1) [2005-2008] [T. John Zachariah, A. Kumar and E. Jayashree].

Research Advisory Committee 2005 Recommendations and Action Taken Report

Sl. No.	Recommendations	Action taken
1.	Principal component analysis for the high oil types and isozyme studies for characterization of ginger germplasm may be done.	At present oil content has been estimated as an index for quality of ginger. Once sufficient data is available PCA will be taken up. 63 genotypes of ginger and 143 genotypes of turmeric were characterized using isozyme profiles
2.	For turmeric improvement, the individual curcuminoid components may also be looked. The economic/ethno-botanical importance of pink ginger (Meghalaya collection) has to be documented. A strategy may be evolved to conserve the germplasm free of disease(s). Separate plots may be established for conserving high quality germplasm lines.	At present a project on characterization of turmeric germplasm based on curcuminoids is already in progress. Pink ginger is a collection from Meghalaya which has slightly pink coloration in the outer skin. Available information regarding the economic and ethno botanical importance of pink ginger will be collected. In black pepper the germplasm is kept in field gene bank and in nurseries. Important lines are also maintained in alternate site (Appangala and this year at CPCRI, Seed farm, Kidu) as well as in *invitro* gene bank at NBPGR and IISR. In Ginger and Turmeric, in addition to field planting, all accessions are planted in cement tubs, in replicates, under protected conditions and also conserved in *invitro* gene bank at NBPGR and IISR. In cardamom the germplasm is located at four centers, Appangala (IISR), ICRI Myladumpara (Spices Board), Pampadumpara (KAU), Mudigere (UAS). In addition important germplasm are also conserved in invitro gene bank at IISR.
3.	Linkages have to be established with other organizations like CSIR, Spices Board (SB) and industry to exploit the potential of quality biochemical compounds of spices and to evaluate them for medicinal properties	Linkages are already in place for various other activities such as in genetic resources, biotechnical approaches for crop improvement, on farm evaluation of tissue culture plants, aflatoxin etc. Regarding the biomedical properties the possibilities of collaboration will be explored.
4.	The prime target of transgenic work	High priority was given to resistance to

	should be on *Phytophthora* resistance in addition to abiotic stresses like drought. All the bio-safety measures have to be taken into account while planning transgenic work. The economic impact of the varieties released by the institute has to be worked out.	*Phytophthora*. The genes used viz., Osmotin and Glucanase were known to induce resistance to *Phytophthora*. Since osmotin is also involved in stress tolerance the transgenics developed will also be screened for their reaction to drought. The institute biosafety committee meets once in 6 months to oversee the transgenic and the proceedings were also sent to the RCGM at DBT, New Delhi.
5.	In black pepper, mapping population size may be increased for screening against *Phytophthora*. The search for male specific primers of nutmeg has to be intensified.	In black pepper, the population used for screening *Phytophthora* resistance was over 150 progenies each from crossed and selfed progenies of each parent giving a total population of about 450. Search for sex specific markers in nutmeg is being done using a larger population.
6.	Studies on response to biofertilizer application may be approached in a holistic way. A permanent manurial plot for organic and Integrated Nutrient Management (INM) systems is suggested.	*Permanent plots for studying the effect of organic*, INM and chemical management systems on pepper, ginger and turmeric have been started to study their sustainability for yield and economics.
7.	For drought tolerance, observations on number of stomata on the leaves and the number of stomata that are open at varying intervals may be recorded.	Stomatal frequency in both sides of leaves already available. The number of opened stomata at various intervals will be taken up.
8.	In depth studies on isozymes to distinguish high or low yielder is suggested.	Isozyme pattern of dehydrogenases will be studied in detail.
9.	Study on physiological parameters under graded light intensity levels may be taken up. To standardize methodologies for assessing soil moisture content under drought tolerant screening process.	Information on physiological parameters and light requirement are already available for a few varieties in black pepper. Regarding soil moisture estimation, accepted standard methods are followed.
10.	Interface with industry once in 2-3 years may be considered. Studies on the effect of location, soil, climate, altitude and other parameters on yield as well as quality of spices may be taken up.	Institute has conducted interfaces during 1996 and 2001. Impact of location on curcumin content was studied in places like Coimbatore, Jagtial, Kumarganj and Pundibari.

11.	The need for studying the demand supply curve for different planting materials and economic impact of the varieties and technologies released by the Institute was emphasized. The feasibility of certifying selected nurseries may be explored	Under Technology Mission on Black pepper, nurseries in 4 districts in Kerala were certified and healthy planting materials were distributed to farmers.
12.	Planting *Piper colubrinum* grafted pepper as mother plant in bamboo nursery, application of PGPR and *Trichoderma* periodically in all nurseries and also in the planting pits of ginger and turmeric are suggested.	Maintenance of grafts with *Piper colubrium* was not successful due to breaking of graft union at the time of intercultural operations. Application of *Trichoderma* and PGPR in all nurseries of black pepper has been taken up. In the case of ginger and turmeric, application of the biocontrol agents will be taken up in the coming crop season.
13.	The planting materials should be systematically screened before supplying to the farmers/users.	The planting materials are screened for viruses, fungi and nematodes before supplying to the farmers.
14.	An organized study on epidemiology of pathogens causing vanilla diseases (stem/ bean rot yellowing) by mimicking situations favourable for different pathogens is suggested to have a clear strategy.	Vanilla plantation is being established at IISR farm, Peruvannamuzhi to undertake detailed studies on epidemiology of various disease of vanilla.
15.	The RAC suggested for repeating the screening procedures for soft rot/bacterial wilt of ginger on germplasm accessions to confirm the disease escapes and also to modify the method of screening. The use of vascular fluid of ginger itself to multiply the pathogen and to study its behaviour was suggested.	The disease escapes are being screened again for bacterial wilt resistance. The experiment is being repeated this year also. Attempt to extract vascular fluid from for culturing *Ralstonia*.
16.	The RAC suggested for investigating the foliar nutrition and physiological influence on immature bean shedding of vanilla where fungicides were not found to be effective.	An experiment will be taken up to study the foliar nutrition and physiological influences on immature bean shedding of vanilla in association with soil scientist and physiologist at the time of initiation of flowering during January 2006 in farmers plot.
17.	The bio-molecules isolated from plant	A bioactive compound from *Chromolena. odorata*

extracts against *Phytophthora* and other pest(s) and pathogen(s) may be patented after detailed investigation. The use of wild non pathogenic strains of pathogens for cross protection may be explored.	has been isolated and characterized, which will be tested for it's efficacy on *P. capsici.*
18. The RAC suggested following standardized methods for isolating the endophytic bacteria from black pepper and other spices to confirm their presence and accumulation by staining techniques and through selective markers if possible. Also it is important to study the rhizosphere region and rhizoplane (root surface) in both sterilized and unsterilized root surface.	Though we have used standardized protocols for isolating true endophytic bacteria from black pepper, the isolates will be tested further using suitable staining method, molecular method and other microbiological assay procedure. We are planning to use intrinsic antibiotic resistance for confirming their endophytic nature. In fact a PhD programme is underway to explain the colonization pattern of the rhizobacteria, its entry and endophytic colonization in black pepper roots and stem.
19. RAC suggested for bringing out the publications in the form of bulletins on cost of production and economics.	Bulletins on cost of production and economics and cost benefit ratio of various spices cultivation are being prepared.
20. It was suggested to create a database on climate and weather forecasting.	Available weather data collected from Peruvannamuzhi and Appangala farm will be utilized for creating the database.
21. In the post WTO era importance must be given for the conservation of genetic resources. It was suggested to explore the possibility of establishing an alternate set of germplasm materials of black pepper at Chethalli (IIHR) farm or at any other site and to utilize facilities available at NBPGR for *in vitro* conservation/ cryoconservation.	In black pepper the germplasm is kept in field gene bank and in nurseries. Important lines are also maintained in alternate site (Appangala and this year at CPCRI, Seed farm, Kidu) as well as in *invitro* gene bank at NBPGR and IISR. In Ginger and Turmeric, in addition to field planting, all accessions are planted in cement tubs, in replicates, and also conserved in *invitro* gene bank at NBPGR and IISR. In cardamom the germplasm is located at four centers, Appangala (IISR), ICRI Myladumpara (Spices Board), Pampadumpara (KAU), Mudigere (UAS). In addition important germplasm are also conserved in *invitro* gene bank at IISR. Also, 100 selected lines will be planted at CPCRI station (Kidu).
22. Scientist should be made aware of the	A core group of scientists have already participated

WTO implications on spices and it is imperative to maintain meticulous records. Each scientist was urged to look for patentable items in each research activity and organize work elements accordingly. The potentials of germplasm have to be properly documented and IPR claims specified and varieties with unique characters registered	in WTO related work shops and a few special lectures on WTO related issues were organized. Registration of important accessions of germplasm with unique characters is in progress and 2 unique lines of black pepper, 1 turmeric, 1 ginger and 1clove were already registered. All the germplasm accessions and released varieties were submitted with NBPGR. One efficient isolate each of *Trichoderma harzianum* and *Pseudomonas fluorescens* have been deposited at IMTECH, Chandigarh.
23. Awareness has to be created among scientists on IPR issues by organizing lectures jointly with spices Board and State department.	This is being done. A core group of few scientists have already participated in WTO related work shops and a few special lectures on WTO.
24. To safeguard IPR on spices involving Geographical Indicators (GI) efforts should be made to define the area from which spices are grown/ collected.	A research project was initiated to define and molecular characterization of Geographical Indicators. At present molecular profiling was done for around 100 genotypes each of black pepper, cardamom, ginger and turmeric.
25. Scientists must be conversant with the process and procedures of patenting, Appropriate training may be arranged for the Scientists with the lawyers involved in patenting process.	This is being done. A core group of few scientists have already participated in WTO related work shops and a few special lectures on WTO related issues were organized through study circle.
26. Efforts must be made to isolate resistant genes/ gene analogues and promoters for transgenic research.	This is in progress. A few putative gene analogues were identified and sequencing and isolation of full length genes is in progress. Possibility obtaining genes from internal sources is being pursued.
27. Developing suitable varieties resistant to aflatoxin contamination during storage shall be taken as a long term objective.	This will be taken as a long time programme after completion of the existing project on aflatoxin management
28. The involvement of down stream enzymes in curcumin synthesis pathway can be intensified	Other biosynthetic enzymes in turmeric viz., hydroxylase and O-methyl transferase will be taken up in the coming crop season.

29. Concerted efforts should be made to converge the source of *Phytophthora* resistance through breeding strategies	This is already in operation. A review was made by the Director and more focus was brought in.
30. A focused breeding strategy may be evolved for black pepper and presented in the next RAC meeting. Dr. V.A. Parthasarathy, Director, IISR may take a lead in this matter.	This is already in operation. A comprehensive strategy involving use of resistant lines in conventional breeding. Resistance to Phytophthora, pollubeetle, nematode and drought were given priority. Identification of markers linked with resistance and isolation disease resistance genes and developing disease resistance trandgenics using transgenic path way are being worked out.
31. Storage and package methods may be standardized for retaining quality for enhancing shelf life of spices like black pepper and cardamom	A vacuum packaging machine with gas flushing facility is procured. Black pepper is kept for storage under vacuum and nitrogen atmosphere
32. Sensitive diagnostic kits may be developed for production of disease free planting material. Potting media may also be worked out with granite powder combinations by suitably amending the C:N ratio.	Sensitive diagnostic kits are being used for screening mother plants for viruses.
33. Clean cultivation and post-harvest technology and drying the spices produce will reduce *Aspergillus* contamination.	A management strategy to prevent aflatoxin contamination would be worked out in the ongoing ICAR-Ad-hoc project
34. Role of foliar nutrition with KCl blended with low dose of Urea on disease suppression and disease incidence/control under organic farming system are to be looked into.	Role of potassium spray on increasing the yield and quality is being studied with Potassium Sulphate. Chloride salts and urea are not allowed under organic farming systems.
35. Awareness may be created on the severity of the root mealybug problem in pepper and the same should be resolved by developing a clear cut package.	Awareness is being created on the complexity of root mealy bug problem during visits to farmers fields in Wyanad. Trials on using IDM/IPM strategies for the management of root mealy bug complex have been initiated.

36. Detailed survey on vanilla disease(s) (root/ stem/bean rot) has to be taken up.	Survey on viral diseases of vanilla in Kerala, Karnataka has been completed and the data published. Survey on vanilla diseases in Calicut and Coorg region has already been done.
37. Standardized methodologies or procedures have to be followed to isolate and identify rhizobacteria /endophytes and a facility to identify the same can be created.	At present facilities such as Biolog system is available to identity bacteria. We need to have this system to identify the bacteria.
38. More specific parameters on rhizome solarization have to be recorded in detail before making any recommendations.	Environmental parameters such as Temperature, Sunlight Intensity, RH, and CO_2 concentration are being recorded during rhizome solarization
39. To ensure buyback arrangement from farmer's interfaces may be held with industry with the help of Spices Board/ SAU.	Spices Board may be approached for this purpose.
40. The ISO specifications for aflatoxin, pesticides, microflora and other physical parameters may be developed for all the spices. Institute can also explore the possibility of obtaining ISO certification.	A net work project on aflatoxin is already in progress. The institute has initiated procedures for obtaining ISO certification by training scientists on accreditation norms.
41. Demonstrations of the technologies developed can be done in farmers fields through KVK in limited locations.	Grafting of *Piper colubrinum* for the management of *Phytophthora* foot rot disease was demonstrated in farmer's field in an area of 4 acres.Application of *Trichoderma harzianum* and *Pseudomonas fluorescens* for the management of *Phytophthora* foot rot disease of black pepper was also demonstrated
42. Spread of varieties released from institute has to be quantified. The impact analysis of technologies/ varieties is also to be worked out to reorient the research.	New project with the studies on the spread of institute's technologies including varieties as the objectives will be initiated immediately by the social science section.
43. ATMA models that are in operation at other States can be studied for adoption in spice crops. Linkages with Spices Board and Industries are needed to work on value addition of spices.	Collection of basic information on the implementation of ATMA model of dissemination of technologies and the study on feasibility of adopting the models are being done.

44. The HRD inputs on Biotechnology training have to be intensified and funds may be provided for the same to have better training and exposure.	ICAR would be approached for specific training needs.
45. Training of Scientists in "Frontier Areas" may be undertaken by using the funds allocated under HRD.	Scientists are being trained in in different S & T institutes as and when needed within the country.
46. Technical Publication on all aspects of *Phytophthora* in a bulletin from may be brought out.	Salient achievements of Phytonet would be brought out as a bulletin.
47. Technology Transfer Brochures may be developed by the Breeding, Management, Crop protection and Extension groups on specific issues which will reflect on the visibility of the Institute.	Technical bulletins on specific topics and package of practices have already been published.

RESEARCH ADVISORY COMMITTEE (RAC)

Chaiman

Dr. S. Kannaiyan
National Biodiversity Authority, Chennai

Members

Dr. A. N. Mourya, Emeritus Scientist,
Banaras Hindu University, Varanasi

Dr. A. Manickam, Professor, Tamil Nadu
Agricultural University, Coimbatore

Dr. Narayan Rishi, CCS Haryana
Agricultural University, Hisar

Dr. Kuruvina Shetti
Professor, University of Agricultural
Sciences, Dharwad

Dr. A. K. Misra
Ministry of Agriculture, New Delhi

Member Secretary

M. Anandaraj, PC (Spices), IISR, Calicut

INSTITUTE MANAGEMENT COMMITTEE (IMC)

Chairman

Director, IISR, Calicut

Members

Assistant Director General (PC)
ICAR, New Delhi

Dr. S Devasahayam, IISR, Calicut

Mr. P A Mathew, IISR, Calicut

Dr. George V. Thomas
CPCRI, Kasaragod

Dr. K V Nagaraja, NRC For Cashew,
Puttur

Sri. Sanjay Mariwala, Kochi

Sri. K Mukundan, Wayanad

Member Secretary

Assistant Administrative Officer
IISR, Calicut

Women's Cell

International Women's day was observed on 7th March 2006. Chief Guest Adv. Noor Bina Rasheed, former member, Kerala Women's Commission, Director, Social Welfare Board, and Executive Member, Kerala State Literacy mission addressed the staff. She stressed the need for Women empowerment and also embarked upon the present scenario of women in Society. This was followed by cultural programme. All the women employees of the institute participated in a training programme, organized by KVK of the Institute on "Vermicompost preparation and usage" and also on "Grafting techniques" in January 2006. Women's cell also participated jointly with the Recreation club in conducting the Communal Harmony Week during November 19-25, 2005. Smt Shobha Balakrishnan, Principal, Amrita Vidyalayam, Calicut spoke on the occasion. Classes were also arranged for the women staff for flower making and various handicrafts.

Training programme on artificial flower making

Official Language Implementation Committee

Quarterly meeting of Official Language Implementation Committee was held four times during the year 2005-06. 32 rubber stamps were prepared in bilingual. Hindi version of the half yearly publication of Spices News vol. 16 (1) Jan-June 2005 and volume 16 Issue (2) July - December 2005 was published separately. Hindi Week was celebrated with various Hindi competitions from 16th Sept to 24th Sept.2005. Sri Sita Ram Kinra, Superintending Engineer, CPWD, Calicut was the Chief Guest of Valedictory Function. Four Hindi Workshops were organized for encouraging the staff members to the use of Official language. Sri Harish Chandra Joshi, Director (OL), ICAR, New Delhi was the chief guest in one of the Hindi Workshops (23.1.2006). Smt P.V. Sali, Personal Assistant has attended one day Hindi Workshop organized by Town Official language Implementation Committee, Calicut. During the year under the Hindi Teaching Scheme, Calicut, Five staff members have passed Praveen examination and seven staff members have passed Pragya examination. Sri. V. V. Sayyed Mohammad, UDC and Sri .P. Sundaran, UDC have attended five days intensive training/ workshop on 4-9 August, 2005 at NAARM, Hyderabad. Summary of annual report and executive summary of AICRPS was translated in Hindi and incorporated in both annual reports. B. Krishnamoorthy, Hindi Officer attended TOLIC meeting on 26.10.2005 at Hotel Malabar Palace. N. Prasannakumari, Hindi Translator attended TOLIC Sub- Committee meeting on 17.11.2005 at SBT, Calicut. Sri P.K. Janardhanan, Assistant and Sri T. H. Nagaraj Assistant Administrative Officer have attended three days Intensive Hindi Training/ Workshop from 2.2.2006 to 4.2.2006 at National Academy of Agricultural Research Management, Hyderabad.

Personnel

HEADQUARTERS

SCIENTIFIC

Sl. No.	Name	Designation
1.	Dr. V.A. Parthasarathy	Director
2.	Dr. M. Anandaraj	Project Coordinator, (Spices)
3.	Dr. (Mrs.) B. Chempakam	Head, Div. Crop Production
4.	Dr. K. Narayana Kurup	Principal Scientist (Agri. Statistics)
5.	Dr. S. Devasahayam	Principal Scientist (Entomology)
6.	Mr. B. Krishnamoorthy	Principal Scientist (Plant Breeding)
7.	Dr. K. Nirmal Babu	Sr. Scientist (Plant Breeding)
8.	Dr. M.S. Madan	Sr. Scientist (Agril. Economics)
9.	Dr. T. John Zachariah	Sr. Scientist (Biochemistry)
10.	Dr. B. Sasikumar	Sr. Scientist (Plant Breeding)
11.	Dr. (Mrs.) J. Rema	Sr. Scientist (Horticulture)
12.	Dr. K. Johnson George	Sr. Scientist (Gen. & Cytogenetics)
13.	Dr. (Mrs.) C.K. Thankamani	Sr. Scientist (Agronomy)
14.	Dr. R. Dinesh	Sr. Scientist (Soil Science)
15.	Dr. Suseela Bhai R.	Sr. Scientist (Plant Pathology)
16.	Dr. A. Ishwara Bhat	Sr. Scientist (Plant Pathology)
17.	Dr. R. Ramakrishnan Nair	Sr. Scientist (Gen. & Cytogenetics)
18.	Dr. P. Rajeev	Sr. Scientist (Agril. Extension)
19.	Dr. K.S. Krishnamoorthy	Sr. Scientist (Plant Physiology)
20.	Dr. K. Kandiannan	Sr. Scientist (Agronomy)
21.	Dr. Santhosh J. Eapen	Sr. Scientist (Nematology)
22.	Dr. N.K. Leela	Sr. Scientist (Org. Chemistry)
23.	Mr. K.M. Abdulla Koya	Scientist (SG) (Entomology)
24.	Mr. K.V. Saji	Scientist (SG) (Economic Botany)
25.	Dr. A. Kumar	Scientist (Sr. Scale) (Plant Pathology)
26.	Dr. V. Srinivasan	Scientist (Sr. Scale) (Soil Science)
27.	Dr. K.N. Shiva	Scientist (Sr. Scale) (Horticulture)
28.	Dr. T.E. Sheeja	Scientist (Sr. Scale) (Biotechnology)

TECHNICAL OFFICERS

1.	Dr. Johny A. Kallupurackal	Technical Officer (T9)
2.	Dr. Hamza Srambikkal	Tech. Officer (Lab), (T7-8)
3.	Mr. Azgar Sheriff P.	Tech. Officer (Lib.), (T7-8)
4.	Dr. (Mrs.) Utpala Parthasarathy	Tech. Officer (T7-8)
5.	Mr. M.M. Augusthy	Tech. Officer (T6)

6.	Mr. K. Jayarajan	Tech. Officer (Stati.) (T5)
7.	Mr. M. Vijayaraghavan	Technical Officer (T5) (Workshop)
8.	Mr. K.T. Muhammed	Technical Officer (T5) (Farm)
9.	Mr. V. Sivaraman	Technical Officer (T5) (Farm)
10.	Dr. (Smt.) C.K. Sushamadevi	Technical Officer (T5) (Lib.)

IISR EXPERIMENTAL FARM, PERUVANNAMUZHI

SCIENTIFIC

1.	Mr. P.A. Mathew	Principal Scientist (Horticulture)
2.	Ms. E. Jayashree	Scientist (Sr. Scale)(AS & PE)

TECHNICAL

1.	Mr. V.K. Abubacker Koya	Farm Supdt. (T7)
2.	Mr. N.A. Madhavan	Technical Officer (T5) (Farm)
3.	Mr. K. Kumaran	Technical Officer (T5) (Farm)

KVK

SCIENTIFIC

1.	Dr. T.K. Jacob	CTO in Charge & Sr. Scientist (Agril. Entomology)

TECHNICAL OFFICERS

1.	Mr. P.S. Manoj	(T7) (Hort.)
2.	Mr. S. Shanmugavel	T (7-8) (Veterinary Science)
3.	Mr. K.M. Prakash	T (7-8) (Agronomy)

IISR CARDAMOM RESEARCH CENTRE, APPANGALA

SCIENTIFIC

1.	Dr. M.N. Venugopal	Principal Scientist (Plant Pathology)
2.	Dr. S.J. Anke Gowda	Sr. Scientist (Physiology)
3.	Dr. D. Prasath	Scientist (Horticulture)

Weather

Cardamom Research Centre, Appangala

Month	Max (%)	Min (%)	Humidity (%)	Rainfall (mm)	No.of rainy days
January	29.0	13.7	69.7	1.4	1
Feb	31.8	13.6	56.3	0.0	0
March	32.7	15.2	63.1	17	1
April	32.3	16.9	72.5	73.5	7
May	32.8	18.2	75.4	63.8	6
June	26.3	16.9	88.8	551.8	20
July	24.5	17.0	92.7	1329	29
Aug	25.6	16.5	87.9	352.1	21
September	27.3	16.7	87.1	287.1	13
October	27.6	16.1	84.5	269.8	9
November	27.6	11.7	74.9	18.4	2
December	28.1	11.3	69.6	0.0	0
				2963.9	109

IISR Experimental Farm, Peruvannamuzhi

Month	Max (%)	Min (%)	Humidity (%)	Rainfall (mm)	No.of rainy days
January	34.0	19.5	64.3	11.0	1
Feb	35.4	19.9	64.4	4.0	1
March	36.4	22.2	62.3	0.0	0
April	34.6	23.7	69.6	159.4	12
May	34.6	24.0	67.5	51.0	5
June	30.1	22.5	85.7	1191.6	26
July	28.0	22.8	91.1	1585.4	29
Aug	29.3	22.5	87.1	647.6	26
September	29.2	21.5	88.6	680.0	19
October	31.1	22.3	85.1	318.4	19
November	31.2	21.7	82.2	397.6	13
December	32.9	19.0	73.7	19.0	4
				5065	155

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