



*Silver Jubilee Year of  
AICRDS  
1971-1996*



वार्षिक प्रतिवेदन  
**ANNUAL REPORT**  
**1996-97**



**ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES**

**Indian Institute of Spices Research**

*(National Institute of Agricultural Research)*

Calicut-673 012, Kerala, India

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# **ALL INDIA COORDINATED RESEARCH PROJECT ON SPICES**

## **ANNUAL REPORT 1996-97** **(APRIL 1996 TO MARCH 1997)**

*Indian Institute of Spices Research*

(Indian Council of Agricultural Research)  
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## FOREWORD

The All India Coordinated Research Project on Spices is completing Silver Jubilee Year of its service to the nation during the current year. The AICRP on spices was formulated with the objectives of developing location specific technologies in the 15 Agro-climatic regions of India with its network of 20 AICRP centres and 8 cooperative centres. The 12 mandatory spice crops of the Project are black pepper, small and large cardamom, ginger, turmeric, nutmeg, clove, cinnamon, coriander, cumin, fennel and fenugreek.

The present Annual Report includes the significant research achievements generated from 80 research projects during the year under report covering broad research areas like Crop Improvement, Crop Production, Crop Protection and Post Harvest Technology. I am sure that the report will be of much relevance to those scientists who are actively engaged in spice research. I record my appreciation for the efforts made by the Project Coordinator and his associates in bringing out such a useful annual report.

*S P Ghosh*  
( S.P. GHOSH )



## सारांश

वर्ष 1971 (चतुर्थ योजना) में मसालों पर अखिल भारतीय समन्वित अनुसंधान परियोजना का प्रारंभ हुआ। नाशक जीव और रोग प्रतिरोधी / सह्य किस्मों को विकसित करना, भारत के विभिन्न कृषि जलवायु प्रदेशों के अनुरूप उचित कृषि प्रविधियों का मानकीकरण, न्यूनतम अवशिष्ट विषाक्तता द्वारा नाशक जीव और रोगों को नियंत्रित करने के लिए नियंत्रण उपायों को विकसित करना तथा मसाले अनुसंधान एवं विकास पर कार्य करनेवाली विभिन्न एजेंसियों के बीच की कड़ी को विकसित करना आदि इस परियोजना के प्रमुख लक्ष्य हैं।

परियोजना में काली मिर्च, छोटी एवं बड़ी इलायची, अदरक, हल्दी, जायफल, लौंग, दालचीनी, धनिया, जीरा, सौंफ, मेथी आदि 12 मसाला फ़सलों पर अनुसंधान किए जाने का अधिदेश दिया गया था। मसाला सुधार, उत्पादन, संरक्षण तथा गुणवत्ता पहलुओं पर वर्ष 1996-97 के दौरान 15 राज्यों में स्थापित 15 कृषि विश्वविद्यालयों, 8 स्वैच्छिक प्रतिभागिता केन्द्रों तथा गंगटोक में स्थापित आई० सी० ए० आर० अनुसंधान कांप्लेक्स के 20 समेकन केन्द्रों में परिचालित 80 अनुसंधान परियोजनाओं से प्राप्त अनुसंधान उपलब्धियों का उल्लेख यहाँ किया गया है।

इस परियोजना के अन्तर्गत 53 वैज्ञानिक और तकनीकी कर्मचारी हैं और इसका कुल बजट आठवी योजना में 327 लाख रुपये है और यह राशि भारतीय कृषि अनुसंधान

परिषद एवं राज्य कृषि विश्वविद्यालय द्वारा क्रमश 75:25 दर से बांटी जाएगी।

परियोजनाओं की लक्ष्य प्राप्ति के लिए वन्य और संबन्धित स्पीसीस युक्त जर्मप्लासम संग्रह और मसालों के विदेशी संग्रह में महत्वपूर्ण प्रगति की गयी है।

पन्नियूर में काली मिर्च के 23 नये अक्सशनस जोड़े गए। सिरसी में 19 वन्य और 10 परिष्कृत अक्सशनस का संग्रह किया। चितापल्ली में 4 वन्य अक्सशनस और दापोली में भी 7 अक्सशनस जोड़े गये। PRS-22, PRS-20, PRS-49, Cul 5308, Cul 5843 और Cul 5403 जैसे अक्सशनस पन्नियूर में आशाजनक पाए गए। सिरसी केन्द्र ने सुपारी के साथ मिश्र सस्यन रीति में प्रतिबेल के लिए 200:80:280 ग्राम NPK के दर में दो समान मात्रा में उर्वरक डालने की रीति मानकीकृत की। 0.25 अनुपात में IW/CPE 8-10 दिन के अन्दर एक बार सिचाई करने की रीति मानकीकृत की गयी। पन्नियूर, सिरसी और चितापल्ली में फाइटोफ्तोरा खुर विगलन को नियंत्रित करने के लिए पैकेज के रूप में प्रबन्ध पद्धतियाँ विकसित की गयी। FYM के 5 किलो ग्राम के साथ जैव नियन्त्रण एजेंट जैसे ट्राइकोडरमा विरिडे, प्रतिबेल 50 ग्राम की दर से प्रयोग करने की सिफारिश की गई है। सिरसी और पन्नियूर में क्रमश 1% BM और 0.2% अकोमिन छिड़ककर या खुराक देकर नर्सरी रोगों को नियंत्रित किया जा सकता है।



इलायची के 4 नये संग्रह पांपाडुमपारा में जोड़े गए और Sel-800, CL 679 और SKP-14 जैसे अक्सशनस का परिणाम आशाजनक रहा । मडिगेरी और पांपाडुमपारा केन्द्रों ने क्रमशः प्रति हेक्टर 75:75:150 किलोग्राम NPK और प्रतिहेक्टर 100:100:175 किलोग्राम NPK उर्वरक डालने की सिफारिश की । जबकि इलायची पर लगने वाले कीड़े, उनके अंडों तथा अंकुर को काटने वाले कीटों को मोनोक्रोतोफोस - फोसलोन - फोसलोन के तीन छिड़कावों द्वारा या निंबीसिडाइन जैसे नीम उत्पादों के प्रयोग द्वारा नियंत्रित किया जा सकता है ।

अदरक के पोटांगी में 3, रायगढ़ में 5 और सोलान में 10 नये अक्सशनस जोड़े गये । सोलान केन्द्र ने DDJR-1230, SG-61, BDJR-117, SDJR-1053, SG-711, SG-689, टुरा और PGS-23 जैसे अक्सशनस को राइसोम रोट के प्रति कम संवेदनशील पाया । पोटांगी के V<sub>1</sub>E<sub>8</sub>-2 में राइसोम रोट को रहने की शक्ति देखी गई । सोलान में बीज राइसोम को डिथाइन M-45 (0.25%) + बाविस्टिन (0.1%) में 60 मिनट डुबोकर रखने से थिमेट 10 ग्राम (प्रति हेक्टर 10 ग्राम) के साथ मिट्टी लगाने के बाद कोनटाफ 5E (0.05%) छिड़ककर अदरक के राइसोम रोट को नियंत्रित कर सकते हैं । दापोली में एक घंटे तक प्रतिलिटर 3 ग्राम के दर में रिडोमिल MZ के साथ राइसोम का पूर्व उपचार बहुत प्रभावी पाया गया । पोटांगी केन्द्र प्रति हेक्टर 125:100:100 किलोग्राम के दर में NPK उर्वरक डालने की सिफारिश करता है ।

हल्दी के पांच अक्सशनस जगतियाल में, तीन पोटांगी

में 26 पुंडिबारी में 15 कुमारगंज और 50 अक्सशनस (एक वन्य जाति सहित) रायगढ़ में जोड़े गये । पोटांगी में PTS-43, RH-5, PTS-4, PTS-51, PTS-16, PTS-55, PTS-52, PTS-59 और PTS-52 आदि को आशाजनक पाया गया । जगतियाल में PCT और CL-I जैसे अक्सशनस को कोलेट्रोटाइकम पर्ण चित्ती और राइसोम रोट रहित पाया गया । धोली में कोहिनूर और जी० एल० पुरम पर्ण चित्ती और पर्ण दाग के प्रतिरोध रूप में देखे गये । पोटांगी में PTS-43 पर्ण चित्ती सह्य देखे गये । भवानीसागर में प्रतिलिटर 2 मिली लिटर के दर में मोनोक्रोतोफोस के साथ 15 मिनट राइसोम उपचार करके शल्क कीटों को नियंत्रित किया ।

वृक्ष मसालों में येरकाड और दापोली में दालचीनी के दो अक्सशनस जोड़े गये । इसके अतिरिक्त दापोली में जायफल के 6 और अक्सशनस जोड़े गये । एअर लेयरिंग प्रविधियाँ और उसी तरह पुरुष वृक्षों को बदलना और "कम उपजवाले सीडलिंग वृक्ष" को अधिक उपजवाले बनाने की रीति दापोली में निष्पन्न की गयी । येरकाड में सीधे सांकुरक पर दो पत्तोंवाले प्रकन्द का प्रयोग करने पर जायफल की ग्रॉफिंग सफल रही ।

धनिये के 44 कृष्ट और 40 विदेशी अक्सशनस जोबनर में, 75 गुंटूर में, 40 हिसार में, 32 कुमारगंज में, 28 रायगढ़ में और 23 अक्सशनस कोयंबतूर में जोड़े दिये गये । ATP-77 और JCO-64 जैसे अक्सशनस कोयंबतूर में पूर्व ज़ारी किस्म के रूप में बहुस्थानीय परीक्षण के लिए लिये गये । गुंटूर केन्द्र में LCC-15, LCC-128 और LCC-137 जैसी कुछ जल्दी पकनेवाली

किस्मों की पहचान की गई। कोयंबतूर में 25 अक्तूबर को 30 से.मी.की दूरी पर धनिया बोने से अच्छी फसल हुई जबकि कुमारगंज में 15 अक्तूबर को की गई बुआई से अच्छी फसल प्राप्त हुई। हिसार में DH-36 अक्सशन स्टम गाल के प्रतिरोधी और DH-58 अक्सशन फ्रूट बोरर के प्रतिरोधी देखे गये। जोबनेर में सोलराइज़ेशन उपचार द्वारा पर्ण रोग की संभावना कम हो गई और प्रतिकिलो ग्राम 40 ग्राम के दर से ट्राइकोडेरमा विरिडे के साथ बीज उपचार करने से कोयंबतूर उपज के मुरझाने का स्तर न्यूनतम रहा।

जोबनेर, जगुदान और कुमारगंज केन्द्रों ने जीरे के क्रमशः 14, 45 और 7 नये अक्सशनस जोड़े। JF-29 और EC-279081 जैसे अक्सशनस जगुदान में आशाजनक रहे। EC-232684, EC-243373, EC-243375 और EC-109635 जैसी विदेशी किस्में जगुदान में फुसेरियम म्लानी (विल्ट) की प्रतिरोधी पाई गई। RZ-19 की एक स्वाभाधिक उत्परिवर्ती किस्म UC-227 जोबनेर में म्लानी सह्य रही। जगुदान में जीरे पर किये गये सिंचाई अध्ययन से सूचित होता है कि पाँच बार की सिंचाई जैसे बीज बोते समय, 10, 30, 50 और 70 दिन से बाद करने पर चार बार की सिंचाई की अपेक्षा अधिक उपज मिल सकती है। जोबनेर के अध्ययन से पुष्ट होता है कि ग्वार-जीरा-ग्वार-गोहूँ-ग्वार-सरसों के रूप में तीन साल सस्यावर्तन करने से जीरे के म्लानी रोग को नियन्त्रित किया जा सकता है।

बड़ी सौंफ में जोबनेर, जगुदान, हिसार और कुमारगंज केन्द्रों ने क्रमशः 28, 183, 24 और 11 अक्सशनस

जोड़े। जगुदान में JF-29 किस्म को अत्यधिक आशाजनक पाया गया। हिसार में पूर्वोद्भेद - अपतृण नियंत्रण के लिए प्रति हेक्टर 1.0 किलो ग्राम के दर में पनडिमेतालिन के साथ 50 DAS एक बार निराई करने से उत्तम फल पा गये। हिसार में 0.4 अनुपात में IW/CPE 50 किलोग्राम नाइट्रोजन के साथ प्रति हेक्टर 30 किलोग्राम  $P_2O_5$  सींचने से उच्चतम उपज प्राप्त हुई।

मेथी में गुंटूर, जोबनेर, कुमारगंज, जगुदान और कोयंबतूर केन्द्रों ने क्रमशः 11, 15, 26 और 15 अक्सशनस जोड़े। जगुदान में JF-102, UM-302 और HM-291 जैसी किस्में आशाजनक पाई गईं। कोयंबतूर में CF-390 और CF-464 जैसी दो ह्रस्वकालीन अधिक पैदावार की किस्मों की पहचान की गयी और उन्हें अंगीकृत क्षेत्रीय परीक्षण के लिए जोड़ दिया गया। जोबनेर केन्द्र ने पाया कि UM-143 उसके मूल स्रोत RMt-1 की अपेक्षा शीघ्र पुष्पित (एक हफ्ते के अन्दर) होता है। हिसार में द्वि-लक्ष्य और शीघ्र बढ़नेलायक के रूप में HM-57 की पहचान की गयी। कसूरीमेथी और EC-257566 को जगुदान में चूर्णिल मिल्ड्यू का प्रतिरोधी तथा HM-302, और UM-304 को हिसार में चूर्णिल मिल्ड्यू के सह्य के रूप में देखा गया। कुमारगंज ने उच्चतम उपज (19.44 किंचटल प्रति हेक्टर) के लिए मेथी बोने का समय 20 अक्तूबर निर्धारित किया। कोयंबतूर में किये गये जैवनियन्त्रण अध्ययन से सूचित होता है कि ट्राइकोडेरमा विरिडे (प्रति किलोग्राम 4 ग्राम) के साथ बीज उपचार करने के बाद मिट्टी में नीम की खली (प्रति हेक्टर 130 किलोग्राम) लगाने से मूल विगलन का प्रभाव बहुत कम (4.9%) अंकित किया।

गुणवता की दृष्टि से  $V_1E_8-2$  और  $V_1S_1-8$  जैसे अदरक अक्सशन कम रेशेवाले घटक के रूप में तथा पोटांगी में बेंगारा संयत रेशा घटक के रूप में पहचाने गए । सोलान में BDJR-1177 और ACC-64 जैसे अक्सशनस को उच्चतम ओलिओरसिन (6-65%) युक्त पाया गया । उधिकतम सुगन्धित तेल (2.10%) के लिए SKR और BDJR-1179, अधिकतम सूखे प्राप्ति (23.12%) के लिए SG-685 अक्सशनस की पहचान की गयी ।

सोलन में हल्दी अक्सशनस जैसे PCT-38, PCT-1 मेघा और PTS-16 उच्चतम ओलिओरसिन (15.32%) के लिए तथा PTS-10 अधिकतम सुगन्धित तेल (9.5%) के लिए, PCT-1 मेघा उच्चतम करकुमिन घटक (6.08%) के लिए और PCT-5 अधिकतम सूखे हल्दी (30.6%) के लिए उत्तम पाए गए ।

बीज मसालों में धनिया अक्सशन JCO-64 (0.38%), जीरा अक्सशन UC-233 (प्रति हेक्टर 11 लिटर) और JC-147 (प्रति हेक्टर 10.2 लिटर), बड़ी सौफ अक्सशन UF-125 (प्रति हेक्टर 26.6 लिटर) और UF-134 (प्रति हेक्टर 25.6 लिटर) आदि को जोबनेर केन्द्र में बाष्पशील तेल के लिए आशाजनक पाया गया ।

समन्वित केन्द्रों में गुणवत्तारोपण सामग्रियों के उत्पादन और वितरण पर महत्वपूर्ण कार्य किए गए । इस दौरान काली मिर्च के 2,00,649 मूल लगाए कतरत, इलायची के 10,016 क्लोन, दालचीनी के 50 सीडलिग्स, 22.7

टन अदरक, 32.6 टन हल्दी, 22.32 टन बीज मसाले आदि राष्ट्र के मसाले उत्पादकों को वितरित किये ।

### समाप्त परियोजना

रिपोर्ट अवधि के दौरान 9 अनुसंधान परियोजनाएँ अपना लक्ष्य पूरा करके समाप्त हुई । समाप्त हुई परियोजनाओं का विवरण निम्न प्रकार है ।

इलायची की समाप्त हुई चार परियोजनाएँ खाद अपेक्षाएँ, प्ररोह बेधक के कारण फसल नाश, थ्रिप्स को नियंत्रित करने के लिए छिड़कने की आवश्यकताएँ (ये तीनों मडिगेरी में चालू की गई थी) तथा इलायची में थ्रिप्स और कैप्सूल बोरर के स्वाभाविक और रासायनिक नियंत्रण हैं जो मडिगेरी और पांपडुमपारा में चालू थे ।

अदरक की समाप्त हुई दो परियोजनाएँ पोटांगी और सोलन केन्द्रों में MLT-1991 सीरीस III और अदरक की उच्च पैदावर के लिए राइसोम आकार का मानकीकरण है जो धोली में चालू थी । हल्दी की समाप्त हुई एक परियोजना वह है जिसमें उपज पर स्थान का प्रभाव होता है जो धोली में चालू की गयी थी ।

बीज मसालों पर कार्यरत दो परियोजनाएँ समाप्त हुई जिनमें से एक जीरे के MLT पर जोबनेर, जगुदान तथा हिसार में तथा दूसरी जोबनेर में धनिये की खरपतवार के प्रबन्धन पर थी ।

## S U M M A R Y

The All India Coordinated Research Project on Spices (AICRPS) was initiated in 1971 (IV Plan) with the objective of evolving varieties resistant / tolerant to pests and diseases, standardization of agro-techniques suited to different agro-climatic regions of India, evolving control measures to manage pests and diseases with minimum residual toxicity and developing linkages between different agencies working on Spices Research and Developments.

The 12 mandatory spice crops of the project are Black Pepper, Small and Large Cardamom, Ginger, Turmeric, Nutmeg, Clove, Cinnamon, Coriander, Cumin, Fennel and Fenugreek. The research achievements generated from 80 research projects during 1996-97 in Spices Improvement, Production, Protection and Quality aspects conducted at 20 Coordinating Centres and eight voluntary/participating centres based at 15 Agricultural Universities and one ICAR Research Complex at Gangtok in 15 states of India are highlighted.

The project has a staff strength of 53 Scientists supported by 32 Technical staffs with the total budget of Rs.327 lakhs in the VIII Plan and is shared @ 75:25 basis between ICAR and SAUs.

Substantial progress has been made towards fulfilling the objective of the projects.

In **Black pepper**, 23 new accessions were added at Panniyur. Sirsi collected 19 wild and 10 cultivated accessions. Four wild accessions at Chintapalli and seven accessions at Dapoli were also added. The accessions viz., PRS-22, PRS-20, PRS-49, Cul.5308, Cul.5843 and Cul.5403 have been found promising at Panniyur. The Sirsi centre standardized the fertilizer schedule as 200:80:280 g, NPK vine<sup>-1</sup> in two split doses in a mixed cropping system with arecanut. Irrigation schedule at IW/CPE ratio of 0.25 once in 8-10 days from Dec. to Mar. was standardized. Management practices to control *Phytophthora* foot rot has been developed as a package at Panniyur, Sirsi and Chintapalli. Use of bio-control agents like *Trichoderma viride* @ 50g vine<sup>-1</sup> along with five kg of FYM was recommended. The nursery diseases can be controlled by spraying and drenching with 1% Bordeaux mixture and 0.2% Akomin respectively at Sirsi and Panniyur.

In **Cardamom**, four new collections were added at Pampadumpara and the accessions viz., Sel.800, CL.679 and SKP-14 were identified as promising. The Mudigere and

Pampadumpara centres recommended the fertilizer schedule as 75:75:150 kg NPK ha<sup>-1</sup> and 100:100:175 kg NPK ha<sup>-1</sup> respectively. Cardamom thrips, capsule and shoot borer could be checked by three sprays with monochrotophos-phosalone-phosalone or by neem products like nimbecidine.

In **Ginger**, three new accessions were added at Pottangi, five at Raigarh and 10 at Solan. The Solan centre identified the accessions viz., DDJR-1230, SG-61, BDJR-117, SDJR-1053, SG-711, SG-689, Tura and PGS-23 as less susceptible to rhizome rot and V<sub>1</sub>E<sub>8</sub> - 2 as tolerant to rhizome rot at Pottangi. Seed rhizome dipping with Dithane M-45 (0.25%) + Bavistin (0.1%) for 60 minutes, coupled with soil application of Thimet 10 G (10 kg ha<sup>-1</sup>) followed by spraying with Contaf 5 E (0.05%) controls the rhizome rot of ginger at Solan. At Dapoli, pre-treatment of rhizome with Ridomil MZ @ 3g litre<sup>-1</sup> for one hour was found effective. The Pottangi centre recommends a fertilizer schedule of 125:100:100 kg NPK ha<sup>-1</sup>.

In **Turmeric**, five accessions at Jagtial, three at Pottangi, 26 at Pundibari, 15 at Kumarganj and 50 accessions (including one wild type) at Raigarh were added. At Pottangi, PTS-43, RH-5, PTS-4, PTS-51, PTS-16, PTS-55, PTS-52, PTS-59 and PTS-52 were identified as promis-

ing ones. The accessions viz., PCT and CL-1 were found free from *Colletotrichum* leaf spot and rhizome rot at Jagtial. At Dholi, Kohinoor and G.L. Puram were identified as resistant to leaf spot and leaf blotch. And PTS-43 showed tolerance to leaf spot at Pottangi. Rhizome treatment with monochrotophos @ 2 ml litre<sup>-1</sup> for 15 minutes checked scale insects at Bhavanisagar.

In **Tree Spices**, Yercaud and Dapoli added two cinnamon accessions. Besides this, six more accessions of nutmeg were added at Dapoli. Air layering technique, as well as conversion of male and "poor yielding seedling trees" to high yielders, has been accomplished at Dapoli. At Yercaud, nutmeg grafts have been successful by using orthotropic scions upon two leaved stage root stock

In **Coriander**, 44 cultivated and 40 exotic accessions at Jobner, 75 at Guntur, 40 at Hisar, 32 at Kumarganj, 28 at Raigarh and 23 accessions at Coimbatore were added. The coriander accessions viz., ATP-77 and JCO-64 were advanced to multilocation testing as pre release cultures from Coimbatore. The Guntur centre identified a few early maturing lines viz., LCC-15, LCC-128 and LCC-137. Sowing coriander on 25th October with 30cm spacing gave higher yield at Coimbatore while 15th October sowing resulted in higher yield at Kumarganj. The ac-

cession DH-36 identified to be resistant to stem gall and accession DH-58 found to be resistant to fruit borer at Hisar. Solarization treatment reduced the disease incidence at Jobner and seed treatment with *Trichoderma viride* @ 4 g kg<sup>-1</sup> seed recorded the lowest wilt incidence at Coimbatore.

In **Cumin**, 14,45 and seven new accessions were added by Jobner, Jagudan and Kumarganj centres respectively. The accessions viz., JF-29 and EC-279081 were identified as promising at Jagudan. The exotic entries viz., EC-232684, EC-243373, EC-243375 and EC-109635 were found resistant against *Fusarium* wilt at Jagudan. The entry UC-227 a natural mutant of RZ-19 is tolerant to wilt under Jobner. Irrigation study on cumin at Jagudan indicated that five irrigations viz., at sowing, 10,30,50 and 70 days after sowing gave more yield and on par with four irrigations. Studies at Jobner confirmed that cumin wilt could be controlled by adopting a three year crop rotation viz., cluster bean-cumin-cluster bean-wheat-cluster bean-mustard.

In **Fennel**, Jobner, Jagudan, Hisar and Kumarganj centres added 28, 183,24 and 11 accessions respectively. At Jagudan, the entry JF-29 was identified as promising. For weed control, Pendimethalin @ 1.0 kg ha<sup>-1</sup> as pre-emergence application + one hand weeding at

50 DAS found effective at Hisar. Irrigation at IW/CPE ratio of 0.4 with 50 kg N + 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> resulted in highest yield at Hisar.

In **Fenugreek**, Guntur, Jobner, Kumarganj, Jagudan and Coimbatore centres added 11,15,26 and 15 accessions respectively. The entries viz., JF-102, UM-302 and HM-291 were identified as promising at Jagudan. Two short duration high yielding types viz., CF-390 and CF-464 were identified at Coimbatore and are under final stage of MLT.

Jobner centre identified UM-143 as early flowering (by a week) than its parental source RMt-1. HM-57 a dual purpose and quick growing type as identified at Hisar. Kasurimethi and EC-257566 were resistant to powdery mildew at Jagudan, HM-302 and UM-304 are tolerant to powdery mildew at Hisar. Time of sowing of fenugreek standardized by Kumarganj as 20th October for highest grain yield (1944 Kg. ha<sup>-1</sup>). Bio-control studies at Coimbatore indicated that seed treatment with *T.viride* (4 g kg<sup>-1</sup>) followed by soil application of neem cake (130 kg ha<sup>-1</sup>) recorded lowest root rot incidence (4.9%).

With respect to *Quality*, the **Ginger** accessions V<sub>1</sub>E<sub>8</sub>-2 and V<sub>1</sub>S<sub>1</sub>-8 were identified for low fibre content, and Vengara for moderate fibre content at Pottangi. At Solan two accessions viz.,

BDJR 1177 and ACC-64 were identified for highest oleoresin (6.65%). For maximum essential oil (2.10%) SKR and BDJR-1179, for maximum dry recovery (23.12%) the accession SG-685 was identified.

The **Turmeric** accessions viz., PCT-38, PCT-1 Megha and PTS-16 were identified for high oleoresin (15.32%), PTS-10 for maximum essential oil (9.5%), PCT-1 Megha for highest curcumin content (6.08%) and PCT-5 for maximum dry recovery (30.6%) at Solan.

In **Seed Spices**, the coriander accession JCo-64 (0.38%), cumin accessions; UC-233 (11 litre ha<sup>-1</sup>) and JC-147 (10.2 litre ha<sup>-1</sup>) fennel accessions; UF-125 (26.6 litre ha<sup>-1</sup>) and UF-134 (25.6 litre ha<sup>-1</sup>) were identified as promising for volatile oil yield at Jobner.

The activities on **production and distribution of quality planting materials** from the Coordinating Centres have been substantial. During the period, 2,00,649 numbers of rooted cuttings of black pepper, 10,016 numbers of cardamom clones, 500 numbers of cinnamon seedlings, 22.7 tonnes of ginger, 32.6 tonnes of turmeric, 22.32 tonnes of seed Spices were dis-

tributed to the spice growers in the country

## CLOSED PROJECT

During the period under report, nine research projects were closed as the objectives of the research projects have been fulfilled. The details of the projects closed are follows.

The four projects closed in **Cardamom** are manurial requirement, crop loss due to shoot borer, spraying requirements to control thrips (all these three were in operation at Mudigere) and the cultural and chemical control of thrips and capsule borer in cardamom which was in operation at Mudigere and Pampadumpara.

The two projects closed in **Ginger** are MLT-1991-Series III at Pottangi and Solan centres and standardization of rhizome size in ginger for higher yield which was in operation at Dholi. The one project closed in **turmeric** is the effect of spacing on yield which was in operation at Dholi

The two projects closed in **Seed Spices** are MLT in cumin which was in operation at Jobner, Jagudan and Hisar and weed management of fenugreek at Jobner.

## I N T R O D U C T I O N

The All India Coordinated Research Project on Spices was initiated as a combined Project on Spices and Cashewnut in 1971, with its headquarters at CPCRI, Kasaragod. In order to bestow undivided attention to research on spices, ICAR bifurcated the combined project into two independent projects on Spices and Cashewnut in 1986. The headquarters of AICRPS is at IISR, Calicut.

The AICRP on Spices initiated in 1971 (IV Plan) with four centres and four crops was expanded to 14 centres and 12 spice crops during the V, VI, and VII Plan periods. The activities of AICRPS was further increased during VIII Plan by adding two new centres viz., Dholi in Bihar and Hisar in Haryana States. The spectrum of AICRPS activities was further increased by ICAR by sanctioning four more centres during the current VIII Five Year Plan period. These four centres viz., Dapoli, Pundibari, Raigarh and Kumarganj would be based at the SAUs one each in the States of Maharashtra, West Bengal, Madhya Pradesh and Uttar Pradesh respectively. These four centres would concentrate on pepper, tree spices and seed spices research. The AICRP started during IV Plan with four cen-

tres and four crops would now have 20 centres and 12 crops during the current Plan period. The 12 crops dealt are black pepper, small and large cardamom, ginger, tree spices - clove, nutmeg and cinnamon and seed spices - coriander, cumin, fennel and fenugreek.

### **Mandate**

The objectives of AICRPS are:

- \* Evolving high yielding varieties resistant / tolerant to diseases and pests;
- \* Standardisation of agro-techniques for the crops under different agro-climatic conditions;
- \* Evolving control measures for major pests and diseases; and
- \* Working as inter-face and feed-back between SAUs, Indian Institute of Spices Research and ICAR.

### **History and activities**

The first Workshop on AICRPS was held at CPCRI, Kasaragod in Dec. 1971 wherein the research problems to be tackled under AICRPS



were identified and technical programmes drawn and implemented. Since then the performance of various research programmes under AICRPS was reviewed at the Annual/Biennial Workshops held during the years 1972, '75, '78, '81, '83, '85, '87, '88, '89, '91, '93, '95, and '97. The works of AICRPS for ten years (1982-92) was reviewed by the Quinquennial Review Team and report submitted to ICAR. QRT recommendations are being implemented.

Dr. M C.Nambiar was the first Project Coordinator of the combined Project on Spices and Cashewnut from its inception in 1971 till his retirement in April 1985. Dr.M.K.Nair, Director, CPCRI Kasaragod held additional charge as Project Coordinator during 1985-86. Dr.S. Edison took over as project coordinator (Spices) during March 1986 and continued up to January 12, 1993. Dr. A.K. Sadanandan Principal Scientist took over charge as Project Coordinator for a period of two years from January 1993 to 1995 during the deputation period of Dr.S. Edison to FAO United Nations as Spices Re-

search Expert. Dr. S. Edison took over as Coordinator in January 1995 for a fresh tenure and continued up to July 30, 1997. And Dr. A.K. Sadanandan took over as Project Coordinator since Dr. Edison joined as Director of CTCRI, Trivandrum.

I place on record the great vision and service rendered by Dr.K.V.A. Bavappa, Retd. Director of CPCRI, Kasaragod who has been instrumental in initiating and establishing the host Institute of AICRP on Spices. His interest in the development of spices projects is duly acknowledged. The guidance and support rendered by Dr.M.K. Nair, Director, CPCRI in the activities of AICRPS is gratefully appreciated. The significant contributions made by Dr.S. Edison, Project Coordinator in streamlining the activities of AICRPS is duly acknowledged. The help and assistance rendered by Dr.K.V. Peter, Director, IISR and my colleagues at the Institute in the smooth running of the Project during the period under report is also acknowledged with thanks.

## PROJECT COORDINATOR'S REPORT

**T**he All India Coordinated Research Project (AICRP) on Spices is vested with the mandate to carry out scientific research to develop location specific technology, to augment Spices productivity and quality in the country. Problem oriented research have been carried out in black pepper, small and large cardamom, ginger, turmeric, tree spices (clove, nutmeg and cinnamom) and seed spices (coriander, cumin, fennel and fenugreek). Scientific research on these 12 spice crops are carried out in 20 centres of AICRPS based in 15 Agricultural Universities and one ICAR Centre at Gangtok. The research programmes are carried out under four broad heads, Genetic Resources, Crop Improvement, Crop Production including quality and Crop Protection. The Project Coordinator is based at the Indian Institute of Spices Research, Calicut.

### History

The AICRP on Spices was formulated during IV Five Year Plan (1971) as a combined AICRP on Spices and cashewnut. The first combined Workshop was held at Kasaragod in 1971 and research programmes initiated in four spice

crops (pepper, cardamom, ginger and turmeric) at four centres (Panniyur, Pampadumpara, Mudigere and Solan). During V Plan, Research on Seed spices was initiated and intensified work on ginger by adding five more centres (Jobner, Jagudan, Guntur, Coimbatore and Pottangi). During VI Plan four new centres were added (Sirsi, Vellanikkara, Chintapalli and Yercaud) to further intensify work on pepper, ginger and turmeric. During VII Plan two more centres were added (Gangtok and Jagtial) one for turmeric and the other for large cardamom in Gangtok. During VIII Plan, six new centres one each at Hisar (Haryana), Dholi (Bihar), Kumarganj (Uttar Pradesh), Dapoli (Maharashtra), Raigarh (Madhya Pradesh) and Pundibari (West Bengal) were added to intensify work on seed spices, turmeric and tree spices thus making the total to 20 Research Centres under AICRPS which are based in 15 Agricultural Universities and at Gangtok under ICAR Research Complex in 15 States of India. Workshops were held at Goa (1978), Trichur (1981), Calicut (1983), Trivandrum (1985), Guntur (1987), Solan (1988), Coimbatore (1989), Trivandrum (1991), Trichur (1993) Jaipur (1995) and Bangalore (1997). The Workshop reviewed the progress of research

and depending upon the needs, formulated new technical programmes.

### **Staff and budget**

The staff strength of AICRP on Spices consists of 53 Scientists supported by 32 Technical and supporting/auxiliary staffs making the total to 85. The annual budget was increased from Rs.15.6 lakhs in 1985-1986 to Rs.70.33 lakhs in 1996-97.

### **Research activities**

The AICRP on Spices is vested with the mandate to develop location specific agro-techniques for sustainable Spices production. A multiprong approach is envisaged and research projects formulated to tackle pests and diseases. There are 80 projects and discipline wise distributions are 41 in Crop Improvement (including Genetic resources), 15 in Crop Production, 19 in Crop Protection and 5 in Quality Improvement. The crop wise distribution of projects are pepper 9, small cardamom 7, large cardamom 3, ginger 8, turmeric 8, tree Spices 6, seed Spices 39 (Coriander 10, cumin 13, fennel 9 and fenugreek 7).

### **Genetic Resources**

The 20 AICRPS Centres and eight voluntary/

participating centres have made substantial progress in the collection of germplasm by surveys for indigenous and wild types, exchange of germplasm between the AICRP Centres, IISR, CPCRI, ICRI and NBPGR. The total germplasm assemblage of AICRPS Centres is about 5160.

In **Black pepper** at Panniyur, 22 new accessions were added to the germplasm through NBPGR Regional Station, Vellanikkara, Kerala. The Sirsi centre added 19 wild pepper accessions from Malemane and Devimane ghats/forest areas and 10 cultivated accessions from Sirsi, Siddapur, Honnavar and Kumta Taluks. The Chintapalli centre added new wild collections viz., Maredumilli Acc.No.2 and No.3, Gujjumamidi valsa Acc.No.1 and No.2. The Dapoli centre also collected Panniyur 1,2,3,4 and 5 besides Panchami and Pournami.

In **Cardamom** Pampadumpara centre added five new collections from Idukki District of Kerala.

In **Ginger** Pottangi centre added three more new indigenous ginger accessions from K.Nuagaon and Tikabali of Phulbani district. The new centre Raigarh collected five local accessions while Solan centre added 10 new cultivated accessions.

In **Turmeric** at Pottangi three new accessions were added from Katringia, Phiringia and Tikabali

areas. The Jagtial centre included five entries. The new centres viz., Pundibari, Kumarganj and Raigarh also added 26, 15 and six accessions (including one wild type) respectively.

In **Tree Spices**, Yercaud centre added two more cinnamon accessions while Dapoli collected Acc. 189 and 203 of cinnamon from IISR, Calicut. In nutmeg at Dapoli six more accessions were added during this period.

In **Seed Spices**, Jobner centre added 44 new cultivated coriander accessions and 40 exotic accessions. Seventy five new accessions of coriander were added by Guntur. The Hisar, Kumarganj and Raigarh centres added 40, 32 and 28 new coriander accessions respectively. The Coimbatore centre added 17 local types and six accessions of coriander (three each from Jobner and Hisar). In Cumin, Jobner centre added 14 new accessions, 45 by Jagudan and seven by Kumarganj. In Fennel, Jobner added 28 collections from Sirohi and Tonk areas. Jagudan added 183 accessions, 24 accessions by Hisar and 11 accessions by Kumarganj centre. In Fenugreek Guntur centre added 11 new accessions, Jobner, Kumarganj, Jagudan and Coimbatore centres added 15, 26, 15 and eight accessions respectively.

### **Germplasm Evaluation**

Any crop improvement programme begins

with the evaluation of germplasm as it can provide wide variation for various traits to be studied. Evaluation and cataloguing of genetic resources, therefore is of immense use in the crop improvement programme. Some of the major achievements of AICRPS centres during the year are highlighted below.

The black pepper accession, 'Nilgiris' (PRS-39) at Panniyur registered an yield of six kg (green berries vine<sup>-1</sup> year<sup>-1</sup>) followed by Kumbakodi (4.25 kg) and Karimunda III (4.08 kg). At Yercaud, the highest green berry yield of 1.33 kg vine<sup>-1</sup> was obtained in accession PN-10.

The cardamom MBP accession recorded the highest green capsule yield of 600Kg ha<sup>-1</sup> and maximum number of capsules (3590 clump<sup>-1</sup>). The other promising clones identified are PS-9, Veeraputhran, PS-12, MCC-43, compound panicle, PS-29, PS-10 and PS-7 at Pampadumpara. The Acc. 103, 99, 91, 123, 105, 114, 74, 95, 11 and 101 were found superior in green capsule yield/clump at Mudigere.

The ginger accessions viz., SG-227, SG-554, SG-610, SG-696, SG-54 and SG-638 recorded the maximum rhizome yield under Solan condition. At Pottangi, the accession SG-30 (22.5 t ha<sup>-1</sup>) and V<sub>1</sub>S<sub>1</sub>4 (20.9 t ha<sup>-1</sup>) recorded maximum

rhizome yield. At Raigarh the Acc. RGS-5 performed well.

The accessions of *C. longa*; PTS-12, PCT-8 and PTS-45 registered 42.0 to 52.5 t ha<sup>-1</sup>, *C. aromatica*; CS-53, Chayapasup-1 and CAS-54 gave 28 to 31.0 t ha<sup>-1</sup> while *C. amada*; CAM-2 recorded 41.5 t ha<sup>-1</sup> and have been found to perform well under Pottangi condition. At Solan, the turmeric accessions BDJR-1113, BDJR-1182, BDJR-1169, BDJR-1148, PCS-2, PTS-10 and ST-345 were promising. At Raigarh, CA-56 recorded highest yield (213.7 g plant<sup>-1</sup>) while at Kumarganj, NDH-6 and NDH-2 produced maximum rhizome.

The coriander accessions UD 347, UD 340, UD 262 and UD 294 were identified as promising at Jobner. At Coimbatore, the pre-release cultures viz., JCO-64 and ATP-77 are under MLT. The Coriander var. RCr-20 developed by Jobner has been recommended for heavy soils of Southern and Eastern Rajasthan and has now been released by State Seed Varietal Evaluation Committee. The Guntur centre identified five promising cultures of coriander viz., LCC 177 (1333 kg ha<sup>-1</sup>), LC 128 (1267 kg ha<sup>-1</sup>), LCC 172 (1250 kg ha<sup>-1</sup>), LCC 133 (1200 kg ha<sup>-1</sup>) and LCC 137 (1167 kg ha<sup>-1</sup>). At Dholi, ATP-102, ATP-77, UD-684, UD-685, DH-13, DH-38, DH-48, UD-686

and UD-20 have been identified as promising. At Kumarganj, RD-23, DH-52 and DH-36 were found promising.

At Kumarganj, the cumin accession NDCL-130 was found promising with an yield of 3.1 g plant<sup>-1</sup>.

The fennel accessions viz., HF-102, HF-104, HF-106, HF-110, HF-119, HF-120 and HF-122 were identified as promising at Hisar centre.

At Guntur, the fenugreek accession LFC-74 recorded the highest yield of 1417 kg ha<sup>-1</sup> followed by LFC-77 and LFC-82 with 1367 and 1183 kg ha<sup>-1</sup> respectively. The accessions viz., HM-144, UM-304, HM-110, UM-301 and NDM-3 produced maximum grain yield at Kumarganj

### Disease tolerance/resistance

In **Ginger**, Solan centre identified few accessions viz., BDJR-1230, SG-61, BDJR-1177, SDTR-1053 and SG-711, SG-689 (all local collections) Tura (Meghalaya) and PGS-23 (Pottangi) having less incidence to rhizome rot. An accession V<sub>1</sub>E<sub>8</sub>-2 (EMS mutant of Rudrapur local) is identified as tolerant to soft rot disease at Pottangi.

In **Turmeric**, CLI and PCT cultures are free

from *Colletotrichum* leaf spot and rhizome rot at Jagtial. Kohinoor and G.L. Puram were graded as resistant to leaf spot and leaf blotch disease respectively at Dholi. Variety PTS-43 (Salem selection) of Pottangi also seems to be tolerant to leaf spot disease at Pottangi.

In **Coriander**, the accession DH-36 was found tolerant to stem gall disease and accession DH-58 seems to be tolerant to fruit borer at Hisar. And the accessions UD-475, CS-4 and CS-6 were found resistant to root knot nematode under Jobner condition.

In **Cumin**, the accessions UC 223 and UD 220 recorded the lowest wilt disease incidence of five and 12.5% respectively at Jobner centre while, the exotic cultures EC-232684, EC-243373, EC-243375 and EC-109635 were found resistant against *Fusarium* wilt disease at Jagudan centre.

In **Fenugreek**, the accessions UM-32, UM-117 and UM-128 were found resistant against root knot nematode at Jobner centre. The exotic culture EC-257566 and Kasuri methi were found resistant against powdery mildew under Jagudan condition and UM-143 had lower incidence of powdery mildew at Jobner. At Dholi, the fenugreek accessions, UM-302, UM-9, UM-29, RM-5, J.Fenu-58, J.Fenu. 115, HM-291, CF-

390, Sel.94, Sel.6, UM-30, JM-61, UM-304 and UM-109 were seems to be tolerant against downey mildew.

### Crop improvement

In the intervarietal hybridization programme at Panniyur, the culture 4879 (Uthirankotta Sp.) recorded the maximum (green berry) yield of 9.52 kg/vine followed by Cul. 5089 (Irumanian OP) and Cul.5621 (Kuthiravally OP) recorded the yield of 8.42 kg/vine and 7.38 kg/vine respectively. At Pampadumpara, the highest yield was obtained in Panniyur-2 (890 g/vine) followed by Vellanambu (667 g/vine) and Cul. 239 (435g/vine). At Yercaud, Panniyur-3 has performed well under shevroys with an yield of 950 g green berry/vine. At Ambalavayal, Panchami recorded a higher yield followed by Panniyur-2. At Sirsi, Panniyur-3 continued to show vigorous growth.

The Mudigere centre identified a breeding line with bold and oblong capsule with an yield of 4.0 q. ha<sup>-1</sup>. In the MLT (1988) at Pampadumpara Sel.800 (311.6 g) followed by CL-678 (286 g) were the highest yielders.

At Pottangi, the ginger accession, Vengara gave the maximum fresh rhizome in the IET and in CYT, V, S<sub>1</sub>-8 was the top yielder. At Solan, the collections SNR, SG-670 and BDJR-1267 were

the high yielders. Accession 64 gave the highest yield in the MLT IV with 10 entries at Pottangi and Chintapalli Centres.

At Pottangi, PTS-16 was the high rhizome yielder under IET while TN-1 (long duration) and PTS-8 (short duration) were the high yielders under CYT. In the MLT (1991) PTS-43 was the highest yielder at Pottangi and JTS-2 at Jagtial. In MLT (1996) RH-5 out yielded other varieties at Dholi and Raigarh. Whereas, at Kumarganj Rajendra Sonia gave the highest fresh rhizome yield but was at par with RH-5 and Acc.861. At Chintapalli, BSR-1 recorded the highest yield (11.5 t ha<sup>-1</sup>).

At Yercaud, the epicotyl grafting in nutmeg have been successful by using orthotropic scions upon two leaved stage root stock. The propagation of cinnamon by air layering has been standardized at Dapoli. The standardization of coppice grafting for conversion of male and "Poor yielding seedling trees" in to superior type has been undertaken at Dapoli. At Yercaud, the cinnamon accession Sel.189 gave the highest bark yield (892 g plant<sup>-1</sup>) followed by Sel.53 (880 g plant<sup>-1</sup>) while Acc. 8 ( 0.785 kg dry quills plant<sup>-1</sup>) and Acc. 9 performed better under Thadiyankudisai.

In the IET at Guntur, the coriander acces-

sions LCC-128 recorded the highest yield of 1150 kg ha<sup>-1</sup>. In the CYT at Kumarganj, DH-36 produced the highest seed yield (1925 kg ha<sup>-1</sup>) followed by RD-23, DH-13 and Rajendra Swathi. At Dholi, Rajendra Swathi gave the highest yield of 1917 kg ha<sup>-1</sup> followed by DH-444 and UD-447. At Jagudan, DH-43 was the highest yielder (1748 kg ha<sup>-1</sup>). In the MLT, the entry UD-446 recorded maximum grain yield (1281 kg ha<sup>-1</sup>) at Jobner and LCC-15 (1117 kg ha<sup>-1</sup>) at Guntur. At Hisar, DH-36, UD-446 and DH-48 gave higher yields of 2020, 1850, 1830 kg ha<sup>-1</sup> respectively.

The cumin entry EC 279081 performed superior for yield (870 kg ha<sup>-1</sup>) at Jagudan as evidenced by the four years pooled data. The entries UC 223 (313 kg ha<sup>-1</sup>) and UC-220 (296 kg ha<sup>-1</sup>) were superior at Jobner during the last two years.

At Hisar, the fennel entries, JF-125, UF-125 and HF-104 gave higher yields of 2090, 2040 and 2030 kg ha<sup>-1</sup> respectively. In the CYT at Jagudan, the entry JF-29 gave significantly higher yield (2934 kg ha<sup>-1</sup>). In the IET at Jagudan, JF-200 gave maximum yield.

In the CYT, the fenugreek accession HM-114 at Kumarganj, JF-102 and HM-110 and Rajendra Kanthi at Jagudan performed well. In MLT at Jobner UM-143 performed better with an yield

of 2362 kg ha<sup>-1</sup>.

### Crop production and management

In **Pepper**, Sirsi centre recommended, in a black pepper-arecanut mixed cropping system, application of 200:80:280 g NPK plant<sup>-1</sup> in two equal splits during May-June and Sept-Oct. for higher yield. Studies at Panniyur concluded that irrigation at IW/CPE ratio of 0.25 (100 litres) applied once in 8-10 days during Dec.-Mar. was effective in increasing the yield.

In **Cardamom**, the Mudigere centre recommended a fertilizer dose of 75:75:150 Kg NPK ha<sup>-1</sup> for higher capsule yield (493 kg ha<sup>-1</sup>) and also revealed that the influence of micro nutrients boron and molybdenum had no significant response to yield.

In **Ginger**, spacing at 30x20cm with regular irrigation (especially at sowing) and adopting regular cultural practices resulted in highest yield (31.5 t ha<sup>-1</sup>) at Solan. The Pottangi centre recommended a fertilizer schedule of 125:100:100 Kg of NPK ha<sup>-1</sup> for realizing maximum yield (16.94 t ha<sup>-1</sup>) with cost benefit ratio of 1:1.2.

At Bhavanisagar, the turmeric rhizomes sown during June-July and regular application of fertilizer during 30, 50, 90 and 120 days after plant-

ing besides periodical weeding and timely irrigation gave maximum yield.

Application of *Azospirillum* and Phosphobacteria @ 50 g each in addition to the application of recommended dose of fertilizers registered highest yield in both clove and nutmeg at Yercaud. Drip irrigation @ eight litres of water per day was advantageous in young clove plants.

In **Coriander**, sowing on 25th October with 30cm row spacing resulted in maximum seed yield (2032 kg ha<sup>-1</sup>). And highest seed yield of 1459 kg ha<sup>-1</sup> was recorded by RCr-41 with a seed rate of 16 kg ha<sup>-1</sup> at Jobner.

Higher yield (898 kg ha<sup>-1</sup>) of cumin was obtained with five irrigations viz., at sowing 10, 30, 50 and 70 DAS at Jagudan and was on par with four irrigations.

Irrigation at IW/CPE ratio of 1.0 recorded significantly higher yield in fennel at Jagudan. The weed control at Hisar, recommended Pendimethalin @ 1.0 kg ha<sup>-1</sup> with one hand weeding at 50 DAS followed by Pendimethalin @ 1.5 kg ha<sup>-1</sup> without hand weeding was ideal for production of maximum seed yield. The highest seed yield was obtained at Hisar when irrigated at IW/CPE ratio of 0.4 and fertilized with 50 kg N + 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>.



At Coimbatore, a closer spacing of 15x10 cm and sowing during 5<sup>th</sup> October registered higher yield of fenugreek. Whereas, under Hisar sowing on November 5<sup>th</sup> with a spacing of 30 x 10 cm was effective. At Kumarganj, 20<sup>th</sup> October sowing registered highest yield (1944 kg ha<sup>-1</sup>). At Dholi sowing on 15<sup>th</sup> October with 30 x 10 cm spacing resulted in maximum yield. Application of 40 Kg N and 40 Kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> recorded maximum grain yield of fenugreek (1818 kg ha<sup>-1</sup>) at Jobner condition. Rhizobium inoculum had no significant effect on growth and yield attributes of fenugreek.

### Quality evaluation

The **Ginger** accessions V<sub>1</sub>E<sub>8</sub>-2 and V<sub>1</sub>S<sub>1</sub>-8 were identified for low fibre content and Vengara for moderate fibre content at Pottangi. At Solan two accessions viz., BDJR 1177 and ACC-64 were identified for highest oleoresin (6.65%). For maximum essential oil (2.10%) SKR and BDJR-1179, for maximum dry recovery (23.12%) the accession SG-685 was identified.

The **Turmeric** accessions viz., PCT-38, PCT-1 Megha and PTS-16 were identified for high oleoresin (15.32%), PTS-10 for maximum essential oil (9.5%), PCT-1 Megha for highest curcumin content (6.08%) and PCT-5 for maximum dry recovery (30.6%) at Solan.

In **Seed Spices**, the coriander accession

JCo-64 (0.38%), cumin accessions; UC-233 (11 litre ha<sup>-1</sup>) and JC-147 (10.2 litre ha<sup>-1</sup>), fennel accessions; UF-125 (26.6 litre ha<sup>-1</sup>) and UF-134 (25.6 litre ha<sup>-1</sup>) were identified as promising for volatile oil yield at Jobner.

### Crop Protection

The management practices to control *Phytophthora* foot rot of black pepper has been developed by Sirsi, Chintapalli and Panniyur centres. For the control of nursery diseases, BM (1%) spraying and drenching at 15 to 20 days interval showed less incidence at Sirsi. And at Panniyur, spraying and drenching with 0.2% Akomin followed by spraying and drenching with 1% Bordeaux Mixture reduced *Phytophthora* incidence. The Biological control of *Phytophthora* disease at Sirsi revealed the effectiveness of *T.harzianum*.

To control cardamom thrips, three sprays with monocrotophos-phosalone-phosalone recorded least thrips damage (25.74%) followed by neem (31.77%) and nimbecidin (34.66%). For control of cardamom borer (*Conogethus Punctiferalis*), use of *Xanthopimpla* sp. and a bacterial pathogen registered promising results at Mudigere.

For the control of rhizome rot of ginger, seed rhizome dipping in Dithane M-45 (0.25%) or Bavistin (0.1%) for 60 minutes coupled with soil

application of thimet 10G (10 kg ha<sup>-1</sup>) was effective at Solan. The biocontrol of ginger rhizome rot at Solan revealed that fungicides had additive effect with biocontrol agents like *T.harzianum* and *T.harmatum* in disease control.

The wilt disease of coriander was controlled by seed treatment with *T.viride* @ 4g/kg under Coimbatore condition.

Soil solarization was effective in reducing the cumim wilt disease (31.89%) at Jobner. Crop rotation with cluster bean - cumin - cluster bean - wheat - cluster bean - mustard was also very effective in control of cumin wilt. Basal application of *T.harzianum* in soil and seed treatment with carbendazim and soil application of neem cake reduced the wilt incidence.

Root rot of fenugreek can be controlled by soil application of neem cake (150 kg ha<sup>-1</sup>) and seed treatment with *T.viride* under Coimbatore condition.

### **Planting material production**

Small scale production of elite/nucleus planting material/foundation seeds of improved high yielding varieties are taken up by the AICRPS centres. The AICRPS centres are also participating in the Intergrated Programme for Development of Spices (IPDS) of Government of India, Department of Agriculture and Cooperation. Seed spices centres have Spices Board sponsored programme for the production of foundation seeds of improved varieties of seed spices. The quantity of planting material/seed material produced and distributed under various programmes during the year 1996-97 are 2,00,649 numbers of rooted cuttings of black pepper, 10,016 numbers of cardamom clones, 500 numbers of cinnamon seedlings, 22.7 tonnes of ginger, 32.6 tonnes of turmeric, 22.32 tonnes of seed spices.



**A. K. Sadanandan**  
Project Coordinator

## TECHNICAL PROGRAMME

### 1. BLACK PEPPER

- |       |   |  |
|-------|---|--|
| 1.1   | Germplasm collection, description and evaluation  | Panniyur, Chintapalli,<br>Yercaud and Dapoli                           |
| 1.2   | <i>Inter varietal hybridization to evolve high yielding varieties</i>   | Panniyur   |
| 1.3   | Multilocation trials (MLTs)   |  |
| 1.3.1 | Multilocation trial of pepper genotypes<br>MLT 1987 - Series III  | Panniyur, Sirsi and Chintapalli  |
| 1.3.2 | Multilocation trial<br>MLT 1991 - Series IV   | Panniyur, Pampadumpara, Yercaud,<br>Ambalavayal, Sirsi and Chintapalli |
| 1.4   | Irrigation-cum-fertilizer requirements on pepper and arecanut in a mixed cropping system                              | Sirsi and Panniyur   |
| 1.5   | <i>Phytophthora</i> - foot rot ( quick wilt ) and nematode disease management   | Panniyur, Sirsi and Chintapalli  |
| 1.6   | Biological control of <i>Phytophthora</i> foot rot of black pepper  | Sirsi, Panniyur and Chintapalli  |
| 1.7   | Management of <i>Phytophthora</i> foot rot disease in pepper  |  |
| 1.7.1 | Observational trial for the control of <i>Phytophthora</i> foot rot disease of black pepper in farmers' field         | Panniyur   |
| 1.7.2 | Studies on the control of nursery diseases of black pepper ( solarisation studies for the control of plant diseases ) | Sirsi and Panniyur   |
| 1.7.3 | <i>Phytophthora</i> foot rot incidence with different density of black pepper in arecanut garden                      | Sirsi  |
| 1.8   | Control of scale insects in black pepper  | Pampadumpara   |

1 9	Survey for the incidence of insect pests of black pepper at high altitudes	Mudigere and Pampadumpara
2.	<b>CARDAMON</b>	
2 1	Germplasm collection, description and evaluation	Mudigere and Pampadumpara
2 2	Multilocation trials ( MLTs )	
2.2.1	MLT 1988 - Series II	Mudigere and Pampadumpara
2.2.2	MLT 1991 - Series III with Malabar type	Mudigere, Appangala Sakleshpur and Thadiyankudisai
2.2.3	MLT 1991 - Series III with Mysore type	Mudigere, Appangala, Sakleshpur and Myladumpara
2.3	Hybridisation and selection in cardamom	
2.3.1	Yield evaluation of promising cardamom selections	Mudigere
2 3.2	Evaluation of synthetics	Mudigere
2.4	Effect of fertiliser levels on the yield of cardamom under natural shade	Mudigere
2.5	Influence of micronutrient on the yield of cardamom under natural shade. (Micronutrient requirement studies)	Mudigere and Pampadumpara
2.6	Integrated nutrient management ( organic and inorganic manures ) in cardamom	Mudigere and Pampadumpara
2.7	Pest management in cardamom	
2 7.1	Evaluation of plant based insecticides for the control of thrips and borers in cardamom	Mudigere
2.7.2	Effect of thrips damage on the capsule quality and yield of cardamom	Mudigere
2 7.3	Bio-ecology of natural enemies of major pests of cardamom	Mudigere

### 3. **LARGE CARDAMOM**

- |     |  |         |
|-----|--|---------|
| 3.1 | Germplasm collection, description and evaluation   | Gangtok |
| 3.2 | Comparative yield trial ( 1991 )                   | Gangtok |
| 3.3 | Studies on the leaf spot disease of large cardamom | Gangtok |

### 4. **GINGER**

- |     |   |   |
|-----|---|---|
| 4.1 | Germplasm collection, description and evaluation  | Solan, Pottangi, Pundibari,<br>Kumarganj, Dholi and Raigarh       |
| 4.2 | Initial evaluation trial ( IET )                  | Pottangi and Solan  |
| 4.3 | Comparative yield trial ( CYT )                   | Pottangi and Solan  |
| 4.4 | Multilocation trial<br>MLT 1996 - Series IV       | Pottangi, Kumarganj, Chintapalli,<br>Solan, Pundibari and Raigarh |
| 4.5 | Maximisation trial on ginger                      | Solan   |
| 4.6 | Effect of seed treatment on rhizome rot of ginger | Solan and Dholi   |
| 4.7 | Biocontrol studies on rhizome rot of ginger       | Solan   |
| 4.8 | Evaluation of germplasm for quality               | Solan   |

### 5. **TURMERIC**

- |     |   |  |
|-----|---|--|
| 5.1 | Germplasm collection, description and evaluation  | Solan, Pottangi, Pundibari, Jagtial,<br>Dholi, Kumarganj and Raigarh |
| 5.2 | Initial evaluation trial ( IET )  | Pottangi, Jagtial and Dholi  |
| 5.3 | Comparative yield trial ( CYT )   | Pottangi, Dholi and Jagtial  |
| 5.4 | Multilocation trial<br>MLT 1996 - Series IV   | Pottangi, Dholi, Pundibari, Jagtial,<br>Kumarganj and Raigarh        |
| 5.5 | Survey and identification of disease causing organisms in turmeric and screening of turmeric germplasm against diseases | Dholi and Jagtial  |

5.6	Chemical control of <i>Tapbrina</i> leaf spot disease of turmeric	Jagtial
5.7	Investigation of the casual organism of turmeric rhizome rot disease occurring in N. Telengana Zone	Jagtial
5.8	Quality evaluation of germplasm collection / varieties	Solan
<b>6.</b>	<b>TREE SPICES</b>	
6.1	Germplasm collection, conservation and cataloguing of tree spices viz., clove, nutmeg and cinnamon	Yercaud, Pechiparai, Thadiyankudisai and Dapoli
6.2	Multilocation trial in clove	Yercaud, Pechiparai and Dapoli
6.3	Multilocation trial in cinnamon	Yercaud, Ambalavayal, Thadiyankudisai and Pechiparai
6.4	Vegetative propagation in nutmeg, clove and cinnamon	Yercaud, Thadiyankudisai and Pechiparai
6.5	Drip irrigation in clove and nutmeg	Yercaud
6.6	Biofertilizer trial in tree spices	Yercaud
<b>7.</b>	<b>CORIANDER</b>	
7.1	Germplasm collection, maintenance and evaluation	Jobner, Jagudan, Guntur, Kumarganj, Coimbatore, Hisar, Dholi and Raigarh
7.2	Initial evaluation trial	Jugudan, Guntur, Hisar, Coimbatore and Dholi
7.3	Multilocation trials	
7.3.1	MLT 1993 - Series II	Jagudan, Jobner, Coimbatore, Guntur, Hisar and Dholi
7.3.2	MLT 1996 - Series III	Jobner, Jagudan, Guntur, Dholi and Coimbatore,
7.4	Comparative yield trial of leafy type coriander	Dholi and Coimbatore

7.5	Mutation breeding in coriander to evolve varieties with earliness and resistance to disease	Jobner and Coimbatore
7.6	Response of coriander to date of sowing and row spacing	Jobner
7.7	Response of coriander varieties to seed rate	Jobner
7.8	Survey to study the disease incidence, collection and identification of casual organism	Dholi
7.9	Studies on wilt and powdery mildew management in coriander / Biocontrol of wilt in coriander	Coimbatore
7.10	Quality evaluation in coriander	Jobner
<b>8.</b>	<b>CUMIN</b>	
8.1	Germplasm collection, description, evaluation and screening against diseases	Jobner and Jagudan
8.2	Initial evaluation trial	Jagudan
8.3	Comparative yield trial	Jagudan
8.4	Multilocation trial MLT 1994 - Series II	Jobner and Jagudan
8.5	Preliminary yield trial	Jagudan
8.6	Preliminary row trial	Jagudan
8.7	Mutation studies and hybridisation programmes in cumin	Jagudan
8.8	Irrigation schedules for cumin with reference to yield and blight disease	Jagudan
8.9	Blight disease control by manipulation of Agronomic practices	Jagudan
8.10	Evolving control measures against cumin wilt disease including crop rotation	Jobner
8.11	Integrated management of pests and diseases of cumin	Jobner and Jagudan

8.12	Epidemiological study of <i>Alternaria</i> blight of cumin	Jobner and Jagudan
8.13	Quality evaluation in cumin	Jobner
9.	<b>FENNEL</b>	
9.1	Germplasm collection, description, evaluation and screening against diseases	Jobner, Jagudan, Hisar and Dholi
9.2	Varietal trial in fennel	Jagudan
9.3	Initial evaluation trial	Jagudan
9.4	Preliminary row trial on fennel	Jagudan
9.5	Multilocation trial MLT 1994 - Series II	Jobner and Hisar
9.6	Mutation studies and crossing programmes in fennel	Jagudan
9.7	Response of Rabi fennel to irrigation, nitrogen and phosphorus	Jagudan
9.8	Quality evaluation studies in fennel	Jobner
9.9	Weed control studies in fennel	Hisar
10.	<b>FENUGREEK</b>	
10.1	Germplasm collection, maintenance, evaluation and screening against diseases.	Jobner, Jagudan, Coimbatore, Guntur, Hisar, Dholi and Kumarganj
10.2	Initial evaluation trial ( IET )	Coimbatore and Jagudan
10.3	Multilocation trial	
10.3.1	MLT 1993 - Series II	Coimbatore, Jobner, Guntur, Hisar, Dholi and Kumarganj
10.3.2	MLT 1995 - Series III	Guntur, Jagudan, Coimbatore, Dholi, Hisar, Kumarganj and Jobner



10.4	Evolving varieties resistant to powdery mildew through mutation breeding and crossing programme	Jobner and Jagudan
10.5	Effect of time of sowing and spacing on the yield of fenugreek	Coimbatore, Dholi, Hisar and Kumarganj
10.6	Response of fenugreek to Nitrogen, Phosphorus and Rhizobium cultures	Jobner
10.7	Biocontrol of root rot disease	Coimbatore

Discipline/Crop wise distribution of technical programme of AICRPS in 1996-97					
Crop	Crop Improvement	Crop Production	Crop Protection	Quality Evaluation	Total Projects
Black pepper	3	1	5	-	9
Cardamom	3	3	1	-	7
Large Cardamom	2	-	1	-	3
Ginger	4	1	2	1	8
Turmeric	4	-	3	1	8
Tree Spices	3	3	-	-	6
Coriander	5	2	2	1	10
Cumin	7	1	4	1	13
Fennel	6	2	-	1	9
Fenugreek	4	2	1	-	7
<b>Total Projects</b>	<b>41</b>	<b>15</b>	<b>19</b>	<b>5</b>	<b>80</b>

## List of closed projects 1996 - 97

### **CARDAMOM**

- |   |                           |
|---|---------------------------|
| 1. Manurial experiment / NPK trial<br>in cardamom under uniform shade | Mudigere                  |
| 2. Estimation of loss due to cardmom<br>shoot borer                   | Mudigere                  |
| 3. Determination of number of sprays<br>for thrips control            | Mudigere                  |
| 4. Cultural and chemical control of<br>thrips and capsule borer       | Mudigere and Pampadumpara |

### **GINGER**

- |  |                    |
|--|--------------------|
| 1. MLT 1991 - Series III   | Pottangi and Solan |
| 2. Standardisation of rhizome size in<br>ginger for higher yield | Dholi              |

### **TURMERIC**

- |   |       |
|---|-------|
| 1. Effect of spacing on yield of turmeric | Dholi |
|---|-------|

### **SEED SPICES**

- |   |                           |
|---|---------------------------|
| 1. Multi location trial in cumin<br>MLT 1989 - series I | Jobner, Jagudan and Hisar |
| 2. Response of fenugreek to weed<br>management.         | Jobner                    |

## BLACK PEPPER

### 1.1 Germplasm collection, description and evaluation

*Panniyur, Sirsi, Chintapalli, Yercaud and Dholi*

In the germplasm collection of cultivated types of black pepper, 65 accessions are maintained at Panniyur. During the year (1996-97), 58 accessions flowered and Nilgiris (PRS 39) recorded the maximum green berry yield of 6.0 Kg/vine followed by Kumbakodi (4.25 Kg) and Karimunda III (4.08 Kg). Maximum number of spikes was produced by Nilgiris followed by Kottanadan. Twenty two new accessions were also added to the germplasm collection at Panniyur centre, during the year from NBPGR Regional Centre, Vellanikkara, Kerala.

Seventy cultivated and 20 wild black pepper accessions were collected and maintained at Sirsi. During the period 1995 to 97, wild pepper accessions were collected from Malemane and Devimante ghats forest areas and cultivated accessions from Sirsi, Siddapur, Honnavar and Kumta. Twenty two germplasm accessions were planted in 1995 in arecanut plantation at Sirsi for assessing their performance. Of the 22 germplasm, Munda recorded the maximum mean plant height (164.8 cm), while 'Kuchung' recorded the highest mean number of laterals per vine (13.8) during the second year of growth. Among the cultivars, 'Kumbakodi' recorded the maximum mean leaf length (17.5 cm) and leaf

breadth (13cm).

The Chintapalli centre holds 16 cultivated and 29 wild accessions of pepper germplasm which included four new wild collections viz, Maredumilli Acc. No.2 and Acc.No 3, Gujjumamidi valsa Acc.No. 1 & 2. Among the cultivated types, Panniyur - 1 has recorded the highest yield (3.93 Kg/vine). In the wild collections, Maredumilli accessions recorded maximum yield of 0.46 Kg pepper/vine.

Germplasm holdings at Dholi consists of seven cultivated and one wild indigenous type and their performance are being studied.

A total of 106 black pepper accessions including three wild types are maintained at Yercaud. The cultivated accessions (103) were obtained from IISR (37), RRS, Panniyur (50), Local Hills (14) and from other hilly areas (12). The 45 accessions planted during 1992-93 flowered, the yield and yield characters observed.

### 1.2 Inter varietal hybridization to evolve high yielding varieties

*Panniyur*

In the inter varietal hybridization programmes, 490 OP progenies/hybrids are maintained. The vines vary in age from two to 10 years. During 1996-97, yield was recorded from 190 cultures. In the evaluation, Cul.4879 (Uthirankotta OP) recorded the maximum green berry yield of 9.52 Kg/vine followed by Cul.5089 (Irumanian OP) and Cul.5621 (Kuthiravaly OP) with 8.42 and 7.38 Kg/vine respectively.

### 1.3 Multilocation trial

#### 1.3.1 Multilocation trial of pepper genotypes (MLT 1987-Series III)

*Panniyur, Sirsi and Chintapalli*

To compare the performance of released pepper varieties, the trial with eight cultures/varieties was laid out in 1990 at Panniyur with two checks. During 1996-97, all the entries tested were on par with respect to green berry yield per vine, the highest green berry yield of 2.24 and 2.23 Kg/vine were obtained with Cul.1558 and Cul.5128 respectively.

The trial was laid out at Sirsi as an intercrop in arecanut plantation during 1993 with cultivars viz, Panniyur-1, Panniyur-2, Panniyur-3, Panniyur-5, Uddakare, Karimalligeswara, Cul.856, KS-88 and Subhakara. Among the entries, Panniyur-3 continued to be vigours in growth with maximum plant height (235.6cm) while Panniyur-5 recorded maximum number of laterals per vine (42.8).

#### 1.3.2 Multilocational trial (MLT 1991-Series IV)

*Panniyur, Sirsi, Chintapalli, Yercaud, Ambalavayal and Pampadumpara*

With the objective to evaluate the performance of released varieties of pepper with promising cultivars at different locations, the MLT series IV was laid out at five centres with 14 varieties / cultures.

In the MLT laid out in 1993 (13 cultures/varieties) at Panniyur, none of them showed superiority with respect to green berry yield.

In the trial with 14 varieties/cultures laid out in field during June 1996 at Chintapalli, morphological observations were recorded.

At Ambalavayal, the trial laid out in 1992, all vines came to bearing in 1995. The 1996 crop was harvested during February 1997 and biometrical observations recorded. Panchami recorded the highest green berry yield(1.96Kg) per vine followed by Panniyur-4(1.17Kg).

In the MLT laid out in 1992 (14 treatments) at Pampadumpara, biometrical observations and reaction to pests and diseases were recorded. Fourteen entries are under evaluation in the MLT at Yercaud in which 10 entries have flowered. Among the 10 entries, Panniyur-3 has performed well under shevroy conditions.

#### 1.4 Irrigation - cum - fertilizer requirements on black pepper and arecanut in a mixed cropping system.

*Panniyur and Sirsi*

The irrigation cum fertilizer trial of pepper and arecanut mixed cropping system at Sirsi (laid out in 1992) consisted of three levels of irrigation (main plot) and four levels of fertilizer on Panniyur-1 variety grown on arecanut standards.

*Treatments*

##### **Main plot treatments (Irrigation levels)**

I<sub>1</sub> IW/CPE = 1.00 30mm water (30 l / palm / vine / day)

I<sub>2</sub> IW/CPE = 0.66 20mm water (20 l / palm / vine / day)

I<sub>3</sub> IW/CPE = 0.33 10mm water (10 l / palm / vine / day)

**Sub plot treatments (fertilizer levels)**M<sub>0</sub> ControlM<sub>1</sub> 50:20:70 NPK g / vineM<sub>2</sub> 100:40:140 NPK g / vineM<sub>3</sub> 150:60:210 NPK g / vine

The fertilizer treatments and irrigation were imposed on the three years old vines during May 1995. Recommended doses of fertilizer (100:40:140 NPK g/palm/year) were applied to arecanut. The observations recorded during 1996-97 showed no significant difference with respect to irrigation levels. All the manurial treatments were significantly superior to control with respect to yield of black pepper and arecanut without showing any significant difference among M1, M2, and M3 fertilizer treatments.

**1.5 *Phytophthora* foot rot and nematode disease management in black pepper***Panniyur, Sirsi and Chintapalli*

At Sirsi, the trial was conducted in farmers field with eight treatments for six consecutive years. Neem cake and phorate were applied to all vines for nematode management. The treatments were imposed before the onset of monsoon and repeated 30 days after first application. The results were recorded at monthly intervals for three months commencing from 30 days after imposition of treatments. The results presented in Table-1 revealed that the disease incidence was least (7.78%) in the treatment T-8 (All cultural practices + 1Kg of neem cake + Phorate 3G(30g) + Bordeaux mixture (1%) spray and

Table 1. *Phytophthora* foot rot and Nematode disease management in black pepper at Sirsi

Treatment	% of incidence						Mean (%) of incidence
	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	
T1	20.00	53.33	50.00	56.66	60.00	40.00	46.66
T2	56.67	43.33	33.00	36.66	33.33	26.00	38.16
T3	10.00	26.27	23.33	23.33	26.66	16.00	21.01
T4	23.33	33.33	20.00	23.33	20.00	16.00	22.66
T5	6.67	26.77	20.00	20.00	20.00	13.00	17.74
T6	3.33	20.00	13.33	13.33	16.66	6.60	12.20
T7	10.00	26.77	10.00	13.33	20.00	6.60	14.45
T8	0.00	16.67	6.66	10.00	10.00	3.30	7.78
C.D. (5%)	0.69	1.22	2.48	1.83	1.80	1.33	1.55

drench for first round + second round with Akomin (0.4%) spray and drench + third round with Ridomil MZ-72 WP as spray and drench). This was followed by the treatment T-6 (All cultural practices + Bordeaux mixture (1%) spray and drench as first round and Akomin (0.4%) spray and drench as second round) with the disease incidence of 12.20% as against control (46.7%).

At Panniyur, the trial was conducted (1991-96) with nine treatments (including control). The pooled mean data presented in Table-2 revealed that the treatments T<sub>6</sub> [All cultural practices + 1Kg neem cake + 3g a.i. photatel/vine +

BM spray as first + 0.2% Akomin spray and drench as second round] and T<sub>7</sub> [All cultural practices + 1Kg neem cake + 3g a.i. phorate /vine + BM spray + 0.2% copper oxy chloride drench] recorded minimum defoliation (7.0%), foliar yellowing (4.0 to 4.5%), death of vines (0.07 to 0.13%) and *phytophthora* infection (4.98 to 6.10%). Since the cost of application was less in T<sub>6</sub> than T<sub>7</sub>, T<sub>6</sub>, could be recommended as the most economic treatment.

The new experiment laid out at Sirsi (1996-97) in six locations with five treatments consisting of different fungicides/bio agents + FYM. The

Table 2. *Phytophthora* foot rot and Nematode disease management in black pepper at Panniyur(1991-96)

Treatment	Defoliation	Foliar yellowing	Death of vines	Fungal pollu.
T1	20.5	11.86	2.07( 1.60 )	7.58
T2	15.8	11.30	0.67(1.08)	6.48
T3	9.2	7.5	0.67(1.08)	7.56
T4	11.3	8.5	0.93(1.20)	5.56
T5	9.9	5.8	0.60(1.05)	4.92
T6	7.0	4.40	0.13(0.79)	4.98
T7	7.0	4.50	0.07(0.75)	6.10
T8	9.9	6.40	0.40(0.95)	4.30
T9	11.7	9.40	0.93(1.20)	7.22
CD ( 5% )	2.96	1.49	0.10	NS

Values in parantheses are transformed ones

results presented in Table-3 showed that disease incidence was least (26.79%) in black pepper vine which was sprayed and drenched with Akomin (0.3%) twice viz, before the onset of monsoon as first round and during the month of August as second round.

Three years result at Chintapalli for the management of *Phytophthora* foot rot and nematode disease indicated that all cultural practices plus 1Kg neem cake + 3g a.i., Phorate (soil application) + Akomin (0.3%) could reduce the disease

incidence.

### 1.6 Biological control of *Phytophthora* foot rot of black pepper

*Sirsi, Panniyur and Chintapalli*

Biocontrol studies against the foot-rot disease caused by *Phytophthora capsici* was conducted in pot culture at Sirsi. The trial had treatments with antagonistic organism, fungicides and neem cake. The trial was laid out at Sirsi with 7 treatments ( Table-4 ). The antagonistic organisms

Table 3. *Phytophthora* foot rot disease management in Black pepper at Sirsi (1996-97)

Treatment	Per cent disease incidence
Control	61.74
Bordeaux mixture (1%) spray and Copper oxychloride (0.2%) drench	30.73
Akomin (0.3%) spraying and drenching twice	26.79
Bio agent ( <i>T. viride</i> ) to the base of vine @ 50g and 5Kg FYM/vine	46.80
Akomin (0.3%) spray + Bio agent ( <i>T. viride</i> )	42.87
CD(5%)	2.52

Table 4. Biological control of *Phytophthora* foot rot of Black pepper at Sirsi

Treatment	Per cent disease incidence				Mean
	1993-94	1994-95	1995-96	1996-97 <sup>a</sup>	
<i>Trichoderma viride</i>	46.66	20.00	26.66	33.33	31.66
<i>T. harzianum</i>	20.00	16.66	30.00	40.00	26.66
<i>Laetisaria arvalis</i>	26.66	23.33	33.33	53.33	34.16
<i>Bacillus subtilis</i>	33.33	23.33	33.33	56.66	36.66
Bordeaux mixture (1%) spraying + Copper oxychloride (0.2%) drench	20.00	13.33	16.66	23.33	18.33
Neem cake @ 100g/pot of 3-4 Kg soil	53.33	43.33	56.00	63.33	53.99
Untreated control	80.00	56.66	63.33	73.33	68.33
C.D(5%)	1.26	1.34	2.27	1.86	1.62

were applied to soil along with neem cake before application of infected material. Fungicides viz., Bordeaux mixture (1%) and copper oxychloride (0.2%) were used (as spray and drench). The four years (1993-97) pooled data revealed that among the antagonistic organisms, *Trichoderma harzianum* was effective in reducing the disease incidence (26.7%) as against untreated control (68.3%).

The study at Chintapalli consisting of three treatments viz., *T.harzianum* as soil application + spray, *T.harzianum* soil application alone and drenching with copper oxychloride. The results of the studies at Chintapalli during 1996-97 revealed that least per cent disease incidence was noticed in the treatment with *T.harzianum* as soil application + spray in both sterilized and unsterilized soils.

## 1.7 Management of *Phytophthora* foot rot disease in black pepper

### 1.7.1 Observational trial for the control of *Phytophthora* foot rot disease of black pepper in farmer's field.

#### *Panniyur*

The experiment to assess the effect of chemical and soil amendments on the foot rot disease

of black pepper was modified by including biocontrol agents with treatments comprising soil application of neem oil cake. *Trichoderma harzianum* and Akomin a specific fungicide effective against *Phytophthora* alone and in combination which was compared with the most effective treatment from the previous experiments - Spraying 1% Bordeaux mixture + drenching copper oxychloride and application of 1 Kg neem cake as treatments and untreated check as control. The trial was laid out at two locations viz., at PRS, Panniyur and at Kannothe Estate, Payam, Irritty. The disease incidence was low during the period. The intensity of leaf infection showed no significant difference between treatments.

### 1.7.2 Studies on the chemical control of nursery disease of black pepper (Solarisation studies for the control of plant diseases)

#### *Sirsi and Panniyur*

The experiment was taken up in Sirsi under three different light intensities viz., 7.21 K lux (high), 3.3 K lux (medium) and 0.48 K lux (low) consisting of eight different chemical treatments. Vigorous growth was observed in medium light intensity. Bordeaux mixture (1%) spraying and drenching at 15 to 20 days interval showed less mortality of cuttings (23.33%) when raised un-



der medium light intensity ( Table-5).

Studies at Panniyur revealed that spraying and drenching with 0.2% Akomin followed by spraying and drenching with Bordeaux mixture (1%) reduced the disease incidence. The experiment was later modified by including biocontrol and soil solarization as treatments using biocontrol agents viz., *Trichoderma harzianum* and *T.viride* together with the most effective Bordeaux mixture as treated check and untreated check as control.

### 1.7.3 *Phytophthora* foot rot incidence with different density of black pepper in arecanut garden.

#### Sirsi

The experiment was laid out at Sirsi in 1996-97 with different densities as per treatment viz.,

25, 50, 75 and 100 per cent of the arecanut standard with black pepper variety Malligeswara. The experiment is in progress.

### 1.8 Control of scale insect in black pepper

#### Pampadumpara

The experiment is to be laid out as per the technical programme.

### 1.9 Survey for the incidence of insect pests on black pepper at high altitudes

#### Pampadumpara

The survey is yet to be conducted at different locations of Idukki district in each village (3 gardens) during December 1997 by the Pampadumpara centre.

Table 5. Chemical control of nursery diseases of black pepper at Sirsi

Treatment	Per cent disease incidence				
	1992-93	1994-95	1995-96	1996-97	Mean
Bordeaux mixture (1%) spraying	53.33	43.33	40.00	43.00	44.91
Difolatan (0.2%) spraying	46.66	46.00	50.00	43.00	46.41
Bordeaux mixture (1%) spraying + drenching	40.00	30.00	26.66	23.33	29.99
Difolatan (0.2%) spraying + drenching	33.33	33.33	40.00	36.66	35.83
Chlorothalonil (0.2%) spraying	33.33	40.00	40.00	40.00	42.50
Cheshnut compound drenching	50.00	40.00	46.66	40.00	42.49
Chlorothalonil (0.2%) spraying + drenching	43.33	30.00	33.33	30.00	34.16
Control	43.33	43.33	76.66	66.66	73.33
	76.66	66.66	73.33	56.00	68.16

## CARDAMOM

### 2.1 Germplasm collection, description and evaluation

#### *Pampadumpara and Mudigere*

The Pampadumpara centre holds 91 germplasm accessions consisting of 77 cultivated and 14 wild types. This includes five new local collections and cultivated types made from Pampadumpara area. Altogether 77 types were evaluated and among these 69 types yielded. The highest yield of 547.9 g and maximum number of capsules per plant (3590) was registered by MBP. The high yielding types identified in the evaluation are MBP, S-1, PS-9, Veeraputhran, PS-12, MCC-34, Compound panicle, PS-10 and PS-7.

The intensity of thrips infestation was lowest (9.08%) in Veeraputhran and highest (21.28%) in SL and borer infestation was minimum (0.15%) in PS-9 and maximum (0.58%) in MBP.

A total germplasm holding of 245 accessions are being maintained at Mudigere from 1989 to 1990, restricting the evaluation to 195 collections. The 195 collections planted in 1989 are being evaluated for the agronomic characters for last six years and yield for four years and the promising accessions are being identified. The mean data of six years (1991-97) with respect to yield and yield components were also studied. Among the 195 germplasm accessions

Acc.No.103, 99, 123, 105, 114, 74, 95, 111 and 101 were found superior in green capsule yield/clump. Maximum capsule number/clump was recorded in case of Acc.No.105 (2374), 101 (2263), 76(1782), 93 (1770) and 116 (1376). During the course of evaluation, nine entries have been lost and few additions were made making the collections to about 250.

### 2.2 Multilocation trial (MLTs)

#### 2.2.1 MLT 1988 - Series II

##### *Mudigere and Pampadumpara*

The trial was relaid with 10 accessions at Pampadumpara in 1994 as per the XII AICRPS workshop decision. Vegetatively propagated planting materials were used and the plants came to yield in the last year. The highest yield of 312.68 Kg/ha was obtained in Sel.800. The total number of capsules was also highest (1929) in Sel.800.

#### 2.2.2 MLT 1991 - Series III with Malabar type

##### *Mudigere, Appangala, Sakleshpur and Thadiyankudisai*

As per the XI workshop decision, comparative yield trial of promising cardamom clones (MLT 1991-Series III) with Malabar types consisting of 14 entries was laid out during 1992 at Mudigere, Appangala, Sakleshpur. At Mudigere the trial was vitiated due to monkey menace and

no valid conclusion could be drawn and the conclusion drawn are tentative and hence needs further confirmation. The available results indicated that SKP - 14 is a high yielder.

### 2.2.3 MLT 1991-Series III with Mysore type

*Mudigere, Appangala, Sakleshpur and Myladumpara*

The MLT 1991-Series III with Mysore types consisting of five entries viz, SKP-51 (Sakleshpur) MCC-12, MCC-21, MCC-85 (Myladumpara) and control MCC-61 was laid out at Myladumpara, Mudigere, Sakleshpur and Appangala in 1992 with an additional 'Local control'

The trial at Mudigere was discontinued due to monkey menace.

## 2.3 Hybrization and selection in cardamom.

### 2.3.1 Yield evaluation of promising cardamom selections

*Mudigere*

Polycross nursery was established with promising selected clones of Mudigere and progeny testing was done (1990 to 1993).

### 2.3.2 Evaluation of synthetics

*Mudigere*

Promising progenies were identified and a

new trial for evaluation of synthetics has been laid out with these selections. Further few promising clones were identified as good general combiners from the evaluation of synthetics and they have been used for new experiment. Planting has been done and the study is in progress.

## 2.4 Effect of fertilizer levels on the yield of cardamom under natural shade

*Mudigere*

The trial laid out during 1992 with graded levels of fertilizer under natural shade using clonal material of Mudigere-1. The treatments included are i) 0-0-0, ii) 38-38-75, iii) 75-75-100, IV) 100-100-175 V) 125-125-200 and VI) 150-150-225 Kg NPK/ha.

Effect of fertilizer levels on the yield of cardamom under natural shade revealed that fertilizer levels 75-75-150 Kg NPK/ha significantly increased capsule yield (493Kg green capsules/ha).

## 2.5 Influence of micronutrients on the yield of cardamom under natural shade. (Micronutrient requirement studies)

*Mudigere and Pampadumpara*

The trial was laid out at Mudigere (1992) with seven treatments using micronutrients boron and molybdenum. The influence of micronutrients on the yield of cardamom Mudigere -I under natural shade revealed that response to micronutrients boron and molybdenum did not show any perceptible difference in respect of

capsule yield. The study was taken up at Pampadumpara to study the effect of different levels of boron, zinc and molybdenum on cardamom and to assess the response of cardamom to different methods of application of micronutrients consisting of eight treatments. The results of the study is not reported.

## **2.6 Integrated nutrient management (organic and inorganic manures) in cardamom**

### *Mudigere and Pampadumpara*

The experiment was laid out during 1994 at Mudigere with six treatments. The treatments comprised of different combinations of both organics and inorganic besides 100% organics and inorganic manure. The preliminary result revealed that application of organic and inorganic manures in different proportions did not influence the cardamom yield. The experiment to assess the response of cardamom to higher yield of fertilizer besides application of neem cake was laid out at Pampadumpara (1994) with clones of PV-I with six treatments viz, NPK-000 Kg/ha, 75:75:150 Kg/ha, 100:100:175 Kg/ha, 125:125:200 Kg/ha, 180:180:225 Kg/ha, 75:75:150 Kg/ha + 0.5 Kg. neem cake/plant were imposed in two split doses. The observation on mean height, tillers/clump, panicle/clump, branches/panicle, wet and dry weight of plants were recorded during the current year.

## **2.7 Pest Management in Cardamom**

### **2.7.1 Evaluation of plant based insecticides for the control of thrips and borer in cardamom**

#### *Mudigere*

Five plant based insecticides (Neem cake, Neemark, Nimbicidine, Margolin, NSKE) were compared for their efficiency to control thrips and shoot and capsule borer of cardamom with monochrotophos and phosalone and an untreated check consisting of seven treatments. The plant based insecticides were sprayed thrice in the month of March, May and August. In the insecticide treatments, the first spray was given in the month of March with monocrotophos followed by two sprays of phosalone in May and August. Treatment with three sprays of monochrotophos-phosalone-phosalone recorded least thrips damage (25.74%) followed by neem cake (31.77%) and nimbicidine (34.66%). The incidence of shoot and capsule borer was low and no treatment difference could be seen.

### **2.7.2 Effect of thrips damage on the capsule quality and yield of cardamom**

#### *Mudigere*

The qualitative damage caused to cardamom capsule by thrips were assessed based on the per cent scabbed surface area of capsule. 15% of the harvested and dried capsule had >33% of the surface area scabbed. Observations re-

corded also showed reduction in capsule weight, number of capsules in 100 g, husk weight, number of healthy seeds per capsule and oil content with increased thrips damage.

### 2.7.3 Bio-ecology of the natural enemies of major pests of cardamom

#### *Mudigere*

Documentation of natural enemies of the major pests of cardamom with special reference to cardamom thrips, shoot and capsule borer were studied at Mudigere. Species of spiders in the cardamom ecosystem, larve of *chrysopa* sp. and certain predatory mites were observed to be the predators of thrips. More often weather factors contributes the population build up of the thrips on cardamom.

The larvae of *Conogethus punctiferalis* under field condition is being parasitised by *Xanthopimpla* sp. A bacterial pathogen has been observed under the field conditions which checks the population.

### Closed project

### 2.7.4 Estimation of loss due to cardamom shoot borer (1991-96)

#### *Mudigere*

Estimation of loss due to shoot borer was done by recording observations on the capsule yield loss in healthy and shoot borer affected shoots. A total 120 healthy and damaged shoots were examined in all the three cardamom types viz., Mysore, Malabar and Vazhukka. The number of new shoots and panicles produced/healthy and damaged suckers were also recorded. The capsule yield loss/panicle was to an extent of nearly 40% in all the cardamom types. Reduction in the number of panicle/shoot was also noticed due to shoot borer damage. However, the number of new shoots produced almost remained the same in both healthy and damaged shoots ( Table-6 ).

A true estimation of yield loss was made by recording observations on the number of shoots

Table 6. Effect of shoot borer damage on production of suckers, panicles and yield of cardamom at Mudigere

	Malabar	Mysore	Vazhukka
No. of suckers/shoot			
Healthy	0.23	0.33	0.36
Damaged	0.20	0.53	0.40
No. of panicles/shoot			
Healthy	2.57	1.64	2.63
Damaged	1.96	1.51	1.91
No. of capsules/panicle			
Healthy	33.35	15.70	33.42
Damaged	27.46	10.22	28.73

damaged in one hectare plot. The total number of healthy shoots and the damaged shoots/ha were counted. A total of 16 per cent of the shoots were infested by shoot borer in the plot. The difference in the capsule yield per panicle between the healthy and damaged shoots was to an extent of 8.93 g which was used for computing the yield loss/ha. The estimated yield loss amounted to 79.86 Kg green capsules/ha ( Table 7 ).

germplasm holdings 150 were evaluated and the genotypes SG-30 (22.5 t/ha) and V<sub>1</sub>S<sub>1</sub>-4 (20.8 t/ha) were identified as promising ones.

The Solan centre maintained 166 germplasm, 10 more new collections were also added during the reported year. The collections SG-227, SG-694, SG-610, SG-54, SG-689 and SG-554 recorded the maximum yield during 1996-97.

Table 7. Estimation of capsule yield loss due to cardamom shoot borer

	Healthy shoots	Damaged shoots
Number of suckers	24070	4447
No. of panicles / sucker	2.38	1.98
Capsule yield / panicle	50.53	41.60
Yield loss kg / ha (green)	79.86	

## GINGER

### 4.1 Germplasm collection, description and evaluation

#### *Pottangi, Solan and Dholi*

At Pottangi, three more new cultivated ginger accessions were collected from K.Nuagam and Tikabali of Phulbani district making the total germplasm collections to 158. It includes three exotic and two wild collections. Of the 158

The Dholi centre maintained 26 accessions and were screened against rhizome rot caused by *Pythium* and *Fusarium* sp. No accession was found to be resistant to the disease.

### 4.2 Initial Evaluation Trial

#### *Pottangi and Solan*

Sixteen promising entries were evaluated under the new IET at Pottangi during the year

1996-97. Vengara (21.88 t/ha) and Raigarh (18.15t/ha) were the top yielders which produced significantly higher yield than Suprabha.

An IET (1996) laid out with 16 cultures along with check (SG-666) at Solan. Significant difference observed for yield per plot. However, none of the cultures out yielded the check variety. Cultures SG-674 and SG-699 were statistically at par with SG-666.

#### 4.3 Comparative yield trial

##### *Solan and Pottangi*

The CYT (1995) with five accessions with check (SG-666) were evaluated at Solan centre during the year 1995-96. In the two years yield performance, SG-682 gave the highest yield of 13.6 t/ha and was almost at par with the check SG-666 (12.6 t/ha)

A new CYT (1996-97) with six collections along with check SG-666 was laid out at Solan for the first year. Significant difference were observed for yield. Accession SNR recorded the highest yield of 23.3 t/ha and was on par with the check SG-666 (21.7 t/ha).

In the new CYT (1996-97) with six cultures evaluated at Pottangi for the first year, the top yielders were  $V_1E_8-2$  (18.63t/ha) and  $V_1S_1-8$ (16.04 t/ha)

#### 4.4 Multilocation Trial MLT 1996 - Series IV

##### *Solan and Pottangi*

The MLT 1996 Series IV with six entries viz.,  $V_1S_8-2$  and  $V_3S_1-8$  from Pottangi,  $V_1S_1-8$  from Jagtial, SG-554 from Solan Acc.64 from IISR were laid out at Pottangi and Solan for the first time. Among the cultivars, the top yielders were  $V_1E_8-2$  (15.97 t/ha) and SG-554 (13.93 t/ha) than the Suprabha (13.54 t/ha) at Pottangi. The trial did not perform well at Solan centre due to the late receipt of the seed rhizomes from the participating centres.

#### 4.5 Maximization trial on ginger

##### *Solan*

As per the decisions taken at the XIII Workshop, Jaipur maximization trial in ginger was laid out at Solan with the variety Himgiri. Ginger rhizomes were planted in a plot comprising 12 x 1M at a spacing of 30 x 20 cm in 1996. Besides the recommended practices, regular irrigation schedule especially after sowing was followed to ensure better germination. Rhizome yield to the tune of 62.0 Kg/plot was recorded which gave a converted yield of 31.15 t/ha.

#### 4.6 Effect of seed treatment on rhizome rot of ginger

##### *Solan and Dholi*

A seed treatment experiment with six differ-

ent fungicides was conducted at Solan. The results presented in Table - 8 confirmed that the combination of seed treatment with Dithane M-45 (0.25%) and Bavistin (0.1%) for 60 minutes along with soil application of Thimet 10G (10 Kg ha<sup>-1</sup>) gave best results in increasing seed germination and yield as well as decreasing the incidence of rhizome rot of ginger.

Another experiment conducted at Solan to study the effect of duration of dipping (0, 15, 30, 60 and 90 minutes) seed rhizome in a combination treatment of Dithane M-45 (0.25%) and Bavistin (0.1%) on germination and rhizome rot incidence and yield of ginger. The results indicated that 60 minutes dip duration with a combination treatment to seed rhizome was quite effective in increasing the seed germination and yield, as well as decreasing the incidence of rhizome rot.

The effect of fungicidal seed dip treatment using four fungicides and their combinations (six treatments) was studied at Dholi. The minimum soft rot disease incidence caused by *Pythium* was observed in seed dip treated with Ridomil MZ (3g lit.<sup>-1</sup> of water) for one hour followed by the treatment consisting of Indofil M-45 (2 g/l) and Bavistin (1 g/l).

#### 4.7 Biocontrol studies on rhizome rot of ginger

##### Solan

Studies were initiated in 1994 at Solan on the effect of seed treatment/soil application of biocontrol agents and in combination with seed treatment of fungicides (six treatments) against the ginger rhizome rot disease. It was found that fungicides had additive effect with biocontrol agents like *Trichoderma harzianum* and

Table 8 Effect of seed treatment on rhizome rot of ginger (1996)

Treatment	Germination (%)	Rhizome rot (%)	Yield	
			(kg/ 3m <sup>2</sup> )	(t/ha)
Celest IDS/WS (0.25%)	65.50	8.00	3.00	10.00
Aureofungin 46.15% sp. (200ppm)	61.30	8.00	3.30	11.00
Contaf 5E (0.05%)	70.58 <sup>b</sup>	5.30 <sup>b</sup>	3.90 <sup>b</sup>	13.00
Captan (0.25%)	67.44	7.50	3.40	11.30
Antracol (0.25%)	67.44	7.50	3.40	11.30
Dithane M-45 (0.25%) + Bavistin (0.1%) + Thimet 10 G (10 kg / ha) as soil application	82.57 <sup>a</sup>	2.50 <sup>a</sup>	4.20 <sup>a</sup>	14.00
Control	62.46	12.30	2.00	6.70
CD (5%)	2.61	--	0.229	



*T.hamatum* in controlling the disease as well as increasing the seed germination and yield of ginger. ( Table-9 )

Maximum essential oil (2.1%) was recorded in SKR and BDJR-1179. The dry matter recovery was highest (23.12%) in SG-683.

Table 9. Biocontrol of rhizome rot of ginger

Treatment	Concentration (%)	Germination (%)	Disease incidence (%)	Yield ( kg / 3m <sup>2</sup> )	( t / a )
T <sub>1</sub> - THR	0.15 (ST)	73.50	8.20	2.75	9.17
T <sub>2</sub> - THM	0.15 (ST)	63.70	8.20	2.8	9.33
T <sub>3</sub> - Indofil M-45 + Bavistin	0.25 (ST) + 0.10 (ST)	71.40	7.00	2.95	9.83
T <sub>4</sub> (T <sub>1</sub> +T <sub>3</sub> )	0.15 (ST) + 0.25 + 0.1 (ST) + 250g / 3m <sup>2</sup>	79.80 <sup>a</sup>	2.90 <sup>a</sup>	4.75 <sup>a</sup>	15.83
T <sub>5</sub> (T <sub>2</sub> +T <sub>3</sub> )	0.15 (ST) + 0.25 + 0.10 + 250 g / m <sup>2</sup> (SA)	72.80	3.00	4.52 <sup>a</sup>	15.10
T <sub>6</sub> (Control)		70.70	7.40	3.42	11.40
CD (5%)				0.54	

THR = *Trichoderma harzianum*

THM = *T. hamatum*

#### 4.8 Evaluation of germplasm for quality

##### Solan

Forty six samples of ginger were analysed for quality attributes viz., oleoresin, essential oil and dry matter content. Among the accessions, two collections viz., BDJR-1177 and Acc. 64 recorded the highest value of oleoresin (6.65%).

## TURMERIC

#### 5.1 Germplasm collection, description and evaluation

*Pottangi, Solan, Jagtial, Dholi, Pundibari, Kumarganj and Raigarh*

The Pottangi center collected three more

cultivated types from Katringia, Phiringia and Tikabali of Phulbari district making the total collections to 200 consisting of 178 cultivated and 22 wild related species. Out of the 200 accessions, 173 were evaluated. Among 153 accessions of *C. longa*, PTS-12, PCT -8 and PTS-45 (42.0 to 52.5 t/ha); among the 17 accessions of *C. aromatica*, CAS -53, Chayapasup -1, CAS-54 (28.0 to 31.0 t/ha), among the three accessions of *C. amada*, CAM-2 (41.5 t/ha) were found promising.

One hundred and eighty five turmeric collections are being maintained at Solan and majority of them are local collections and the top yielders are BDJR-1113, BDJR -1182, BDJR -1169, BDJR -1182, BDJR-1148, PCS-2, PTS-10, ST-345 and PTS-7.

The 56 germplasm collections maintained at Dholi includes local as well as varieties from different states of India.

At present, 188 genotypes are being maintained at Jagtial. Based on duration, the collections are grouped into long, medium and short duration types.

## 5.2 Initial evaluation trial

### *Pottangi and Dholi*

An IET with 15 cultivars viz. PTS -34, PTS-46, PTS-16, PTS-6, PTS-13, PTS-29, PTS-4, PTS-47, PTS-27, T.No.3, PTS-51, PTS-50, PTS-37, Allepey (Check), Roma (check) was laid

out at Pottangi.

Among the 15 cultivars, PTS-4 (30.81 t/ha.), PTS-51 (27.88 t/ha) and PTS-16 (26.93 t/ha.) were the top yielders.

In the IET of 10 cultivars at Dholi, Rajendra Sonia (check) out yielded (38.65 t/ha) in comparison with RH-24, RH-57, N-24, Chaya puspa, Vontimeeta and Kodur.

## 5.3 Comparative yield trial

### *Pottangi, Dholi and Jagtial*

The new CYT with six accessions in each of long and short duration types was laid out at Pottangi. Among the long duration types, significantly higher yield was obtained by PTS-55 (20.77 t/ha), PTS-43 (17.09 t/ha), PTS-62 (16.88 t/ha) and Turmeric No.1 (16.88 t/ha). Among six short duration types, PTS-59 (28.82 t/ha) and PTS-52 (20.61 t/ha) were the top yielders.

A CYT with seven entries was initiated in 1996-97 at Dholi centre. The check (Rajendra sonia) out yielded (39.99 t/ha) in comparison with PCT-8 (26.73 t/ha) and PCT-11 (21.87 t/ha).

A CYT with short/long and medium duration turmeric varieties were evaluated for growth and yield characters at Jagtial (1996-97) to identify high yielding types. Out of seven long duration entries tested, JTS-6 gave significantly higher yield (33.6 t/ha) followed by JTS-8 (30.22 t/ha) while the check (Duggirala) recorded 29.44 t/ha

of fresh rhizomes. Out of 13 entries tested under intermediate duration group, significantly higher yield recorded in JTS-313 (29.22 t/ha) followed by JTS-303 (26.99 t/ha) while check (CLI 317) recorded 18.88 t/ha of fresh rhizomes.

Among the seven entries tested under short duration types, JTS-602 has given significantly higher yield (25.25 t/ha) followed by JTS-601 (23.47 t/ha) while, the check (PCT -13) gave 19.24 t/ha fresh rhizomes.

#### 5.4 Multilocation trial MLT 1996-Series IV

*Pottangi, Dholi and Jagtial*

The MLT 1996 series IV with ten cultivars viz., RS-5, Rajendra Sonia (Bihar), PTS-12, PTS-62, Roma (Pottangi), Acc. 360 and 361 (IISR), JTS-1, JTS-2 (Jagtial) was laid out at Pottangi, Dholi and Jagtial centres.

At Pottangi, PTS-43 and RH-5 registered highest yield during the first year in the evaluation of 10 entries. In the MLT with nine entries at Dholi, the data observed that RH-5 and Rajendra Sonia were the best for different characters studied. RH-5 yielded 47.3 t/ha followed by Rajendra Sonia (42.3 t/ha) and other entries did not show any significant difference in yield.

Out of 10 entries tested at Jagtial, significantly higher yield was recorded in JTS-2 (39.0 t/ha) followed by JTS-1 (32.7 t/ha), Duggirala

(30.3 t/ha) and Rajendra Sonia (25.7 t/ha).

#### 5.5 Survey and identification of disease causing organism in turmeric and screening of turmeric germplasm against disease.

*Dholi and Jagtial*

A survey was conducted by Dholi centre in the turmeric growing areas of N. Bihar and disease samples were collected and the casual organism was identified and isolated. It was observed that leaf blotch incidence was more serious in comparison with the leaf spot in all the districts surveyed.

Fifty six turmeric germplasm accessions at Dholi were screened against disease and out of which only Kohinur and G.L. Puram were graded as resistant against leaf spot disease caused by *Taphrina maculans*. The cultivar Kodur was graded as highly resistant and G.L. Puram as resistant to leaf blotch disease caused by *Colletotrichum capsici*.

The turmeric germplasm at Jagtial was evaluated against foliar disease viz. *Colletotrichum Taphrina* and rhizome rot. The results showed that majority of CLI and PCT cultures were susceptible to *Colletotrichum* leaf spot and rhizome rot. Out of the 124 germplasm evaluated, 30, 91 and 120 lines were free from *Taphrina*, *Colletotrichum* and rhizome rot incidence respectively.

## 5.6 Chemical control of *Taphrina* leaf spot disease of Turmeric

*Jagtial*

An experiment to control leaf spot disease using seven fungicides viz. Difenconazole (0.1%), Propiconazole (0.1%), Ketazin (0.1%), Mancozeb (0.1%), Carbendazim (0.1%), Copper-oxychloride (0.3%) and Bordeaux mixture (1%) was laid out at Jagtial. Lower percentage of disease index was registered with Difenconazole followed by Propiconazole. However, the result obtained was not significant for different fungicides applied. The mean fresh rhizome yield and net incremental cost: benefit ratio was higher in Carbendazim treatment followed by Mancozeb.

## 5.7 Investigation of the casual organism of turmeric rhizome rot disease occurring in N. Telengana zone

*Jagtial*

The etiology of Turmeric rhizome rot disease was studied at Jagtial. The fungus *Pythium* sp. and *Fusarium* sp were isolated from root and rhizome of diseased plants.

## 5.8 Quality evaluation of germplasm collection / varieties

*Solan.*

Thirty five turmeric samples were analysed for quality attributes at Solan. The highest curcumin (6.08%) and oleoresin(15.32%) con-

tent were observed in PCT-1 Megha. The essential oil was maximum (9.5%) in PTS-10 and maximum dry recovery (30.5%) in PCT-5.

## TREE SPICES

### 6.1 Germplasm Collection, Conservation and Cataloguing of tree spices viz., Clove, Nutmeg and Cinnamon

*Yercaud, Thadiyankudisai, Pechiparai and Dapoli.*

A total of 13 elite clove lines were identified by Yercaud centre from traditional clove growing areas viz., Courtallam, Nagercoil, and Kallar. The progenies of those lines were planted in the field(1993-94) and have been established well. The germplasm collection of cinnamon consisted of 10 accessions of *C. verum* (nine from IISR and one from HRS, Thadiyankudisai) and one accession of *C. cassia* (collected from Anamalai Hills) and are being maintained for evaluation at Yercaud. In allspice, two more accessions were collected making a total of five accessions at Yercaud, which includes one variegated type also.

Under germplasm collection in clove 14 high yielding selections from IISR and seven local estate collections, are under evaluation at HRS, Pechiparai. The growth characteristics of the trees were recorded and all the selections are in the pre-bearing stage. Under the nutmeg germplasm collection, four grafts of IISR selection along with one selection from SHF,

Courtallam(planted in September 1991) and seven other high yielding types collected from Kanyakumari district( May 1994) are under evaluation at Pechiparai. They are in pre-bearing stage and growth observations were continued in all the 12 types. The germplasm collection of cinnamon constituted of 12 selections (which includes nine elite lines from IISR and three local estate collections) planted at Pechiparai during September 1991 and 1994 are progressing. Among these types, selection 63 has shown maximum plant height(539 cm), maximum stem girth(33 cm) with maximum branches(27 nos.) All the types flowered and the trial is in progress.

The germplasm of nutmeg consisted of six accessions (planted during September 1996) at Dapoli and the growth performances are being studied. A survey conducted by the centre during the current year, around Dapoli Tahasil and five elite types have been identified based on their yield and quality. Under Cinnamon, four accessions viz., Konkan Tej, Sel.5(RCRS,

Ratnagir) and ACC.No. 189 and Acc.No. 203 (IISR, Calicut) have been planted during 1991 and 1996 respectively are being evaluated.

## 6.2 Multilocation trial in clove

*Yercaud and Pechiparai.*

Six clove accessions viz., Sel-1,2,3,4,5 and Kallar local are under evaluation at Horticultural Research Station at Yercaud. The growth parameters were recorded periodically and among them Sel-1 has performed well which showed vigorous growth.

## 6.3 Multilocation trial in cinnamon

*Yercaud, Ambalavayal, Thadiyankudisai and Pechiparai*

The MLT with five elite lines (from IISR, Calicut) was laid out during 1992 in all the four centres. Coppicing of the plants were done and the data recorded during September 1996 for the first time from different accessions at Yercaud are presented in Table-10 .

Table 10 Multilocation trial in cinnamon

Selection	Mean fresh leaf yield (kg)/tree	Mean wet bark yield (g)/tree
Sel. 44	3.600	562
Sel. 53	2.400	880
Sel. 63	2.100	455
Sel 189	3.200	892
Sel 203	3 420	674

At Ambalavayal, five accessions from IISR along with Acc. No.1 and 2 of RARS, Ambalavayal were added in the MLT laid out during 1992. The biometric observations were recorded and plants are coming up well. The trees were coppiced during May 1996.

#### 6.4 Vegetative propagation in Nutmeg, Clove and Cinnamon

*Yercaud, Pechiparai and Thadiyankudisai*

Epicotyl grafting techniques in nutmeg at different stages of scion and root stock were carried out at Yercaud to standardise maximum success through wedge grafting. The fresh shoots collected from orthotrophic and plageotrophic were used as scion materials. The root stocks used were with two, four and six

leaved stages. The maximum success of 50.0 and 48.0% were recorded in two leaved stage root stock in both orthotrophic and plageotrophic scions respectively.

#### 6.5 Drip irrigation in Clove and Nutmeg

*Yercaud.*

The drip irrigation experiment in clove laid out at Yercaud during July 1992 consisting of five irrigation treatments ( identified for per-bearing age upto the seventh year). The drip system was installed and was in operation since March 1994. Observations on growth parameters were taken during May 1997 and are presented in Table-11. Among the treatments, dripping of eight litres of water per day recorded maximum plant height (209.0 cm ) and number of branches per plant (48.0 nos.).

Table 11 Drip irrigation studies in clove at Yercaud

Treatment	Mean plant height (cm.)	Mean No. of branches/plant
T <sub>1</sub> -Dripping of 2 lits of water/day/plant	189	33.2
T <sub>2</sub> - " 4 lits "	198	35.0
T <sub>3</sub> - "6 lits "	203	39.6
T <sub>4</sub> - " 8 lits "	209	48.0
T <sub>5</sub> - Pot watering 8 lits "	150	23.2

## 6.6 Biofertilizer trial in Tree spices

### Yercaud

#### Clove

An experiment with biofertilizers (*Azospirillum* and phosphobacteria) and organic fertilizers was conducted in 15 years old clove trees at Shevroys by the Yercaud centre. Inorganic and biofertilizers were applied in two split

doses during June and September. The results presented in Table-12 indicated that among the different treatments, application of the recommended dose of fertilizers (100 Kg FYM, 400 g N, 350 g P<sub>2</sub>O<sub>5</sub> and 1200 g K<sub>2</sub>O /tree/year) with *Azospirillum* and phosphobacteria (50 g each/tree/year) recorded the highest green bud yield of 3.51 and 3.97 Kg/tree/year in 1995-96 and 1996-97 respectively. The other growth charac-

Table 12. Growth and yield attributes in clove

Treatment	Mean tree girth (cm)		Annual increase in tree girth (cm)		Mean No. of buds/cluster		Mean 100 bud weight (g)		Mean green bud yield (Kg)	
	95-96	96-97	95-96	96-97	95-96	96-97	95-96	96-97	95-96	96-97
T <sub>1</sub> -Control (50 g FYM + 50 g bone meal)	28.63	30.25	2.12	1.62	6.8	7.0	19.6	18.7	2.12	2.30
T <sub>2</sub> -100 Kg FYM+ 400 g N 350 g P and 1200 K <sub>2</sub> O/tree/year	30.72	31.76	2.50	1.04	6.9	7.3	21.8	21.7	2.98	3.52
T <sub>3</sub> - T <sub>2</sub> +50 g each of <i>Azospirillum</i> and phosphobacteria/tree/year	33.22	35.50	4.94	2.2	7.6	7.8	21.6	21.9	3.51	3.97
T <sub>4</sub> - 75% of T <sub>2</sub> +50 g each of <i>Azospirillum</i> and phosphobacteria/tree/year	31.84	33.52	3.48	1.68	7.4	7.5	20.7	21.0	2.76	3.67
T <sub>5</sub> - 50% T <sub>2</sub> +50 g each of <i>Azospirillum</i> and phosphobacteria/tree/year	30.10	32.00	2.23	1.90	7.0	7.2	19.5	20.6	2.70	3.55
CD(5%)	NS	1.52	—	—	0.36	0.31	0.29	0.28	0.20	0.21

Table 13. Growth and yield attributes in Nutmeg at Yercaud

Treatment	Mean tree girth (cm)		Annual increase in tree girth (cm)		Mean fruit weight (g)		Mean fruit yield (numbers)	
	95-96	96-97	95-96	96-97	95-96	96-97	95-96	96-97
T <sub>1</sub> -control (50 kg FYM +5 kg bone meal)	38.5	44.8	5.00	6.3	60.3	64.3	328.6	421.5
T <sub>2</sub> -100 g FYM+NPK 400. 300 and 1200 g / tree / year	42.9	50.2	8.6	7.4	65.7	69.7	472.7	555.0
T <sub>3</sub> -50% of T <sub>2</sub>	40.3	47.4	6.3	7.1	67.5	69.5	402.5	465.5
T <sub>4</sub> - T <sub>2</sub> + 50 g in each of <i>Azospirillum</i> and phosphobacteria	45.3	36.7	10.6	6.6	74.1	70.4	528.0	620.5
T <sub>5</sub> -T <sub>3</sub> +50 g in each of <i>Azospirillum</i> and phosphobacteria	30.1	36.7	4.6	6.6	68.4	70.4	483.2	543.0
CD (5%)	1.14	1.57	—	—	1.12	1.35	12.30	13.75



ters were also maximum in the same treatment. The soil microflora also showed positive trend in the plots received *Azospirillum* and phosphobacteria.

### Nutmeg

A similar experiment was conducted in one to five years old nutmeg at Yercaud. The treatmental details are in the Table-13. The two years result indicated that the application of 100 Kg FYM, 400 g N, 300 g P<sub>2</sub>O<sub>5</sub> and 1200g K<sub>2</sub>O / tree/year along with 50g in each of *Azospirillum* and phosphobacteria recorded the maximum yield of 528.1 and 620.5 fruits per tree per year during 1995-96 and 1996-97 respectively. The population dynamics of the soil microflora also increased after 60 days of application of the bacterial inoculants.

## CORIANDER

### 7.1 Germplasm collection maintenance and evaluation

*Jobner, Jagudan, Coimbatore, Guntur, Dholi and Hisar*

The Jobner centre maintains a total of 730 coriander accessions which includes 105 exotic collections. In the evaluation of 97 accessions, nine accessions performed better in yield than check (Rcr-41). The promising accessions identified are UD-347, UD-340, UD-262, UD-294. Based on different characters the germplasm accessions were also classified.

The stem gall disease in coriander appears in a serious form at Danta (Sikar) as well as Baramur, Jhalawar and Kota districts of Rajasthan. Thirty seven germplasm entries of coriander were tested against stem gall disease caused by *Protomyces macrosporus* by the Jobner centre. The screening was continuously undertaken at farmers' field in Danka (Sikar). The variety Rcr-41 was continuously found to be tolerant and other were susceptible to the disease. Eleven entries of coriander were also screened against root knot nematode (*M.incognita*) in the field at Durgapura. The accessions UD-475, CS-4 and CS-6 were found resistant while UD-373 was highly susceptible at Jobner.

The coriander variety Rcr-20 (UD-20) developed by Jobner centre which has been recommended for release during the XIII workshop of ATCRPS (Jaipur), has now been released by the State Seed Varietal Evaluation Committee meet on Oct. 10-11, 1996. The variety has been recommended for heavy soils of Southern and Eastern Rajasthan including Kota, Baran, Jhalawar and Bundi areas of the state.

The Jagudan centre had a total of 166 entries consisting of 26 exotic and 140 indigenous accessions in coriander. The centre has retained 53 accessions from 166 collections evaluated. None of the seven tested cultivars was found either resistant or tolerant against powdery mildew disease as well as root knot nematodes in the screening at Jagudan.

The Coimbatore centre is maintaining a total of 182 coriander accessions. During the period three accessions each from Jobner and Hisar were added to the germplasm. All the accessions were evaluated and the highest yield among the accessions was registered in CS-89 and CS-102. The pre-release cultures viz, Jco-64 and ATP-77 are under MLT in Tamil Nadu.

Local surveys conducted by the Guntur centre in the predominantly coriander growing areas of the state (Prakasam, Kurnool, Cuddupah, Ananthapur) in collaboration with NBPGR, RC Hyderabad resulted in 110 coriander collections. The centre at present holds 235 coriander accessions including five exotic accessions. Seventy five collections have been evaluated during the period and LCC-177 recorded highest yield of 133 and LCC-137 with 1267, 1250, 1200 and 1167 Kg/ha respectively.

Altogether 95 germplasm accessions have been collected and maintained at Dholi, out of which 10 entries were found promising with respect to growth and yield. Out of 80 entries screened against disease at Dholi, two entries were graded as highly resistant against stem gall disease.

During the year 1996, Hisar centre collected 40 entries from Jobner centre. Fifty eight accessions of coriander were evaluated using RCr-41 and Narnaul selection as check. Thirty two lines gave higher seed yield than the check (Narnaul selection) and 26 lines yield higher than RCr-41.

## 7.2 Initial evaluation trial (IET)

### *Coimbatore, Dholi, Guntur, Hisar and Jagudan*

The IET carried out at Coimbatore during Rabi 1995-96 and 1996-97 with 10 accessions along with check (CO.3). Studies on plant and yield characters revealed that the accessions differed significantly for the yield potentialities in both the years. All the accessions tested were found to be low yielders compared to CO.3.

Eleven promising coriander collections were evaluated under IET at Guntur with Sadhana as check. LCC-128 observed to be promising which recorded significantly highest yield of 1150 Kg/ha over check.

The trial was laid out at Dholi with 10 entries for the second year and observations recorded. The maximum yield of 2222 Kg/ha was obtained by Acc.No.UD-684 consecutively in the second year. The variety ATP-77 retained the maximum plant height (111.67cm) followed by UD-20 (109.33cm).

The preliminary yield evaluation trial-1 (PYT-I) with 12 entries at Jagudan revealed that yield difference were not significant. Average of two years data revealed that the entry JCO-373 was the only high yielder compared to control. In PYT-II at Jagudan three years pooled analysis revealed that yield differences were not significant and none was superior to check (G.C-2).

In the IET carried out during 1992-93 to 1995-96 at Hisar with nine accessions, the seed yield of these lines varied from 1270 Kg/ha (DH-132) to 1720 Kg/ha (DH-52) closely followed by DH-13 (1700 Kg/ha) at DH-48 (1600Kg/ha) during 1995-96. The pooled data is presented in Table-14.

### 7.3 Multilocation Trials

#### 7.3.1 Multilocation trial (MLT 1993-Series II)

*Jobner, Jagudan, Coimbatore, Guntur, Hisar and Dholi*

The MLT 1993 with nine entries consisting of three entries from Jobner, two each from Haryana, Jagudan and Guntur was laid out in all coriander centres viz., Jobner, Jagudan, Coimbatore, Guntur, Hisar and Dholi centers.

At Hisar, 11 entries were tested along with Narnaul Selection (Check). Significant difference were obtained for all the morphological parameters observed. Maximum seed yield was obtained in DH-36 (2020 Kg/ha) which was statistically at par with CC-964, DH-38, JCO-123, UD-446, JCO-64, UD-447.

Table 14. Initial evaluation trial (IET) in Coriander during 1992-96 at Hisar

Accession number	Seed yield ( kg / ha )				Mean
	1992-93	1993-94	1994-95	1995-96	
DH-7	1420	1350	1600	1650	1510
DH-13	1690	1700	1650	1750	1700
DH-28	1330	1400	1520	1380	1410
DH-48	1560	1500	1710	1630	1600
DH-52	1700	1660	1750	1750	1720
DH-54	1310	1300	1750	1630	1500
DH-84	1370	1400	1600	1380	1440
DH-132	1370	1430	1280	1000	1270
DH-138	1520	1400	1360	880	1320
Pant Haritima(Check)	1270	1300	1250	1210	1260
CD (5%)	2.3	2.8	3.2	4.1	

Of the nine entries of coriander evaluated in MLT at Jobner, the entry UD-446 recorded maximum grain yield of 1563 Kg/ha closely followed by UD-447 (1188 Kg/ha), Rcr-41 (1116 Kg/ha), JCO-123 (923 Kg/ha). The mean yield performance of the entries over 1993-94 to 1995-96 presented in Table-15 showed the maximum yield of 1281 Kg/ha by UD-446 followed by Rcr-41 (1272 Kg/ha). The entry UD-446 was early

in flowering (68.8 days), compared to Rcr-41 (82.9 days).

The MLT-1993 conducted with 11 entries was concluded during 1995-96 at Jagudan centre. Even though there is significant difference in yield, none of the entry was superior over control. Pooled results of three years, data showed that the entries CC-964, CC-462, ATP-77 and

Table 15. Mean performance of coriander entries evaluated in MLT at Jobner (1993-94 to 1995-96)

Entry	Yield (kg/ha)				Days to flowering			
	93-94	94-95	95-96	Mean	93-94	94-95	95-96	Mean
UD-446	1316	964	1563	1281	71.0	67.5	68.0	68.83
UD-447	1656	839	1188	1228	80.5	74.5	76.3	77.10
JCO-64	1313	682	827	941	60.3	56.8	58.0	58.36
JCO-123	1765	755	923	1147	64.3	59.0	62.3	61.86
DH-36	2083	800	784	1222	77.5	67.8	70.0	71.77
DH-38	1368	740	895	1001	80.8	70.0	74.0	74.93
ATP-77	514	485	332	444	51.0	53.8	50.8	51.87
ATP-102	375	496	430	434	51.0	51.3	50.8	51.03
Rcr-41	1904	797	1116	1272	85.5	82.8	80.5	82.93
CD (5%)	3.02	1.20	4.63	1.83	---	---	---	---

JCo-123 were high yielders, but it was on par with control Table-16.

Eleven entries including CO.3 as check was evaluated during rabi 1995-96 and 1996-97 at

Table 16. Yield performance of coriander in comparative yield trial at Jagudan

Entry	Yield (Kg/ha)			Average yield Kg/ha	% increase over control
	1993-94	1994-95	1995-96		
CC-462	1635	813	917	1121	3.03
CC-964	1653	862	1111	1209	11.12
ATP-77	1496	746	1083	1108	1.83
ATP-102	1476	653	993	1041	—
DH-36	1199	600	666	822	—
DH-38	982	539	639	720	—
J.Co-64	1542	831	882	1035	—
J.Co-123	1653	787	875	1105	1.56
UD-446	1306	694	715	905	—
UD-447	949	659	673	760	—
G.C-2 (Check)	1394	878	993	1088	—
CD (5%)	1.81	2.02	2.05	1.87	

Coimbatore. The data on plant and yield characters is furnished in Table-17. In respect of

yield, the lines tested exhibited significant deviation in both the years. However, the mean

Table 17 Multilocation trial in coriander ( 1995-96 and 1996-97)

Acc. No	No. of umbels/ plant			No. of umbellets / umbel			Yield (kg/plot)			Estimated yield (kg/ha)
	1995-96	1996-97	Mean	1995-96	1996-97	Mean	1995-96	1996-97	Mean	
DH 36	19.20	17.76	18.48	4.80	5.30	5.05	0.216	0.336	0.276	276
ATP 102	21.13	18.90	20.01	4.60	7.30	5.82	0.403	0.332	0.367	367
CC 462	23.87	15.66	19.76	5.07	5.83	5.45	0.400	0.449	0.424	424
JCO 123	19.00	15.60	17.30	5.13	4.93	5.03	0.700	0.750	0.725	725
UD 446	19.60	15.00	17.30	4.93	4.53	4.73	0.618	0.518	0.568	568
ATP 77	14.83	11.66	13.24	4.13	4.93	4.53	0.583	0.620	0.601	601
DH 38	21.33	18.30	19.81	4.40	4.60	4.50	0.330	0.350	0.340	340
1080	17.80	15.73	16.76	5.6	5.1	5.4	0.883	0.850	0.866	866
748	23.53	11.60	17.56	5.2	5.7	5.5	0.667	0.610	0.638	638
462	15.50	11.73	13.61	5.3	5.2	5.3	0.352	0.370	0.361	361
CO 3	19.93	15.50	17.71	5.4	4.4	4.4	0.883	0.950	0.916	916
CD (5%)	2.34	1.96	-	NS	NS	-	0.025	0.019	---	

yield was high (916 Kg/ha) in the check (CO.3). Among the entries, lower incidence of wilt was observed in accessions DH-36, DH-38, CO.3 and JCo-64.

The MLT with nine entries with Rajendra Swathi (Check) was laid out at Dholi and yield and yield contributing characters recorded. The yield differences were significant and UD-446 gave the highest yield (1990 Kg/ha).

### 7.3.2 Multilocation Trial - 1996 Series III

*Jobner, Jagudan, Guntur, Dholi, Coimbatore and Hisar*

The MLT-III (1996) with 13/15 entries from Jobner, Hisar, Jagudan, Guntur and Coimbatore was laid out at six coriander centres. The yield levels were low in the trial laid out at Jobner and was therefore cancelled. The trial will be again taken up in Rabi 1996-97 at Jobner.

At Jagudan, the yield difference were found non-significant in the MLT laid out during 1995-96. whereas, the entry DH-13 was found significantly superior over control during the year 1996-97.

The trial laid out at Hisar (without the entries from Coimbatore and Jagudan) along with Hisar Anand and Narnaul Selection as checks. Significant differences were observed for all the parameters studied. Maximum seed yield of 2150

Kg/ha was recorded in Hisar Anand which was statistically at par with UD-648, UD-685 and these three entries were statistically superior to Narnaul Selection which yielded 1560 Kg/ha.

Nine entries were evaluated in the MLT at Guntur. Among the entries LCC-15 (Guntur entry) recorded significantly highest yield of 1117 Kg/ha. whereas, the Jobner and Hisar entries recorded lower yield than the check (Sadhana).

Nine entries along with check (CO.3) was tested during rabi 1996-97 at Coimbatore. The data revealed that there was considerable variation among the entries tested. In respect of yield, the lines tested exhibited significant variation. All the entries tested were found to be low yielder as compared to CO.3.

The MLT was conducted with 11 entries along with Rajendra Swathi (Check) for the first year at Dholi (1996-97). The maximum yield of 2361 Kg/ha was obtained by UD-686 in the evaluation.

### 7.4. Comparative yield trial of leafy type coriander

*Dholi and Coimbatore*

A CYT conducted at Dholi, with 11 entries to study the green leaf yield at 40, 55 and 70 days after sowing of coriander. The variety Pant Haritima was observed significantly superior for green yield due to its late flowering. The variety is rated as the best green yielder even, at later stage of crop. The varieties UD-446 and UD-

447 were next superior in green leaf yield.

Eleven leafy types along with CO.3 were tested for the efficacy of herbage yield during Rabi-Kharif 1996-97 at Coimbatore. In both the seasons, the entries tested, registered significant difference for leaf yield. Acc. EC-232666 recorded higher leaf yield (12.14 g/plant). The entries UD-485 and EC-279047 were the next best with 10.40 and 11.01g green leaf per plant respectively and were superior in leaf yield than check CO.3 (9.50 g/plant).

#### **7.5 Mutation breeding in coriander to evolve varieties with earliness and resistance to diseases**

*Jobner and Coimbatore*

Twenty progenies of coriander derived from 5, 10, 15 and 20 Kr doses of gamma radiation (to UD-20) were evaluated at Jobner in the IET along with Rcr-20 and Rcr-41 as checks. The trial was initiated in November 1993 and the vegetative and reproductive characters were recorded. The progenies differed significantly for all characters studied except branches per plant and umbellets per umbel (1995-96). The three years mean performance (1993-94 to 1995-96) revealed that the progeny 10 Kr-15 produced maximum mean grain yield of 596 Kg/ha followed by 5 Kr-14 (575 Kg/ha), 20 Kr-5 (574 Kg/ha) and 5 Kr-68 (571 Kg/ha). On the basis of the yield performance, three progenies viz., 5 Kr-14 (UD-684), 5 Kr-68 (UD-685) and 20 Kr-5 (UD-685) were identified and included as new MLT.

#### **7.6 Response of coriander to date of sowing and row spacing**

*Jobner.*

The experiment consisted of 15 treatment combinations including five dates of sowing (15 and 25th Oct., 4, 14 and 24th Nov.) and a row spacing of 20, 30 and 40 cm was conducted during rabi 1994-95 and 95-96 at Jobner. The observation on yield and yield attributing characters recorded and harvest index was also worked out. Two years experimental findings revealed that maximum seed yield of 2032 Kg/ha was obtained with 25th Oct. sowing at 30 cm row spacing but was statistically at par with the sowing on same date at 20 and 40 cm (1893 and 1952 Kg/ha respectively) and at 4th November sowing at 20, 30 and 40 cm (1910, 1997 and 1865 Kg/ha respectively). The interaction effect of date of sowing and row spacing on plant height, harvest index and seed yield was significant.

#### **7.7 Response of coriander varieties to seed rate**

*Jobner*

The experiment comprising of three varieties (Rcr-41, UD-20 and UD-436) and five seed rates (12, 14, 16, 18 and 20 Kg/ha) comprising 15 treatment combinations was conducted during rabi 1994-95 and 1995-96 at Jobner. The growth, yield and yield contributing characters recorded and harvest index worked out. Two years experimental findings revealed that Rcr-41 and UD-20 gave the highest seed yield of



1459 and 1430 Kg/ha respectively with 16 Kg/ha seed rate and UD-436 gave maximum seed yield of 973 Kg/ha with 12 Kg/ha seed rate. The interaction effect of varieties and seed rate on harvest index and straw yield was significant.

### 7.8 Survey to study the disease incidence, collection and identification of casual organism.

#### Dholi

Survey was conducted consecutively during 1995-96 and 1996-97 by Dholi centre in different coriander growing areas viz., Muzaffarpur, Siwan, Gopalganj, Darbaanga, Vaishali and Samstipur and incidence of stem gall disease recorded. The study revealed that the stem gall disease was very serious in coriander under Bihar.

### 7.9 Studies on wilt and powdery mildew management in coriander / Biocontrol of wilt in coriander

#### Coimbatore

The biocontrol studies on coriander wilt, conducted in three seasons during Rabi 1994-95, 1995-96 and 1996-97 at Coimbatore with the variety CO.3. Pre-sowing seed treatment with bio control agent *T. viride*, *T.harzianum*, *Bacillus subtilis* and *Pseudomonas fluorescens* was tested for their efficacy as compared to the fungicide carbendazim. The three years study showed significant difference in controlling wilt disease. Coriander seed treatment with *T. viride* @ 4 g/kg was found to be effective in reducing the wilt disease. The incidence was reduced to 5.3% as against 28.3% in untreated plot ( Table-18 ) which also reflected the yield of co-

Table 18. Biological control of coriander wilt (1995-96 and 1996-97)

Treatment	Mean wilt incidence			Mean(%)	Yield (Kg/ha)			Mean yield (Kg/ha)
	1995-96	1996-97	1996-97		1995-96	1996-97	1996-97	
ST with <i>T. viride</i> (4 g/kg)	6.0 (14.18)	4.5 (13.44)	4.5 (12.11)	5.3	389.5	387.5	385.5	387.5
ST with <i>T. harzianum</i> (4 g/kg)	8.5 (16.95)	6.8 (15.12)	4.8 (12.11)	6.7	320.0	331.0	342.0	331.0
ST with <i>B. subtilis</i> (10 g/kg)	12.5 (20.70)	10.5 (18.91)	8.5 (16.95)	10.5	310.0	302.5	295.0	302.5
ST with <i>P. fluorescens</i> (10 g/kg)	16.7 (24.12)	8.7 (17.15)	10.2 (18.63)	13.2	295.0	285.0	275.0	285.0
ST with carbendazim (2 g/kg)	6.5 (14.77)	5.6 (13.69)	5.3 (12.92)	5.8	385.0	350.0	315.0	350.0
Control	36.6 (37.23)	28.3 (32.14)	20.0 (26.57)	28.0	168.0	162.0	156.0	162.0
CD (5%)	2.76	2.24	2.18		7.44	8.66	7.47	

(Figures in parentheses are transformed values); ST = Seed Treatment

riander. The three years study showed that *T. viride* treatment showed significant difference in respect of yield. The mean yield was significantly higher in seed treatment with *T. viride* with 387.5 Kg/ha as against very low yield of 156 Kg/ha obtained in untreated plot. The cost: benefit ratio was better with *T. viride* treatment.

### 7.10 Quality evaluation in coriander

#### Jobner

The volatile oil content of nine entries of cori-

ander tested under CYT, were determined at Jobner. The volatile oil content ranged from 0.25 to 0.4% in coriander seeds. The maximum volatile oil of 0.4% was observed in UD-446, UD-447, JCo-123, DH-38 and JCo-64. The mean performance of entries for volatile oil contents estimated over three years are (1993-94, 1994-95, 1995-96) presented in Table-19. The highest mean volatile oil of 0.38% was recorded in JCo-64 followed by 0.35% in JCo-123.

Table 19. Mean performance of coriander entries in MLT at Jobner (1993 - 1996).

Entry	Mean grain Yield (kg/ha)	Volatile oil %			Mean	Mean yield (l/ha)
		1993-94	1994-95	1995-96		
UD-447	1227	0.30	0.30	0.40	0.333	4.085
UD-446	1280	0.25	0.30	0.40	0.316	4.044
RCR-41	1272	0.33	0.30	0.30	0.316	4.019
J.Co-123	1147	0.35	0.30	0.40	0.350	4.014
J.Co-64	940	0.35	0.40	0.40	0.383	3.600
DH-36 1223	0.20	0.30	0.25	0.250	3.057	
DH-38 1001	0.10	0.30	0.40	0.266	2.662	
ATP-77	443	0.40	0.30	0.30	0.333	1.475
ATP-102	433	0.35	0.30	0.35	0.333	1.441

The coriander entries of out station MLT received from Hisar on analysis for volatile oil was compared with Jobner variety. The volatile oil content in different entries of Hisar varied from 0.3 to 0.4% and maximum content was recorded in UD-446, UD-447, DH-38, ATD-77, CC-462, CC-964 and narnual selections. On comparison of volatile oil content of entries grown at Jobner as well as Hisar revealed that there was no difference in the volatile oil contents.

## CUMIN

### 8.1 Germplasm collection, description, evaluation and screening against diseases

#### *Jobner and Jagudan*

The Jobner centre added 14 new cumin collections from Kekri (Ajmer), Bilada(Jodhpur), Jetaran (Pali) and Merta (Nagour) areas making the total to 265 accessions which consists of 10 exotic collections.

In the disease resistance screening programme (1996-97) at Jobner it was observed that out of eight entries of cumin screened against wilt disease, the per cent mortality due to wilt incidence was lowest in UC-223 (5.0) followed by UC -220(12.5) with the grain yield of

313 and 269 kg/ha respectively.

Extensive survey was carried out by the Jagudan centre and collected 45 new diverse cultures of cumin during 1996-97. Out of the total 212 accessions (7 exotic and 205 indigenous), 142 accessions were retained at this centre.

In the disease resistance screening programme, eight exotic entries were screened at Jagudan, out of which four entries viz., EC-232684, EC-243373, EC-243375 and EC-109635 were found resistant against *Fusarium* wilt disease during 1996-97. Twenty six cumin entries were screened against blight and powdery mildew disease at Jagudan during 1996-97. None of the tested cultures were found resistant/tolerant to powdery mildew disease.

### 8.2 Initial evaluation trial

#### *Jagudan*

In the IET-I (1993-94) with 10 entries at Jagudan, the yield differences were found significant among the entries. The entry EC-279081 recorded significantly the highest yield (907 kg/ha) which was 31.25% higher than the check GC-2-(690 kg/ha.)

The pooled analysis of four years yield data

presented in Table-20 indicated the better performance of EC-279081, which gave significantly the maximum yield (870 kg/ha).

The IET -II initiated in 1996-97 with 12 entries was vitiated due to the physiological disorder at the flowering stage.

### 8.3 Comparative yield trial

#### *Jagudan*

The CYT (1995-96) with seven entries at Jagudan was vitiated due to the unknown physi-

ological disorder at the flowering stage. During 1995-96 the yield difference observed was significant among the entries and none of the entry was found significantly superior over the control. But the wilt resistant entry EC-232684 had given 6.57% higher yield (710 kg/ha) than control.

### 8.4 Multilocation Trial

#### **MLT 1994-Series II**

#### *Jobner and Jagudan*

In the MLT 1994-Series II, eight entries viz.,

Table 20 Yield performance of cummin in initial evaluation trial- I at Jagudan

Entry	Yield (kg/ha)				Average yield (kg/ha)	% increase over control
	1993-94	1994-95	1995-96	1996-97		
EC-232684	695	667	668	615	661	—
EC-243373	421	738	640	627	607	—
EC-243375	548	738	582	528	599	—
EC-279053	644	778	722	716	715	—
EC- 279054	646	789	799	801	760	3.68
EC-279081	684	939	949	907	870	18.69
EC-109635	753	883	698	770	776	5.87
EC-59	757	661	701	792	728	—
JC-105	656	722	803	724	726	—
GC-2 (Check)	763	789	689	690	733	—
<b>CD (5%)</b>	<b>1.35</b>	<b>NS</b>	<b>NS</b>	<b>1.70</b>	<b>1.13</b>	

UC-217, UC-220, UD-223 and RZ-19 from Rajasthan, JC-147, EC-279081 and EC-232684 from Gujarat including local check were evaluated at Jobner (1995-96). The yield and yield attributing characters were recorded and the entries showed significant variability for days to flowering, umbels per plant, test weight and grain yield. The entry UC-223 recorded maximum grain yield of 313 Kg/ha followed by UC-220 (296 Kg/ha) and JC-147 (284 Kg/ha). The mean performance over 1994-95 and 1995-96 indicated the superior performance of UC-223 (292 Kg/ha) followed by UC-220 (241 Kg/ha) and UC-217 (213 Kg/ha). The entry UC-223 also showed low wilt incidence (5.63%).

The trial with 10 entries conducted at five different locations of Jagudan showed significant yield differences among the entries in all locations except at S.K.Nagar. The pooled data (five locations) revealed non-significant differences. However, the entry JC-59 gave maximum yield (674 Kg/ha)

### 8.5 Preliminary yield trial in cumin

*Jagudan*

The preliminary yield trial on cumin with 22 entries was conducted at Jagudan during 1995-96. The experiment was vitiated due to the unknown disease and/or physiological disorders at flowering stage.

### 8.6 Preliminary row trial (PRT) in cumin

*Jagudan*

A PRT was conducted (1996-97) with 48 entries at Jagudan with a spacing of 30 cm between two rows. The grain yield ranged from 629 to 1304 Kg/ha. In PRT, the entries JC-94-37, JC-94-159, JC-94-252, JC-94-32, JC-94-148, JC-94-69 and JC-94-263 were found promising.

### 8.7 Hybridization programme in Cumin

*Jagudan*

These  $F_1$  seeds (collected during 1995-96) were sown. Observations recorded in the progenies of the crosses between GC-2 x Hairy Cumin and GC-2 x White flower Cumin and seeds collected separately for  $F_2$  studies.

In the hybridization programme the following successful crosses were made and seeds harvested.

Parent	No. of $F_1$ seeds harvested	Purpose
GC-2 x Hairy Cumin	147	For inheritance study
Hairy Cumin x GC-2	128	"
GC-2 x White flower	103	"
White flower x GC-2	124	"
GC-2 x EC-2326844	188	For wilt resistance

### 8.8 Irrigation schedules for Cumin with reference to yield and blight disease

#### Jagudan

An irrigation experiment with five treatments was conducted at Jagudan to workout ideal irrigation schedule for cumin crop with reference to yield and blight disease ( Table-21 ). The high-

### 8.9 Blight disease control by manipulation of Agronomic practices

#### Jagudan

An experiment with five treatments was laid out at Jagudan to find out the factors influenc-

Table 21. Yield of Cumin as affected by different irrigation

Treatment	(Kg/ha) Yield
T-1 Two irrigations (i.e at sowing time + 8 to 10 DAS)	513
T-2 Three irrigations (i.e at sowing time + 8 to 10 DAS + 30 DAS)	656
T-3 Three irrigations (i.e at sowing time + 8 to 10 DAS + 40 DAS)	725
T-4 Four irrigations (i.e at sowing time + 8 to 10 DAS + 30 & 50 DAS)	860
T-5 Five irrigations (i.e at sowing time + 8 to 10 DAS + 30, 50 & 70 DAS)	898
CD (5%)	85.53

est yield of 898 kg/ha was obtained with five irrigations (at sowing, 10, 30, 50 and 70 DAS). However, it was at par with four irrigations (at sowing, 10, 30 and 50 DAS). Blight disease did not appear during the year.

ing blight disease.

The grain yield of cumin did not get influenced by various treatments. And blight disease did not appear and therefore no valid conclusion could be drawn.

### 8.10 Evolving control measures against Cumin wilt disease including crop rotation

#### *Jobner*

To control cumin wilt disease, an experiment with six treatments viz., soil solarisation, seed dressing with Captan (0.33%), Bavistin (0.1%), Thiram (0.3%) and *Trichoderma* (0.4%) was laid out at Jobner under irrigated conditions. The disease incidence and yield showed significant differences. The solarisation treatment reduced disease incidence (31.89%) resulting in maximum grain yield of 198 kg/ha followed by *Trichoderma* (33.26%) with an yield of 135 kg/ha. The control resulted in maximum disease incidence (52.06%) and lowest yield of 87.5 kg/ha.

An experiment with 10 treatments was conducted to assess the effect of crop rotation on yield and wilt infection of cumin at Jobner. The experiment was initiated in 1984-85 and 12 years experimental data revealed that three years crop rotation i.e. cluster bean-cumin-cluster bean - wheat - cluster bean - mustard recorded the highest yield of 257.6 Kg/ha and the wilt incidence of 36.55% as against 81.5 Kg/ha and 61.0% wilt incidence respectively under the one year crop rotation with cluster bean.

### 8.11 Integrated management of pests and diseases of cumin

#### *Jobner and Jagudan*

An experiment for the integrated management of pests and diseases of cumin conducted

at Jobner with four main treatments and 13 sub treatments. The wilt incidence was recorded as the per cent of plants wilted till maturity. Observations on blight and powdery mildew diseases were made and number of aphids and thrips per plant before and after 72 hours of each spray. Basal application of *T. harzianum* in soil + seed treatment with Carbendazim and soil application of neem cake reduced the wilt disease. The efficacy of fungicides (Mancozeb, Captafol, Topas and Topsin-M), insecticides (Monochrotophos and Acephate), Neem oil with tipol alone and/or in combination with the basal application could not be worked out due to the poor occurrence of foliar diseases (blight and powdery mildew) and pests. In general, the incidence of disease and pest in the sprayed plots were almost nil.

An experiment to find out the economics of integrated management schedule for diseases and pests of cumin conducted at Jagudan with three main treatments and 10 sub treatments during 1995-96 revealed that spraying of Mancozeb was superior to manage the blight disease, in comparison to other fungicidal spray. During 1996-97 wilt, blight and major insect pests were not observed in the field.

### 8.12 Epidemiological study of *Alternaria* blight of cumin

#### *Jobner and Jagudan*

Experiments were conducted at Jobner with five dates of sowing at an interval of 10 days i.e. 10<sup>th</sup>, 20<sup>th</sup>, 30<sup>th</sup> Nov. and 10<sup>th</sup> and 20<sup>th</sup> Dec. to study

the epidemiological parameters on the incidence of blight in cumin. Observations recorded as the percentage of plants wilted till maturity of the crop. Blight disease did not appear during the year (1995). However, the data on wilt incidence showed that out of the five dates of sowing, the minimum wilt incidence of 13.75% with highest seed yield of 291 Kg/ha obtained in the early sown crop (10<sup>th</sup> Nov.).

Studies were conducted at Jagudan, to quantify several epidemiological parameters, which account the quantitative relationships of weather factors, crop factors and pathogen/disease development during an epidemic under natural condition. There were five dates of sowing viz, 5<sup>th</sup>, 15<sup>th</sup> and 25<sup>th</sup> Oct., 5<sup>th</sup> and 15<sup>th</sup> Nov. During 1995-96, blight disease intensity was observed lowest in early sown crop (e. 5<sup>th</sup> Oct and 15<sup>th</sup> Oct.) with highest yield. The relationship of meteorological (relative humidity and sunshine hours) and biological factors (crop age) worked out. During 1996-97 blight disease of cumin was not observed.

### 8.13 Quality evaluation in cumin

#### *Jobner*

The volatile oil contents of eight cumin entries tested under MLT ranged from 2.8 to 3.6%. The highest volatile oil of 3.6% was recorded in JC-147 followed by UC-223(3.5%), UC-220 (3.4%). The total yield of volatile oil depends upon the grain yield and percentage of volatile

oil present in the seed. The varieties having higher volatile oil are important for value addition and export. The volatile oil yield was found to be highest in UC-223 (11.0 lit/ha) followed by JC-147 (10.2 lit/ha) and UC-220 (10.1 lit/ha).

## FENNEL

### 9.1 Germplasm collection, description and screening against diseases

#### *Jobner, Jagudan, Hisar and Dholi*

The Jobner centre holds a total of 198 collections (190 indigenous and eight exotic) which includes 28 new collections (1996-97) made from Malapura, Kekri, Angor, Sindarath and Khambal of Sirohi areas.

The Jagudan centre has a total of 280 collections (259 indigenous and 21 exotic) out of which 158 accessions were retained. Survey for enrichment of fennel collection carried out during 1996-97 gave 183 new diverse cultures.

Sixteen fennel entries (14 exotic, PF-35 and GF-1) were screened against *Rumularia* blight disease at Jagudan. Most of the rabi planted exotic entries were found resistant against *Rumularia* blight under natural conditions, except EC-243376-1, EC-241499-2, EC-241499-3 and GF-1 during 1995-96. During 1996-97 *Rumularia* blight has not appeared.

Twenty nine accessions of fennel were evalu-



ated at Hisar during 1992 to 1996. The seed yield ranged from 245.0 g (HF 123) to 371.3 g (HF-102) per 3 m long single row plot. Fourteen lines gave higher seed yield than the highest yielding check (PF-35). The most promising lines identified are HF-102, HF-104, HF-106, HF-110, HF-119, HF-120 and HF-122.

At Dholi, 34 germplasm have been collected and maintained. Among the entries, RF-17 produced significantly higher yield.

## 9.2 Varietal trial in fennel

### *Jagudan*

Five entries including check (GF-1) were tested in the IET at Jagudan. The yield differences were significant and entry JF-192 gave 28.6% higher yield (2986 Kg/ha). The two years pooled data showed that the entry JF-192 gave 38.84% higher yield (2123 Kg/ha) which is significant over control (GF-1.)

## 9.3 Initial evaluation trial

### *Jagudan*

Seven entries were tested in the IET at Jagudan. The yield differences among the en-

tries were non-significant during 1995-96 and 1996-97. But the entry JF-200 gave 19.32% more yield (2050 Kg/ha) than control.

## 9.4 Preliminary row trial on Fennel

### *Jagudan*

In the PRT with 11 entries, yield differences were significant and JF-183 recorded the maximum yield (3176 Kg/ha) and in another PRT with 12 entries yield differences were significant among treatments and the entry JF-273 gave 36.83% higher yield (3370 Kg/ha).

## 9.5 Multilocation trial (MLT 1994-Series II)

### *Jobner, Hisar and Jagudan*

The MLT 1994-Series II with eight entries consisting of UF-12, UF-133, UF-134 (from Rajasthan), JF-25, JF-29 (from Gujarat), HF-71, HF-102 and HF-104 (from Haryana) along with local check were evaluated at Jobner, Jagudan and Hisar.

The results of the studies at Jobner indicated that the entries differed significantly for all characters except test weight. The mean performance of entries evaluated over 1994-95 and

1995-96 revealed the superior performance of UF-125 ( Table-22 ) which recorded maximum

none of the entry was significantly superior to control (GF-1). However, JF-29 gave 12.47%

Table - 22 Mean performance of fennel entries evaluated in MLT

Entry	Yield (kg/ha)		
	1994-95	1995-96	Mean
UF-125	1375	1400	1488
UF-133	1075	1413	1248
UF-134	1188	1425	1300
JF-25	1350	1200	1275
JF-29	1213	1388	1300
HF-71	1113	1113	1089
HF-102	1275	1050	1163
Local check	1313	1100	1200
CD ( 5% )	1.32	3.87	1.95

mean grain yield of 1488 Kg/ha while, local check provided 1207 Kg/ha. The variety was also dwarf and early maturing type.

In the evaluation of CYT at Jobner, the data on pooled analysis over three years (1994-95, 95-96 and 96-97) showed significant yield differences among the treatments ( Table-23 ). But

higher yield (1939 Kg/ha) than control, but was on par with control (1724 Kg/ha).

In the CYT at Hisar, significant differences were obtained for all the parameters observed. The maximum seed yield (2360 Kg/ha) was recorded in UF-125 closely followed by JF-25 and HF-104 during 1994-95 while JF-25 recorded the

Table 23. Yield performance of fennel in comparative yield trial at Jobner

Entry	Yield (kg/ha)			Average yield (kg/ha)
	1994-95	1995-96	1996-97	
JF-25	1417	1111	2405	1644
JF-29	1552	1333	2934	1939
UF-125	1342	970	2487	1599
UF-133	811	641	2539	1330
UF-134	898	689	2370	1319
HF-71	1177	766	2370	1438
HF-102	1068	847	2270	1395
HF-104	—	804	2426	1615
GF-1 (Check)	1399	1205	2569	1724
CD (5%)	3.67	0.94	2.62	4.22

maximum seed yield (2094 Kg/ha) closely followed by UF-125 and HF-104 during 1995-96. These three entries viz., UF-125, JF-25 and HF-104 gave significantly increased seed yield over local check during both the years.

In the evaluation of CYT entries, the yield differences were significant among the eight entries (1995-96). An entry JF-29 gave 14.21% higher yield (2934 kg/ha) than the control. None of the entry was found significantly superior than control over three years but significant yield differences were observed among entries.

### 9.6 Mutation studies and crossing programmes in fennel

*Jagudan*

The crossing programmes were initiated in Fennel at Jagudan Centre. The following crosses were made during the year ( Table-24 ).

The 200 seeds of  $F_2$  of Bloomless x GF-1 were sown during the year. Among those 165 seeds have germinated and the types were, Bloomless - 33 plants, Intermediate - 44 plants and GF-1 - 88 plants.

### 9.7 Response of Rabi Fennel to irrigation, Nitrogen and Phosphorus

*Jagudan*

An irrigation cum fertilizer trial in fennel with three levels of irrigation, nitrogen and phosphorus were conducted at Jagudan. The data presented

Table 24. Particulars of crossing programme in fennel

Parent	No. of $F_1$ seeds harvested	Purpose
GF-1 x Bloomless	147	For inheritance study
GF-1 x EC-386375 (German culture)	128	For dwarfness

in Table-25 revealed significant effect due to irrigation, nitrogen and phosphorus. IW/CPE ratio of 1.0 recorded significantly higher grain yield over lower level (0.6 IW/CPE) of irrigation. Application of 90 KgN/ha recorded significantly highest grain yield, but it was at par with 120

Kg N/ha . The application of phosphorus (60 Kg P<sub>2</sub>O<sub>5</sub>/ha) produced significantly higher grain yield and remained to be on par with 30 Kg P<sub>2</sub>O<sub>5</sub>/ha. The interaction effect of irrigation, nitrogen and phosphorus was found non-significant in respect of grain yield.

Table 25. Effect of irrigation and fertilizer levels on grain yield of fennel

**A: MAIN PLOT TREATMENTS**

<u>Irrigation levels</u>	<u>Grain yield (Kg/ha)</u>
I <sub>1</sub> - 0.6 ( 83.33 mm CPE )	1500
I <sub>2</sub> - 0.8 ( 63.33 mm CPE )	1728
I <sub>3</sub> - 1.0 ( 50.00 mm CPE )	1864
CD (5%)	272.98

(The depth of irrigation will be maintained at 50mm at each irrigation)

**B. SUB PLOT TREATMENTS**

**Fertilizer levels**

<u>Nitrogen level</u> (Kg/ha)	<u>Grain yield</u> (Kg/ha)	<u>Phosphorus level</u> (Kg/ha)	<u>Grain yield</u> (Kg/ha)
N <sub>1</sub> = 60	1626	P0 = 00	1509
N <sub>2</sub> = 90	1795	P1 = 30	1717
N <sub>3</sub> = 120	1771	P2 = 60	1786
CD (5%)	109.75		109.75

## 9.8 Quality evaluation studies

### *Jobner*

The volatile oil content of nine entries of fennel (under MLT) ranged from 1.4 to 1.9%. Maximum volatile oil of 1.99% was recorded in UF-125 with total volatile oil yield of 26.6 lit/ha followed by 1.8% in UF-134 with oil yield of 25.6 lit/ha. The mean volatile oil content of entries evaluated in 1994-95 and 1995-96 indicated that highest mean volatile oil 1.8% was recorded in UF-125, UF-134, local and HF-71.

## 9.9 Weed control studies in Fennel

### *Hisar*

The weed management experiment at Hisar comprised of four herbicide treatments (viz. fluchloralin, pendimethalin, isoproturon and oxyfluorfen) each at two concentrations. And the lower dose of herbicide was supplemented with one hand weeding at 50 days after sowing. There were 16 treatments. Fluchloralin was applied one day before sowing while the other pre-emergence herbicides were applied three days after sowing (DAS) as per the treatments. The major weed flora observed in the experimental field was *Chenopodium album*, *C. murale*, *Coronopus didymus*, *Tribulus terrestris*, *Portulacca oleracea*, *Cyperus rotundus* and *Cynodon dactylon*. The results indicated that the treatments significantly reduced the weed population and their dry weight compared with weedy check. The trial on weed

control studies revealed that maximum seed yield was recorded in weed free closely followed by Pendimethalin at 1.0 Kg/ha + one hand weeding at 50 DAS and Pendimethalin at 1.5 Kg/ha without weeding.

## FENUGREEK

### 10.1 Germplasm collection, maintenance, evaluation and screening against diseases

#### *Jobner, Jagudan, Coimbatore, Guntur, Hisar Dholi and Kumarganj*

The Jobner centre holds a total of 320 accessions in Fenugreek including 12 exotic accessions. Five entries of fenugreek were screened against root knot nematode *Meloidogyne incognita* under infected field at Jobner. Out of the five entries, UM-32, UM-117 and UM-128 were found resistant against root knot nematode.

One hundred germplasm have been collected and maintained at Dholi centre. Among which eight lines are performing well. Fourty three germplasm were screened against downy mildew. No single entry showed highly resistant reaction against the disease whereas, UM-302, UM-9, RM-5, UM-29, J. Fenu-58, UM-66, RM-1, HM-291, J. Fenu-115, Rajendra Kanti, C.F-390, Sel-9, Sel-6, UM-30, JM-61, UM-304 and UM-109 appears to be resistant.

A total of 146 accessions are maintained and evaluated at Coimbatore centre. During the period eight more accessions (four each) were obtained from Jobner and Hisar centres. All the accessions were evaluated during Rabi 1995-96. And most of the accessions (104) gave higher yield than the ruling variety (CO.1). The cultures CF-390 and CF-169 identified and isolated under the crop improvement programme are under MLT at the Coimbatore centre.

The Guntur centre added 11 more new accessions making a total of 84. Among the new collections, LFC-74 recorded highest yield of 1417 Kg/ha followed by LFC-77 and LFC-82 with 1367 and 1183 Kg/ha respectively.

The Jagudan centre holds 73 accessions, which includes two exotic accessions. All the six cultures of fenugreek screened were moderately susceptible to *M.incognita* or *M.javanica* at Jagudan. Nineteen entries were tested against powdery mildew, an exotic culture EC-257566 and Kasuri Methi were found resistant against the disease at Jagudan.

The new centre Kumarganj made extensive surveys in the State of UP, Bihar, Rajasthan and Haryana and made few fenugreek collections. All the entries were evaluated and the performance on the basis of yield was assessed. Among the entries, HM-114 produced the high-

est grain yield followed by UM-304, HM-110, UM-301 and NDM-3.

## 10.2 Initial evaluation trial (IET)

### *Coimbatore and Jagudan*

In the IET at Coimbatore all promising entries were evaluated and observations recorded (Rabi 1995-96 and 1996-97) on plant characters and yield. In respect of yield, the entries differed significantly in both the years. The highest yield was recorded by Acc. CF-464 and most of the entries tested registered higher yield in compared to CO.1.

Nine entries along with Methi local were tested in the preliminary yield trial (PYT) at Jagudan. None gave significantly higher yield than check. However, JF-195 gave higher yield. But pooled analysis of two years data showed significant difference in yield among the entries. The entry JF-195 gave maximum yield (1998 Kg/ha) followed by JF-197 (1993 Kg/ha).

## 10.3 Multilocation trials

### 10.3.1 Multilocation trial (MLT 1993- Series II)

#### *Coimbatore, Jobner, Guntur, Hisar, Dholi and Kumarganj*

Eight entries were evaluated at Jobner during 1993-94 to 1995-96. RMT-1 recorded the

maximum grain yield. None of the entry was significantly superior over RMt-1 and or UM-143. However, UM-143 was early in flowering (50 days).

The MLT consisting of 10 entries from different coordinating centres conducted at Jobner for the third year. The results indicated that the entries differed significantly for various characters. UM-143 recorded maximum grain yield (2597 Kg/ha) followed by UM-144, RMt-1, HM-141, JF-102. The mean performance of the en-

tries evaluated over 1993-94 to 1995-96 ( Table 26 ) revealed that maximum grain yield of 2362 Kg/ha recorded in UM-143. This entry was also early in flowering as well as showed low incidence of powdery mildew compared to RMt-1. The other promising entries identified are UM-144, HM-103 and HM-141.

At Guntur, among the eight entries tested, UM-144 recorded the highest yield of 522 Kg/ha which was significantly superior over the check

Table 26 Mean performance of fenugreek entries evaluated for grain, powdery mildew incidence and days to flowering during 1993-94 to 1995-96.

Entry	Grain yield (Kg/ha)			Mean
	1993-94	1994-95	1995-96	
UM-143	2263	2227	2597	2362
UM-144	2144	2122	2428	2231
UM-103	2313	2209	2123	2212
HM-141	1833	2122	2376	2110
CF-169	1910	1588	2019	1839
CF-390	1708	1823	1816	1782
RMt-1	2790	2357	2409	2519
Local check	2359	1419	2025	1934
CD (5%)	5.04	3.30	4.28	3.98

(Lam Sel-1, 433 Kg/ha. The yields of other entries were less than check. In the evaluation significant differences among the entries were observed with regard to yield attributes like plant height, Number of branches, Number of pods per plant and Number of seeds per plant.

At Dholi, out of the eight entries tested, the check (Rajendra Kanti) produced maximum grain yield of 1551 Kg/ha.

The trial was conducted during Rabi 1995-96 and 1996-97 with eight accessions and CO.1 as control at Coimbatore. The observations on plant characters and yield were recorded. With respect to yield the entries differed significantly in both the years. The Acc. MH-141 registered the highest yield (1063 Kg/ha).

The trial conducted at Jagudan with nine entries gave significant yield differences among the entries. None of the entry performed significantly superior over control. However, entry JF-145 and HM-103 gave higher yield than control. The pooled results over three years showed non-significant differences in yield.

Eleven entries of fenugreek including Pusa Early Bunching, Hisar Sonali and Local check were evaluated at Hisar in 1994-95 and 1995-96. The data on yield and yield attributes recorded significant differences in all the param-

eters, except length of pod during both the years. The maximum seed yield was recorded in Hisar Sonali during both the years which was closely followed by HM-103 and J. Fenu-148 in 1994-95 and CF-390 and HM-103 in 1995-96.

### **10.3.2. Multilocation trial 1995 - Series III**

*Guntur, Jagudan, Coimbatore, Dholi, Hisar, Kumarganj and Jobner*

Eleven entries from different coordinating centres were tested at Guntur. Among the entries, JF-102 recorded highest yield.

Thirteen lines of fenugreek were tested under CYT at Kumarganj. The entry HM-114 produced maximum grain yield (2647 Kg/ha) followed by UM-304 and HM-110.

The MLT 1995-Series III consisted of 10 entries from different centres were evaluated at Jobner and observations recorded. The results indicated wide range of variability for number of days to flowering, branches / plant, pods / plant, grains / pod, test weight, grain yield etc. The entry UM-302 recorded maximum grain yield of 2534 Kg/ha closely followed by UM-303 (2500 Kg/ha), HM-110 (2344 Kg/ha), HM-294 (2188 Kg/ha) and UM-304 (2153 Kg/ha).

The trial was laid out at Dholi (1996-97) with 12 entries including check (Rajendra Kanti). The performance of the entries was studied and the



varieties gave significantly increased yield in comparison with the check. HM-110 gave the higher yield of 1875 Kg/ha followed by UM-303 (1805 Kg/ha) in comparison with check (1296 Kg/ha).

Eight entries along with CO.1 as check were evaluated during Rabi 1996-97 at Coimbatore. Considerable variation observed in respect of plant height. Significant variation in respect of yield among the entries were noticed and HM-114 recorded the maximum yield (1373 kg/ha).

Eleven entries along with methi local as check, were tested at Jagudan gave significant difference in yield, but none of the entries gave significantly higher yield than the check. However, entries JF-102, HM-291 and UM-302 gave 0.30, 0.18 and 0.13% higher yield than the check. The pooled analysis of two years (1995-96 & 1996-97) data showed non-significant difference in yield among the entries. However, the entries UM-302 (1956 Kg/ha), UM-301 (1912 Kg/ha), HM-110 (1861 Kg/ha), JF-102 (1832 Kg/ha) and HM-114 (1820 Kg/ha) gave little higher yield than check (1906 Kg/ha). The MLT-III at Hisar centre consisted of 14 entries from different centres showed significant difference in all the parameters tested and maximum seed yield was recorded in Hisar Sonali (2380 Kg/ha) which was statistically at par with UM-301 and UM-302.

#### **10.4. Evolving varieties resistant to Powdery mildew through mutation breeding and crossing programme.**

*Jobner and Jagudan*

Mutation studies were initiated in 1988-89 in fenugreek (Rmt-1) with Gamma rays at Jobner. Sixteen progenies derived from gamma rays treated Rmt-1 were evaluated and observations recorded (1995-96). Of these, 14 progenies showed increased yield. The progeny 764-3 recorded maximum grain yield (168.33 g) followed by 552-1 (160 g) and 764-2 (156.66 g). Forty four progenies of fenugreek evaluated in IET from 1992-93 to 1995-96, observations were recorded on yield and yield contributing characters. In the two years mean performance, progeny 40Kr-2-11 recorded maximum grain yield of 1900 Kg/ha followed by 40Kr-3-4 (1840 Kg/ha). The progenies 40Kr-34 (1.20 score) and 40Kr-1-15 (1.70 score) showed low incidence of powdery mildew compared to Rmt-1 (4.70 score).

#### **10.5 Effect of time of sowing and spacing on the yield of fenugreek**

*Coimbatore, Dholi, Hisar, Kumarganj.*

Experiments were conducted at all the four centres to find out the optimum time of sowing and suitable spacing for higher seed yield in fenugreek.

The trial to determine the optimal time and

spacing for fenugreek with three spacings (15 x 10, 22.5 x 10, 30 x 10 cm) and with six dates of sowing was conducted at Coimbatore. The results revealed that the number of days taken for flowering increased with delayed sowing from Sept. to Nov. while, the plants sown during Nov. 20th took 50.50 (15 x 10 cm) and 50.33 (30 x 10 cm) days and Sept. and Oct. sown flowered in 40-41 days. The variation in pod length due to spacing and date of sowing was marginal which ranged narrowly from 5.55 to 6.65 cm in Nov. 20th sowing and Oct. 5th sowing respectively. In respect of yield, a closer spacing (15 x 10 cm) and sowing during 5th Oct. registered better yield (1733 Kg/ha). This was closely followed by the treatment sowing during Oct. 20th adopting a spacing of 15 x 10 cm (1666 Kg/ha).

At Hisar, significant differences were observed for all the parameters except length of pods and seeds per pod. Maximum seed yield was obtained when the sowing was done on 5th Nov. followed by 20th Oct. with a spacing of 30 x 10 cm.

At Kumarganj, the effect of time of sowing on yield of fenugreek was conducted with five dates (20th Sept. 20th Oct., 20th Nov., 20th Dec. and 20th Jan.) of sowing. The study showed that 20th Oct. sowing recorded the highest yield of 1944 Kg/ha.

A similar trial with three spacings and five

dates of sowing conducted at Dholi with Rajendra Kanti recommended the most optimum spacing as 30 x 10 cm and optimum date of sowing as 15th Oct. for cultivation of fenugreek in Bihar.

### **10.6 Response of fenugreek to Nitrogen, Phosphorus and Rhizobium cultures**

#### *Jobner*

An experiment consisting of 12 treatments which includes nitrogen (0, 20 and 40 Kg/ha.), phosphorus (20 and 40 Kg P<sub>2</sub>O<sub>5</sub>) with and without Rhizobium inoculation using the variety RMT-1 was conducted at Jobner with a seed rate of 20 Kg/ha during rabi 1994-95 and 1995-96. Nitrogen and phosphorus were applied at the time of sowing and observations on yield and yield attributes recorded and harvest index worked out. The two years experimental findings revealed that application of 40 Kg N and 40 Kg P<sub>2</sub>O<sub>5</sub>/ha recorded maximum fenugreek yield of 1818 and 1789 Kg/ha respectively. The inoculation of Rhizobium had no significant effect on growth, yield and yield attributes.

### **10.7 Biocontrol of root rot disease**

#### *Coimbatore*

A biocontrol trial against root-rot in fenugreek was conducted for the management of root-rot in fenugreek at Coimbatore for three seasons (1995-96 to 1996-97). The experiment consisted of eight treatments which showed different effi-

cacy in root rot management in all the three seasons tested. Soil application of neem cake (150 Kg/ha) and seed treatment with *T. viride* seems to be most effective where the incidence of the

disease was very low (4.9%) compared to 23.5% incidence in control. The yield also showed significant variation due to the treatmental effect. ( Table-27 ).

Table 27. Biological control of root rot in Fenugreek

Treatment	Mean wilt incidence(%)			Mean (%)	Yield ( kg/ha )			Mean yield ( kg / ha )
	1995-96	1996-97	1996-97		1995-96	1996-97	1996-97	
ST with carbendazim ( 2 g / kg ) + soil drenching( 0.1% )	16.0 ( 23.58 )	13.5 ( 21.56 )	10.7 ( 19.09 )	13.4	245.0	275.0	370.0	230.0
ST with <i>T. viride</i> ( 4 g / kg )	9.2 ( 17.66 )	8.2 ( 16.64 )	7.2 ( 15.56 )	8.2	387.5	337.5	324.5	362.5
SA of <i>T. viride</i> 20 DDBS	5.5 ( 13.56 )	8.4 ( 16.85 )	11.0 ( 19.37 )	8.3	298.0	312.5	327.0	312.5
SA of Neem cake ( 150 kg / ha )	12.7 ( 20.88 )	12.3 ( 20.53 )	11.9 ( 20.18 )	12.3	315.0	285.0	300.0	300.0
SA of Neem cake + ST with <i>T. viride</i>	4.8 ( 12.66 )	4.9 ( 12.79 )	5.0 ( 12.92 )	4.9	397.0	368.0	382.5	382.5
SA of Neem cake + SA with <i>T. viride</i>	5.0 ( 12.92 )	6.0 ( 14.18 )	7.0 ( 15.34 )	6.0	325.0	300.0	312.5	312.5
SA of Neem cake + ST with carbendazim	6.7 ( 15.00 )	7.5 ( 15.89 )	6.0 ( 14.18 )	7.4	325.6	275.0	300.0	300.0
Soil drenching Control		30.6 ( 33.58 )	21.5 ( 30.33 )	25.5	23.5	215.0	295.0	235.0 225.0
CD ( 5% )	2.28	2.22	2.40		60.66	24.33	49.16	

SA = Soil Application; ST = Seed Treatment ( Figures in parantheses are transformed values )

**Germplasm holdings at AICRPS centres as on 31-03-1997**

Crops/Centres	Indigenous		Exotic	Total
	Cultivated	wild and related sp.		
<b>Black pepper</b>				
Panniyur	65			65
Sirsi	70	20		90
Chintapalli	13	24		37
Yercaud	102	4		106
Dapoli	7			7
<b>Cardmom</b>				
Pampadumapara	77	14		91
Mudigere	245			245
<b>Large Cardamom</b>				
Gangtok				34
<b>Ginger</b>				
Pottangi	153	2	3	158
Solan	176			176
Chintapalli	5			5
<b>Turmeric</b>				
Raigarh	5	1		6
Solan	185			185
Pottangi	178	22		200
Jagtial	188			188
Dholi	56			56
Pundibari	26			26
Kumarganj	15			15
<b>Clove</b>				
Yercaud	13			13
Pechiparai	16			16

Crops/Centres	Indigenous		Exotic	Total
	Cultivated	wild and related sp.		
<b>Nutmeg</b>				
Pechiparai	12			12
Dapoli	16			16
<b>Cinnamon</b>				
Yercaud	10	1		11
Pechiparai	12			12
<b>Coriander</b>				
Jobner	625		105	730
Jagudan	140		26	166
Coimbatore	211			211
Guntur	230		5	235
Hisar	98			98
Dholi	92			92
Raigarh	28			28
<b>Cumin</b>				
Jobner	241		10	251
Jagudan	205		7	212
<b>Fennel</b>				
Jobner	162		8	170
Jagudan	259		21	280
Hisar	58			58
Dholi	34			34
<b>Fenugreek</b>				
Jobner	308		12	320
Jagudan	71		2	73
Coimbatore	169			169
Guntur	76		8	84
Hisar	92			92
Dholi	92			92
Raigarh	24			24

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## FUNCTIONING OF THE COORDINATED PROJECT

INDIA, the *Home of Spices* grow over 50 spices in the country. Among them, black pepper, small and large cardamom, chilli, ginger, turmeric, cumin, coriander, fennel, fenugreek, clove, nutmeg, cinnamon, garlic, saffron and onion are the most important.

The major states growing these spices are Kerala, Karnataka, Andhra Pradesh, Tamil Nadu, Rajasthan, Punjab, Maharashtra, Orissa, West Bengal, Uttar Pradesh, Madhya Pradesh and North Eastern Region. Of late, the non-traditional areas in the NE Region are gaining importance in introduction and expansion of areas under spices. India grow spices in about 2.3 million ha and the annual production is approximately 2.6 million tonnes. During the year 1996-97, India exported 2.2 lakh tonnes of spices worth Rs. 1180 crores. In this contest, the performance of Research Centres under the All India Coordinated Research Project on Spices gain special significance. Over the years, the number of centres has risen from four in 1971 to 20 during 1995-96.

The year 1996-97 marks the Silver Jubilee of the AICRP on Spices. This marks a new era in the network of the AICRP on Spices because, almost all the major states in the country are covered under the AICRPS Project except Punjab and Jammu & Kashmir.

In fact, the project has now become rather unwidely with the 20 centres spread out in 15 states under the purview of 15 State Agricultural Universities besides one ICAR Institute. In addition, eight voluntary centres are reporting to AICRPS on the technical programmes assigned to them, finalized during the Workshops/Group Meetings. As on today, a total of 80 Research Projects are distributed in Crop Improvement-41, Crop Production-15, Crop Protection-19 and Quality Evaluation-5. The crop wise distribution of projects are pepper-9, small cardamom-7, large cardamom-3, ginger-8, turmeric-8, tree spices-6, seed spices-39 (coriander-10, cumin-13, fennel-9 and fenugreek-7). And in large cardamom, there are three projects. The mandate crops are 12 which are cited already. It is also proposed to include crops like ajowan and celery under AICRPS during the coming year.

The total sanctioned budget of the Coordinated Project for the year 1996-97 was Rs. 70.33 lakhs and was shared by 75:25 per cent basis between ICAR and SAUs and the funds were disbursed from ICAR till July, 1996. And from the second half of the financial year, the ICAR has authorized the Project Coordinator to release funds to the 20 Coordinating Centres. Thereby the AICRPS Coordinating Unit at IISR, Calicut released funds directly from Coordinator's Cell to 20 centres from July, 1997 onwards amounting to Rs.45.5 lakhs.

The performance of the centres were evaluated at the Spice Workshops that were attended by the scientists from all the coordinating centres. The recommendation made during the Jaipur workshop have been implemented by the different coordinating centres.

### **Performance of the Centres**

#### *Black Pepper Centres*

The performance of Panniyur, Sirsi and Chintapalli centres are satisfactory. The black pepper research has also been initiated at the three Cardamom centres viz., Yercaud, Mudigere and Pampadumpara, but the progress has been satisfactory only in Yercaud. The new centre at Dapoli has laid out trial in black pepper. The MLT in black pepper was laid out at the participating centre at Ambalavayal(KAU). The Panniyur centre has developed management techniques against *Phytophthora* foot rot, the irrigation cum fertilizer requirement experiment gave encouraging results. The research on bio-control of *Phytophthora* are progressing.

There has been very high demand for the planting materials of released varieties of black pepper from Kerala, Karnataka and Tamil Nadu. In order to meet the requirement, the centres have taken up massive programmes on multiplication and distribution of rooted pepper cuttings ( 2,00,649 nos.). The performance of the Chintapalli and Sirsi centres have been critically examined. After repeated persuasion, the University has filled up all the three posts at Sirsi. At Chintapalli, the post of Pathologist though

vacant for the last few months is also filled up.

#### *Cardamom Centres*

The work at two Cardamom centres viz., Mudigere and Pampadumpara have been progressed. The Mudigere centre has made substantial progress and successfully laid out all the trials systematically. Four projects were closed viz., the cultural and chemical control of thrips and capsule borer at Mudigere and Pampadumpara centres and manurial requirement, estimation of crop loss due to cardamom shoot borer and determination of number of sprays for thrips control which were in operation at Mudigere. The Mudigere centre is imparting modern techniques in cardamom.

The Pampadumpara centre has improved its performance subsequent to the filling of all the sanctioned scientific positions except the breeder post. Some of the experiments which were not taken up during the past years have been laid out. This includes the new MLT in black pepper. The plant pathology programmes in cardamom were discontinued. Black pepper research needs to be strengthened in view of the crop becoming more popular in the zone.

The Gangtok, the lone centre working on large cardamom did not participate in the Jaipur Workshop and the reports have not been received during the past two years. This may perhaps be due to the fact that the centre is functioning under non-plan budget which is under the ICAR Research Complex, Shillong.

### *Ginger and Turmeric Centres*

Ginger work is being conducted at Solan, Pottangi as well as the new centre at Pundibari. All the assigned technical programmes in ginger have been laid out systematically. The Coimbatore centre has taken up turmeric work and Chintapalli centre has taken up ginger research on voluntary basis. The MLT 1991-Series III in ginger at Pottangi and Solan, standardization of rhizome size in ginger for high yield at Dholi were discontinued. The turmeric work is satisfactory at Pottangi, Jagtial and Dholi centres. The new centres at Kumarganj, Raigarh and Pundibari have initiated the work on turmeric. The Solan centre discontinued the work on turmeric as per the Workshop decision at Jaipur. The centre is concentrating on ginger research. The effect of spacing on yield of turmeric at Dholi was closed.

In short, the Turmeric centres are carrying out commendable work. All the ongoing trials are systematically laid out and progressing well. The Pottangi centre is meeting very great demand for seed rhizome of ginger and turmeric of the released varieties.

### *Tree Spices Centres*

Substantial progress has been made in tree spices research by the Yercaud centre. As per the Workshop decision, the programme on cardamom was discontinued because of less priority. Black pepper research is therefore included at Yercaud centre in view of the importance of

the crop in the region. In addition, Pechipara, Thadiyankudisai (TNAU) and Ambalavayal (KAU) are functioning as participatory centres. The new centre Dapoli in Maharashtra is doing substantial work in tree spices.

### *Seed Spices Centres*

The Seed Spices centres viz., Jobner, Jagudan, Guntur, Hisar, Coimbatore and Dholi laid out all the trials as per the technical programme. The new centres initiated during 1995-96 viz., Kumarganj and Raigarh were also linked in the system and initiated the work.

In short, all the eight Centres working on seed spices are making steady progress.

The Hisar centre though identified to work on the four seed spices, the work on cumin was discontinued in view of the heavy incidence of wilt disease as per the decisions of XII Workshop.

The Programme on the response of coriander to weed management at Jobner and MLT 1989-Series I in cumin were closed at Jobner, Jagudan and Hisar centres. Two more crops viz., ajowan and celery are proposed to be included during IX Plan.

The post of Horticulturist which was vacant for about three years is filled up at Guntur. In the four new centres, all the scientific positions were filled except the Jr. Pathologist at Kumarganj and Jr. Breeder at Pundibari.

**ACTION TAKEN ON THE RECOMMENDATIONS OF THE XIII WORKSHOP ON SPICES HELD AT JAIPUR DURING JULY 1995 AND ACTION TAKEN REPORT ON THE EARLIER DECISIONS**

<i>DECISIONS</i>	<i>ACTION TAKEN / REMARKS</i>
<b>GENERAL</b>	
<p>1. Emphasis should be given for collecting germplasm from local areas of coordinating centres. Passport data should be maintained for all the germplasm collected and separate minimum descriptor has to be prepared for every spice.</p>	<p>Surveys are being taken up and collections are being made. The NBPGR Regional Stations at Hyderabad and Trichur have been involved in the programmes. Separate minimum descriptors have been provided for Black pepper, Cardamom, Ginger and Turmeric.</p>
<p>2. Any variety for release has to be considered based upon the yield increase of 10-15% over the standard check varieties or they should possess desirable characters like better quality, adaptability or resistance to biotic and abiotic stresses.</p>	<p>Black pepper variety Panniyur-5 has been released by the KAU. Coriander variety UD-40 from Jobner has been sent for notification. The mango ginger variety viz., Amba and turmeric variety viz., Sonali are still pending finalisation for release. Due to certain deficiency in data, the proposals have been advised for resubmission.</p>
<p>3. Crop cafeteria of all released varieties to be established to serve as a demonstration block.</p>	<p>Only at Yercaud, Panniyur, Pottangi, Coimbatore and Jobner Centres, this activity has been exhibited. Other Centres have been advised to repeat the same.</p>
<p>4. The MLT experiments have to be initiated and laid out only sufficient planting materials in all the entries are made available, only the best released/pre-released varieties should be entered in the MLTs.</p>	<p>Being followed by all Centres.</p>
<p>5. Promising cultures under MLT should be</p>	<p>Has been taken up by centres which have re-</p>

evaluated in farmers' field besides being evaluated at the Research Station.

6. In all the manurial experiments, the soil and plants analysis should be taken up immediately.

7. In all the experiments, Cost : Benefit ratio are to be worked out.

8. In view of the growing awareness to environmental pollution and eco-friendly produce, more emphasis on reaction to pests and diseases have to be laid during varietal screening.

9. The Pathologist of the Scheme at Solan will find out the suitable date for obtaining training on the VAM technology, toxin isolation and tissue culture techniques from IISR.

10. The IISR may organise short term training on isolation, mass multiplication and application of biocontrol agents used in management of soil borne pathogens of spices.

11. Need to create plant quarantine units in Centres in view of the threat for inter-State transmission of diseases and pests.

12. Provision of passport data and minimum description for each spice.

leased varieties.

This has been initiated; but there is lack of initiative in some Centres to recognise this important suggestion.

The Cost : Benefit ratio have been worked out in the concluded trials and the data incorporated in the Reports.

Being attended to by all centres.

Training has already been given at IISR to the Pathologist from Solan Centre during October 1996. The Scientists from Chintapalli, Panniyur and Jagtial centres did not turn up although a well drawn programme was arranged at the IISR. The Scientists need to be motivated to undergo this important requirement.

Being organised in consultation with the Centres.

The importance has been highlighted to the Centres and perhaps during the IX Plan, special steps will be taken to create this facility.

Necessary proforma have already been provided to all the Coordinating Centres and in fact

13. Project Coordinator may update information on seed stock of improved varieties of various spices and pass on the same to user agencies and ensure the Transfer activity.

14. Frequent transfer of Scheme Scientists affect the work and long term vacancies like Horticulturist at Guntur, Breeder at Pampadumpara etc. need to be pursued.

15. Efforts on research on large cardamom are inadequate and hence we may initiate some programmes through the ICAR Research Complex.

### **CARDAMOM**

1. The promising, short listed cardamom lines of Mudigere need to be mass multiplied through tissue culture. The ICRI, Myladumpara will take up the multiplication programme.

2. All the centres working on cardamom will collect data on the tiller, no. of bearing tillers, no. of panicles, no. of capsules per panicle, no. of capsule per node and yield per clump.

3. The voluntary centre at Thadiyankudisai will have to relay the MLT in cardamom.

4. All the data pertaining to the ecology and management of thrips in cardamom may be

duplicate sets have been sent to them again. The Centres may be advised to under take this item urgently.

PC is periodically monitoring the issue and needful has been done for Kerala, Karnataka, Andhra Pradesh, Tamil Nadu, Orissa, Gujarat, Madhya Pradesh, etc.

SAUs have been periodically reminded on this; vacant positions have been repeatedly reminded to SAU authorities.

The Gangtok Centre is not very much active and all efforts have been taken to obtain reports from the Centre; Director has been requested to sponsor Scientists to attend our Workshops.

Mudigere centre has been equipped with a micropropagation laboratory recently and work has been initiated at Mudigere itself.

This is being done.

Needful has been done.

Centres have been reminded to attend to this.

compiled by Mudigere and Pampadumpara. Residue analysis may be carried out in all the chemical control trials.

## **BLACK PEPPER**

1. The MLT-IV 1991 will be laid out in all the pepper and cardamom centres. MLT on black pepper 1991 Series IV is to be discontinued at Chintapalli. The Project Coordinator may visit the Chintapalli Centre for a review.

2. Experiment on Phytophthora foot rot and nematode disease management to be continued.

3. The incidence of pests on black pepper in irrigation-cum-fertilizer trial / experiment to be recorded at Sirsi. It was suggested to replace the necessary loss due to disease.

4. New experiment on disease management of black pepper consisting of chemical and biocontrol measures may be laid out.

5. An Adhoc Scheme proposal on feasibility of pepper cultivation in tribal areas in Orissa to be prepared by Pottangi Centre.

6. The Pottangi Centre will also take up a MLT on black pepper with released varieties.

7. The nursery management results may be compiled and new schedule of treatment may be finalised.

As per the Jaipur Workshop decision, the MLT-1991 is dropped at Sirsi and the new MLT has been initiated. The Project Coordinator has visited the Chintapalli Centre and the progress has been satisfactory.

Being continued.

About 20% of the vines were destroyed due to foot rot disease and replanting work and necessary control measures have been adopted. The missing accessions are being replaced at Sirsi.

New technical programme has been communicated to all the Centres and the trials already laid out.

Centre has been reminded to give the proposal.

Centre has been reminded to take up the programme.

Panniyur centre has been reminded to finalise the matter soon.



8. Solarisation of nursery mixture and incorporation of antagonists can form part of nursery management technology in black pepper by all Centres.

9. As observation trial on impact of basin management with marigold may be assessed in relation to population of pathogenic nematodes of pepper. The required seed materials of marigold seeds will be supplied by M/s. Synthite Industrial Chemicals Ltd., Kozhanchery

10. Plantation of pepper may be monitored periodically in March, June-July-October by Mudigere to assess the pest incidence in hilly regions.

11. The experiment on irrigation cum fertilizer level at Panniyur may be concluded and one new experiment on drip irrigation cum fertilizer may be laid out with latest, released varieties (one each in OP and hybrid)

## GINGER

1. The trial on maximization of ginger will be taken up at Solan.

2. A greater attention for developing low fibre varieties will have to be done

3. The experimental results on ginger at Chintapalli centres are to be compiled and sent to PC

Centres have been advised to follow this decision.

The seeds have since been supplied by M/s. Synthite and the results are expected from the Centres.

Centre did not take up the programme due to want of manpower and finance. The University authorities may be requested to provide additional support to the Mudigere Centre.

The trial has been laid out.

Has been done at Solan.

Solan and Pottangi centres were advised.

Details have since been received but the Centre is advised to provide the consolidated progress report for three years.

4. Planting material of released varieties may be supplied to needy States by Pottangi Centre

### **TURMERIC**

1. An *Ad hoc* Scheme on rhizome rot and leaf spot diseases of turmeric will be prepared by PC and the Project will be located in three selected centres.

2. To confirm etiology of disease and associated pathogens / pathogenicity of *Pythium* sp. and *Fusarium* sp. singly and in combination, studies may be undertaken by Jagtial centre.

3. Planting materials of released varieties may be supplied to needy States

### **TREE SPICES**

1. It was suggested to try multiplication of Orissa Cinnamon through air layering in the month of June-July at Yercaud

2. The Yercaud Centre will study the quality aspect of cinnamon bark on harvest during September 1995

3. All experiments on tree spices at Yercaud will continue. Seeds of wild nutmeg available in the Kolli hills region may be used for grafting

The Centre has supplied 14 q Suprabha to Maharashtra and 18 q Suprabha to West Bengal.

Jagtial centre has been advised to take up the programme and discuss with the PC.

Work has been initiated.

Pottangi Centre has supplied 14 q Roma to Madhya Pradesh

Vegetative propagation programme with Orissa Cinnamon has been initiated at Yercaud in December 1995; unrooted cuttings treated with Seradix gave 76% success in 45 days; further trials with air layering are under evaluation

As per PC's suggestion, the coppicing of cinnamon during September 1995 was postponed as the plants have not attained the proper height and growth; coppicing will now be done in late 1996 and quality analysis confirmed at IISR. Results awaited.

Arrangements were made to procure wild nutmeg from the Kolli hills and the centre is yet to report on the further progress.

4. In the biofertilizer trial on tree spices at Yercaud, the method of application may be standardised. The soil microflora may be monitored continuously throughout the year.

5. Periodical monitoring may be undertaken in identifying the pest & disease problems in tree spices in all centres.

### SEED SPICES

1. The available fenugreek germplasm may be evaluated for "green purpose" and simultaneously, the germplasm from Jobner may be collected and evaluated at Guntur.

2. The Coimbatore Centre has been asked to collect germplasm materials in coriander and fenugreek at least 4 different districts in Tamil Nadu viz., Madurai, Ramanad, Kamarajar and Kattabomman, during 1995-96.

3. Hisar centre has been advised to take up quality analysis of leafy type in coriander

4. Germplasm material of Ajowan in Guntur, Dholi and Hisar Centres may be exchanged.

5. The quality analysis facilities available at Jobner has to be availed by all seed spices centres. It is suggested that an exploration for exotic types for oil content could be taken up on priority; the role of variety and agro climatic situations on the quality of oil has to be established.

Adequate care has been taken during the year for the application of biofertilizers. A time gap of 15 days has been given after application of *Azospirillum* and Phosphobacteria for the inorganic fertilizer. The soil population dynamics is being monitored periodically.

Being done in all centres.

Being done.

Material has since been collected and evaluation commenced.

Work has been initiated.

Correspondence initiated between centres in this regard.

Jobner centre is already extending this facility. Exploration work is yet to be initiated outside Rajasthan; a beginning has been made for Fennel in Madhya Pradesh.

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6. The new MLT in coriander and fenugreek with the identified entries to be taken up in all Centres.

Since initiated in all centres.

7. Promising cultures from screening programme since 1972 may be short listed and made use in future MLT by all centres.

Centres have been requested to provide this information.

**All India Coordinated Research Project on Spices**  
**Centre-wise Head-wise Annual Plan Allocation and Expenditure for 1996-97**

Centres	Salary		TA		RC		NRC		Total	
	Alloc.	Exp.	Alloc.	Exp.	Alloc.	Exp.	Alloc.	Exp.	Alloc.	Exp.
Pampadumpara	3.33	4.06	0.08	0.08	0.60	0.37	-	-	4.01	4.49
Mudigere	6.17	6.29	0.14	0.01	1.00	1.00	-	-	7.31	7.30
Yercaud	2.51	2.31	0.06	0.05	0.40	0.40	-	-	2.97	2.76
Panniyur	6.37	6.63	0.12	0.17	0.80	0.87	0.49	-	7.78	7.67
Chintapalli	2.66	2.26	0.08	0.13	0.40	0.40	-	-	3.14	2.79
Sirsi	2.11	2.45	0.10	0.10	0.40	0.40	-	-	2.61	2.95
Solan	3.49	4.69	0.12	0.26	0.60	0.59	-	-	4.21	5.54
Pottangi	2.66	2.78	0.10	0.10	0.40	0.40	2.00	2.00	5.16	5.28
Jobner	7.10	9.70	0.20	0.20	1.54	1.34	-	-	8.84	11.24
Guntur	2.66	1.91	0.04	0.03	0.40	0.39	-	-	3.10	2.33
Jagudan	2.66	3.08	0.08	0.07	0.40	0.40	-	-	3.14	3.55
Coimbatore	2.66	3.97	0.04	0.06	0.40	0.39	-	-	3.10	4.42
Jagtial	2.11	1.70	0.02	0.02	0.40	0.40	-	-	2.53	2.12
Hisar	2.21	2.29	0.05	0.05	0.40	0.39	-	-	2.66	2.73
Dapoli	3.54	2.14	0.10	0.10	0.60	0.66	2.00	2.00	6.24	4.90
Pundibari	3.54	1.64	0.10	-	0.60	0.43	-	-	4.24	2.07
Kumarganj	4.15	1.00	0.10	0.03	0.60	0.58	2.00	2.00	6.85	3.61
Raigarh	3.54	1.08	0.10	0.01	0.60	0.60	-	-	4.24	1.69
Dholi	2.66	NA*	0.06	NA	0.40	NA	-	-	3.12	3.12
<b>TOTAL</b>	<b>66.13</b>	<b>59.98</b>	<b>1.69</b>	<b>1.47</b>	<b>10.94</b>	<b>10.01</b>	<b>6.49</b>	<b>6.00</b>	<b>85.25</b>	<b>80.56</b>
<b>ICAR Share(%)</b>	<b>49.60</b>	<b>44.99</b>	<b>1.27</b>	<b>1.10</b>	<b>8.21</b>	<b>7.51</b>	<b>4.87</b>	<b>4.50</b>	<b>63.94</b>	<b>60.42</b>

\* - Not Applicable

## STAFF

### PROJECT CO-ORDINATOR'S CELL

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Asst. Professor (Agron.)	:	C. George Thomas
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Lab Assistant Gr.I	:	P.V. Joseph
Farm Assistant	:	V.P. Prasad
Peon	:	Aleykutty

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Jr.Plant Pathologist	:	M.P. Jain
Asst.Biochemist	:	S. Agarwal
Sr.Technical Assistant	:	Dhirendra Singh
Jr.Technical Assistant	:	S.R. Kumawat

**10.REGIONAL AGRICULTURAL RESEARCH STATION, APAU, GUNTUR**

Horticulturist	:	Vacant
Jr.Breeder(Hort.)	:	N. Hariprasad Rao
Sub Assistant	:	K. Sivakumar

**11. SPICES RESEARCH STATION, GAU, JAGUDAN**

Sr. Plant Pathologist	:	A.J. Patel
Jr.Breeder (Hort.)	:	G.M. Patel
Jr.Technical Assistant	:	R.N. Patel

**12.DEPARTMENT OF SPIECs & PLANTATION CROPS, TNAU, COIMBATORE**

Breeder (Assoc.Prof.)	:	T. Thangaraj
Jr.Pathologist	:	Muthukrishnan
Agricultural Assistant	:	D. Elumalai

**13. REGIONAL AGRICULTURAL RESEARCH STATION, APAU, JAGTIAL**

Jr.Pathologist	:	C.L. Narsimha Chary
Asst.Horticulturist	:	A. Manohar Rao
Technical Asst. / Sub-Asst.	:	Vacant

**14.ICAR RESEARCH COMPLEX FOR NEH REGION, GANGTOK**

Scientist S <sub>2</sub> (Pl.Path.)	:	L.S. Srivastva
Scientist S <sub>1</sub> (Hort.)	:	G.S. Karibasappa



**15. DEPARTMENT OF VEGETABLE CROPS (CCS-HAU), HISAR**

Olericulturist/Horticulturist	:	K.K. Thakral
Assistant Scientist (VC)	:	Suresh Tehlan

**16. TIRHUT COLLEGE OF AGRICULTURE, RAU, DHOLI**

Horticulturist	:	S.P. Singh
Jr.Pathologist	:	Bimla Rai
Technical Assistant	:	Vacant

**17. KONKAN KRISHI VIDYAPEETH, DAPOLI**

Horticulturist	:	A.D. Rangawala
Jr.Breeder	:	D.S. Bagade
Jr.Pathologist	:	N.R. Padeldar
Tech.Assistant	:	S:D. Tambe
Tech.Assistant	:	S.G.Thore

**18. NARENDRA DEV UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, KUMARGANJ**

Horticulturist	:	T. Singh
Jr.Breeder	:	B.N. Singh
Jr.Pathologist	:	Vacant
Tech.Assistant	:	R.K. Gupta
Tech.Assistant	:	Vacant

**19. INDIRA GANDHI KRISHI VISHWA VIDYALAYA, RAIGARH**

Horticulturist	:	Shashank Singh
Jr.Breeder	:	Satish Verulkar
Jr.Pathologist	:	A.K. Singh
Tech.Assistant (2 Posts)	:	Vacant

**20. BIDHAN CHANDRA KRISHI VISWA VIDYALAYA, PUNDIBARI**

Horticulturist	:	P. Hazra
Jr.Breeder	:	Vacant
Jr.Pathologist	:	B.N. Panja
Tech.Assistant (2 Posts)	:	Vacant

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## WEATHER DATA 1996

Centre : Pampadumpara

Latitude : 9° 45' N  
 Longitude : 77° 10' E  
 Altitude : 1100 m MSL  
 Soil : Clay loam

Month	Monthly rainfall (MM)	Rainy Days (No)	Temperature (°C)	
			Max	Min
January	100.0	2	25.0	13.0
February	10.6	2	28.5	13.5
March	4.6	1	32.0	14.5
April	233.4	13	31.0	17.5
May	--	--	29.0	17.0
June	358.6	18	29.0	16.0
July	470.2	26	27.0	15.5
August	223.7	30	25.0	17.0
September	205.2	22	25.0	16.0
October	288.8	19	29.0	14.5
November	70.6	15	26.0	15.5
December	58.8	10	26.0	13.0
Total/Mean	2023.5	158	27.7	15.20

## WEATHER DATA 1996

Centre : Chintapalli

Latitude : 17° 52' N  
 Longitude : 82° 14' E  
 Altitude : 818 m MSL  
 Soil : Clay loam

Month	Monthly Rainfall (MM)	Rainy Days (No)	Temperature (°C)		RH (%)
			Max	Min	
January	--	--	25.0	12.9	78.9
February	--	--	29.0	12.6	86.7
March	--	--	34.3	14.5	80.7
April	116.0	6	31.8	18.9	83.1
May	92.0	5	33.3	20.5	74.3
June	254.1	9	28.8	21.6	77.1
July	160.2	15	27.3	21.5	83.6
August	246.0	20	20.0	21.3	87.0
September	212.9	19	27.8	20.6	90.0
October	113.4	12	25.3	19.3	90.2
November	28.5	2	26.8	10.3	89.2
December	--	--	28.3	7.8	86.9
Total/Mean	1223.1	88	28.14	16.81	--

## WEATHER DATA 1996

Centre : Guntur

Latitude : 16° 18' N  
 Longitude : 80° 29' E  
 Altitude : 32 m MSL  
 Soil : Black clayey

Month	Monthly rainfall (MM)	Rainy Days (No)	Mean Temperature (°C)		Mean RH (%)
			Max	Min	
January	--	--	30.7	16.8	90.2
February	2.2	--	32.5	18.7	86.5
March	--	--	36.5	22.1	82.9
April	6.6	2	37.5	25.8	78.9
May	31.2	1	43.0	27.2	77.5
June	124.0	5	37.3	26.6	76.9
July	209.0	9	34.9	25.2	81.1
August	370.6	14	32.6	24.8	87.4
September	134.8	7	33.6	24.8	88.1
October	151.2	7	31.1	23.9	92.3
November	41.6	1	31.4	19.9	88.2
December	6.1	0	29.9	17.2	89.3
Total/Mean	1077.3	46	34.3	22.7	

## WEATHER DATA 1996

Centre : Kumarganj

Soil : Clay loam

Month	Monthly rainfall (MM)	Mean Temperature (°C)		Mean RH (%)
		Max	Min	
January	--	--	--	--
February	--	--	--	--
March	--	--	--	--
April	0.6	37.3	19.2	42.3
May	2.2	41.2	25.3	37.2
June	99.2	35.7	27.0	65.2
July	132.6	33.4	26.7	81.7
August	368.6	31.9	26.1	88.8
September	168.2	32.3	25.8	84.1
October	165.2	30.1	20.0	73.7
November	--	28.2	11.4	59.4
December	--	24.4	6.4	63.1
Total/Mean	936.6	32.7	20.9	

## WEATHER DATA 1996

Centre : Yercaud

Latitude : 11° 4' N  
 Longitude : 78° 5' E  
 Altitude : 1450 m MSL  
 Soil : Clay loam

Month	Monthly rainfall (MM)	Rainy Days (No)	Mean Temperature (°C)		Mean RH (%)
			Max	Min	
January	--	--	22.4	12.0	57.1
February	--	--	25.0	12.9	58.0
March	--	--	28.7	16.0	53.0
April	193.2	12	27.8	16.6	62.9
May	41.7	2	30.8	17.8	64.3
June	272.4	10	24.8	17.1	68.0
July	34.8	3	24.0	16.6	67.1
August	317.6	11	24.3	16.5	67.9
September	476.5	19	23.8	16.5	68.0
October	187.9	8	22.5	16.0	66.6
November	76.5	5	21.6	14.1	65.6
December	356.7	12	20.7	13.1	67.2
Total/Mean	1957.3	82	24.7	15.43	



## WEATHER DATA 1996

Centre : Jobner

Latitude : 23° 52' N  
 Longitude : 72° 43' E  
 Altitude : 90.6 m MSL  
 Soil : Sandy loam

Month	Monthly rainfall (MM)	Rainy Days (No)	Mean Temperature (°C)		Mean RH (%)
			Max	Min	
January	10.8	6	21.4	4.4	52.4
February	1.2	5	22.0	5.9	55.6
March	5.5	17	30.5	13.4	43.7
April	--	3	33.4	14.6	40.6
May	10.4	10	38.8	19.9	40.0
June	151.8	19	36.0	23.8	57.6
July	154.1	26	35.0	25.2	66.1
August	285.1	31	30.7	23.9	81.1
September	76.2	18	30.0	22.6	74.0
October	23.0	19	31.6	16.4	66.0
November	--	2	29.1	7.4	50.8
December	--	3	24.8	3.1	51.8
Total/Mean	658.0	159	30.2	15.0	

## WEATHER DATA 1996

Centre : Hisar

Latitude : 29° 1' N  
 Longitude : 75° 5' E  
 Altitude : 215.2 m MSL  
 Soil : Sandy loam

Month	Monthly rainfall (MM)	Rainy Days (No)	Mean Temperature (°C)		Mean RH (%)
			Max	Min	
January	5.3	2	20.1	4.3	92
February	35.2	4	23.6	6.8	92
March	31.6	3	28.8	11.7	89
April	--	--	36.7	16.0	65
May	13.0	2	39.8	22.3	48
June	107.7	11	37.5	24.8	71
July	69.5	7	36.7	25.8	79
August	95.5	9	34.0	24.6	88
September	87.7	5	34.4	22.3	84
October	3.0	1	33.2	15.7	80
November	2.0	1	28.7	8.1	81
December	--	--	23.1	2.3	82
Total/Mean	450.5	45	31.4	15.4	

## WEATHER DATA 1996

Centre : Panniyur

Latitude : 12° 5' N  
 Longitude : 74° 55' E  
 Altitude : 95 m MSL  
 Soil : Laterite

Month	Monthly rainfall (MM)	Rainy Days (No)	Mean Temperature (°C)		Mean RH (%)
			Max	Min	
January	--	--	33.9	20.6	80.9
February	--	--	36.8	20.0	80.1
March	--	--	38.8	23.6	80.5
April	31.0	4	36.9	24.0	77.9
May	59.4	5	36.1	24.3	73.8
June	1087.1	18	32.0	23.0	87.4
July	997.4	26	28.5	22.4	89.3
August	661.6	24	29.0	23.0	92.0
September	204.2	15	30.6	23.1	90.4
October	352.8	18	29.9	22.1	89.2
November	70.3	4	31.7	21.6	88.0
December	105.8	4	32.9	19.4	86.3
Total/Mean	3569.0	118	33.1	22.3	

## WEATHER DATA 1996

Centre : Sirsi

Latitude : 14° 36' N  
 Longitude : 74° 50' E  
 Altitude : 619 m MSL  
 Soil : Laterite

Month	Monthly rainfall (MM)	Rainy Days (No)	Temperature (°C)	
			Max	Min .
January	--	--	30.0	16.4
February	--	--	31.2	16.9
March	--	--	33.5	17.5
April	--	--	34.1	20.2
May	36.0	1	33.6	21.4
June	410.5	11	27.8	20.1
July	901.0	20	24.7	19.7
August	310.8	27	25.3	18.9
September	145.8	9	24.4	18.9
October	230.1	13	26.5	19.8
November	--	--	26.5	15.7
December	287.9	4	26.8	15.2
Total/Mean	2322.0	85	28.7	18.4

## WEATHER DATA 1996

Centre : Jagudan

Latitude : 23° 52' N  
 Longitude : 72° 43' E  
 Altitude : 90.6 m MSL  
 Soil : Sandy loam

Month	Monthly rainfall (MM)	Rainy Days (No)	Temperature (°C)	
			Max	Min
January	18	1	28.1	10.4
February	--	--	32.4	10.7
March	--	--	38.3	17.4
April	--	--	40.5	17.3
May	--	--	42.1	23.5
June	50	3	41.5	27.0
July	178	8	36.3	26.1
August	122	7	34.5	24.4
September	100	5	35.6	22.2
October	13	1	36.8	18.5
November	--	--	33.9	13.3
December	--	--	30.6	10.5
Total/Mean	481	25	35.9	18.42

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## WEATHER DATA 1996

Centre : Dapoli

Soil : Clay loam

Month	Monthly rainfall (MM)	Rainy Days (No)	Mean Temperature (°C)		Mean RH (%)
			Max	Min	
January	--	--	30.1	11.7	54
February	--	--	31.8	10.3	46
March	--	--	33.2	14.1	70
April	--	--	33.3	22.5	72
May	--	--	32.1	22.4	73
June	461.7	18	30.7	23.6	80
July	1533.2	29	33.4	23.6	88
August	618.5	29	27.5	22.5	89
September	363.2	14	28.2	21.9	87
October	173.5	7	29.9	19.5	62
November	9.0	1	31.4	13.9	71
December	4.0	1	31.4	12.9	72
Total/Mean	3164.1	99	31.10	18.3	

## WEATHER DATA 1996

Centre : Solan

Latitude : 30° 5' N  
 Longitude : 77° 8' E  
 Altitude : 1000 m MSL  
 Soil type : Loam

Month	Monthly rainfall (MM)	Mean Temperature (°C)		Mean RH (%)
		Max	Min	
January	96.6	16.6	3.7	69.0
February	110.6	18.8	5.4	68.0
March	88.4	22.7	9.7	59.0
April	4.6	27.4	14.5	44.0
May	26.6	31.2	15.7	36.0
June	176.2	30.0	18.4	66.0
July	81.6	28.1	20.0	81.5
August	353.6	27.3	19.7	87.0
September	498.2	27.0	18.0	86.0
October	36.8	26.0	11.7	58.0
November	--	23.1	6.5	50.0
December	3.4	20.0	3.0	47.0
Total/Mean	1476.6	298.2	148.3	

## WEATHER DATA 1996

Centre : Dholi

Latitude : 25° 41' N  
 Longitude : 34° 6' E  
 Altitude : 52.8 m MSL  
 Soil : Sandy loam

Month	Monthly rainfall (MM)	Rainy Days (No)	Mean Temperature (°C)		Mean RH (%)
			Max	Min	
January	20.4	2	22.1	8.9	85
February	39.0	2	25.0	10.2	89
March	--	--	32.7	17.2	80
April	4.8	1	37.2	19.8	70
May	21.2	1	29.1	25.7	76
June	307.2	9	34.6	25.8	82
July	260.7	11	31.5	27.2	88
August	254.2	6	32.1	26.5	88
September	127.2	8	31.9	26.0	89
October	109.4	5	31.2	22.6	86
November	--	--	28.8	14.8	86
December	--	--	24.7	8.9	86
Total/Mean	1144.1	45	30.9	19.5	



## WEATHER DATA 1996

Centre : Pottangi

Latitude : 18° 34' N  
 Longitude : 82° 52' E  
 Altitude : 917 m MSL  
 Soil : Sandy loam

Month	Monthly rainfall (MM)	Rainy Days (No)	Mean Temperature (°C)		Mean RH (%)
			Max	Min	
January	--	--	25.3	22.7	72.3
February	--	--	26.0	23.0	76.0
March	--	--	28.0	24.0	68.0
April	10.7	6	28.0	23.0	65.0
May	2.9	3	29.0	25.0	61.0
June	19.3	12	25.0	22.0	70.0
July	37.8	27	24.0	22.0	85.0
August	41.7	28	25.0	23.0	85.0
September	18.9	15	26.5	24.5	86.0
October	8.8	18	22.0	19.0	80.0
November	6.8	8	25.0	14.0	75.0
December	1.5	5	19.0	13.0	64.0
Total/Mean	148.1	122	25.2	21.3	

## WEATHER DATA 1996

Centre : Coimbatore

Latitude : 11° N  
 Longitude : 77° E  
 Altitude : 426.72 m MSL  
 Soil : Clay loam

Month	Monthly rainfall (MM)	Rainy Days (No)	Mean Temperature (°C)		Mean RH (%)
			Max	Min	
January	--	--	30.4	18.7	86
February	--	--	32.5	20.0	84
March	--	--	35.6	20.0	76
April	167.5	11	34.4	23.6	86
May	6.9	2	35.1	23.5	81
June	56.4	8	32.1	23.0	77
July	47.7	8	30.6	22.6	84
August	36.2	2	31.6	22.4	85
September	52.8	3	30.7	22.4	87
October	197.6	9	30.3	20.9	87
November	61.4	5	30.0	20.6	90
December	117.2	7	27.9	18.2	--
Total/Mean	743.7	55	32.0	21.3	

## WEATHER DATA 1996

Centre : Jagtial

Latitude : 18° 58' N  
 Longitude : 78° 56' E  
 Altitude : 243.4 m MSL  
 Soil : Sandy loam

Month	Monthly rainfall (MM)	Rainy Days (No)	Mean Temperature (°C)		Mean RH (%)
			Max	Min	
January	--	--	30.7	17.7	87.0
February	20.2	1	32.4	23.6	82.0
March	--	--	37.3	24.7	71.0
April	22.2	--	38.3	24.1	68.0
May	16.4	--	43.1	25.6	53.5
June	56.4	5	38.7	25.2	79.0
July	168.2	11	32.9	24.8	81.0
August	232.8	19	30.4	23.5	87.0
September	119.2	7	32.8	23.5	88.0
October	97.4	6	31.6	21.3	87.3
November	--	--	31.0	16.8	82.0
December	--	--	29.6	13.2	78.0
Total/Mean	733.2	49	34.1	22.0	

## WEATHER DATA 1996

Centre : Mudigere

Latitude : 13° 50' N  
 Longitude : 75° 39' E  
 Altitude : 1175 m MSL  
 Soil : Clay loam

Month	Monthly rainfall (MM)	Rainy Days (No)	Mean Temperature (°C)		Mean RH (%)
			Max	Min	
January	0.4	--	28.3	14.4	87
February	--	--	29.5	15.0	87
March	--	--	32.5	17.1	88
April	64.2	7	31.2	18.8	93
May	36.7	2	30.7	19.3	91
June	698.5	14	25.0	19.0	94
July	590.8	23	23.7	18.6	96
August	303.8	27	23.1	18.5	94
September	254.8	16	25.2	18.5	92
October	144.0	11	25.3	18.0	88
November	22.0	1	26.8	17.2	85
December	50.2	3	25.8	14.8	--
Total/Mean	2165.4	104	27.3	17.4	

## WEATHER DATA 1996

Centre : Raigarh

Latitude : 21° 15' to 23° 15' N  
 Longitude : 82° 95' to 84° 20' E  
 Altitude : 237 m MSL  
 Soil : Sandy loam

Month	Monthly rainfall (MM)	Rainy Days (No)	Mean Temperature (°C)		Mean RH (%)
			Max	Min	
January	--	--	27.4	14.9	72.2
February	3.8	1	30.9	13.1	63.3
March	--	--	36.2	17.3	58.8
April	--	--	41.0	24.0	43.3
May	--	--	43.7	29.8	39.8
June	216.6	9	36.5	26.1	71.0
July	345.7	12	32.8	25.0	74.4
August	421.9	22	28.7	23.8	89.8
September	132.0	9	31.4	24.5	84.5
October	--	--	31.5	23.6	76.8
November	--	--	32.0	14.1	67.1
December	--	--	28.2	9.7	63.2
Total/Mean	1120.1	53	33.4	20.5	

**ALL INDIA COORDINATED  
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Indian Institute of Spices Research**

