वार्षिक रिपोर्ट ANNUAL REPORT 1999-2000

AGRO-TECHNIQUES FOR RAINFED COTTON PRODUCTION

CICR

केन्द्रीय कपास अनुसंधान संस्थान

CENTRAL INSTITUTE FOR COTTON RESEARCH

भाकृअनुप
ICAR

वार्षिक रिपोर्ट

ANNUAL REPORT
1999-2000

केन्द्रीय कपास अनुसंधान संस्थान

पोस्ट बैग नं 2, शंकर नगर, नागपुर - 440010 (महाराष्ट्र) भारत

CENTRAL INSTITUTE FOR COTTON RESEARCH

Post Bag No. 2, Shankar Nagar, PO, Nagpur-440010 (MS), India.

Correct citation : CICR, Annual Report 1999-2000
Central Institute for Cotton Research, Nagpur, India
PP. 118

Published by : **Dr. C. D. Mayee**
Director
Central Institute for Cotton Research,
Post Bag No. 2, Shankar Nagar, PO, Nagpur - 440010
(MS), India.

Editorial committee : **Dr. CD Mayee, Dr. Sheo Raj, Dr. K Venugopal, Dr. MRK Rao, Dr. RG Dani, Dr. P Ramasundaram**

Compilation, collation and production : **Dr. Mahendra Singh Yadav**

Hindi version : **Dr. Kaumudini Nautiyal**

Cover : Promising rainfed cotton production technologies

Cover Design Concept : **Dr. Mahendra Singh Yadav**

Photography : **PG Ghangare**

Printed at : Surya Offset, Ramdaspeth, Nagpur.

PREFACE

Cotton, supporting the livelihood of millions of farmers and others, continues to be the principal producer of raw material supporting India's globally favoured textile industry. For this and for numerous other reasons - byproducts, for instance, such as oil, coming freely with this crop, it is considered appropriate to accord prioritized attention to cotton improvement, as is our prime effort and cause for existence.

India, today is the third largest producer of cotton in the world. Our production levels of this crop have satisfactorily increased five-fold, since independence. Yet, the current yields tend to linger on lower averages, which has been a matter of concern and a national challenge. In our quest for a change, besides productivity, we are optimistically concerned and committed to priming modern and upcoming technologies - transgenic cultivars, for example, meant to revolutionize crop yields and quality.

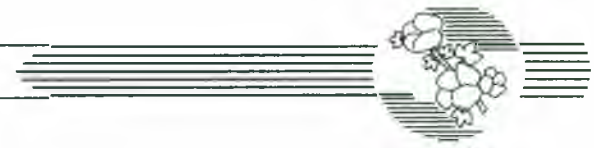
Talking of possible near future goals, as in the wake of the forthcoming WTO requirements to follow soon, our breeding programmes have now been specially reoriented to strengthen quality parameters. The enclosed current research-extension activity report, among other useful findings, seeks to elaborate on the high potential of our new hybrids and cultivars, especially of the diploid *desi G. arboreum* of medium staple cottons. Attributes such as added tolerance to abiotic stresses and resistance to sucking pests, offer much promise. Several other new findings, such as those providing deeper insight into optimum utilisation of fertilizers, efficient rain water recycling, judicious usage of agro-chemical inputs and natural resources, present long-term gain possibilities, as also our first-hand technologies. Those have proved quite capable of providing breakthrough, as in region and location specific integrated pest and disease management. A critical appraisal of the next pages would thus validate our continued success in campaigns for transfer and adaptation of such rapidly emerging technologies.

I shall take this opportunity to place on record our sincere appreciation for the patronage that we continue to receive from the Indian Council of Agricultural Research, with a note of personal gratitude to Padma Bhushan Dr. R. S. Paroda, Director General, ICAR, and Secretary, DARE for his erudite guidance with innovative thinking. I am also thankful to Dr. Mangala Rai, Deputy Director General (Crop Sciences) and to. Dr. K C Jain, Assistant Director General (Commercial Crops), for their kind, incessant help.

Our appreciation is also due to the Project Coordinator and Head, Regional Station, Coimbatore, Head, Regional Station, Sirsa, Heads of Divisions/Sections, Scientists, Technical, Administrative and Supporting Staff, the Research Coordination & Management Unit, Farm Section, Hindi Cell, ARIS Cell, Library and Maintenance Engineering Unit, for their active support in conducting research and for their contribution and assistance in bringing out this edition of the annual report.

As CICR proudly steps into its 25th year since inception, it has been a happy coincidence, as also a privilege for me, to take over as Director, with the implicit responsibility to strive for greater collective professional & academic excellence. In this task, I humbly seek assistance and constructive advise from colleagues and readers of the report in hand. With a highly qualified personnel in my team and the upcoming infrastructure at hand, I feel quite convinced that the strategic and pivotal role of CICR would be better evolved and its mandate made more realistic, so as to match the needs of the hour and strive in every possible manner, primarily to promote the cause of welfare of the cotton farmer our noble client.

(C. D. Mayee)
Director



अधिदेश

- कपास की उपज, रेशे की गुणता तथा उप-उत्पादों को सुधारने के लिए मूलभूत व अनुकूल अनुसंधान करना ।
- कपास - आधारित फसल पद्धतियों में स्थान विशेष द्वारा अपनाये जाने के लिए आनुवंशिक विविधता उत्पन्न करना ।
- उपयोग में लाने वाली एजेंसियों के लिए कपास उत्पादन की नवीनतम प्रौद्योगिकी के हस्तांतरण में सहायता करना ।
- उपर्युक्त अधिदेशों को पूर्ण करने हेतु परामर्श देना तथा अंतर्राष्ट्रीय एजेंसियों के साथ संपर्क करना ।

MANDATE

- To conduct basic and strategic research on cotton to improve yield, fibre quality and by-products.
- To create new genetic variability for location-specific adoption in cotton-based cropping systems.
- To assist in the transfer of modern cotton production technology to various user agencies.
- To extend consultancy and link with international agencies to accomplish the above mandate.

Contents

1. Introduction

This is the twenty fourth Annual Report of the Central Institute for Cotton Research, Nagpur and its Regional Stations Coimbatore and Sirsa. The Institute was established in April, 1976 at Nagpur. The Regional Station, Coimbatore established in 1960 by ICAR as PIRRCOM Centre was transferred to the control of the Institute to serve as its Regional Station for the southern region. The erstwhile IARI Regional Station , Sirsa was also transferred to the institute in April, 1985 to serve as its Regional Station for the northern region.

Nagpur

The Institute is located about 15 kms, from the Nagpur Railway Station and about 5 kms, from the Nagpur Airport on the National Highway No.7 (Nagpur - Wardha Road).

Coimbatore

The Regional Station at Coimbatore is located about 4 kms, from the Coimbatore Railway Station and about 20 kms, from the Airport on the Maruthamalai road, adjacent to the Tamil Nadu Agriculture University.

Sirsa

The Regional Station, Sirsa is located about 3 kms, from the Bus Station.

Weather

The monthly weather data for the crop season during the year 1999-2000 at Nagpur (Maharashtra) in Central zone, Coimbatore (Tamil Nadu) in the Southern zone and Sirsa (Haryana) in the Northern zone are presented in Table 1A, 1B & 1C respectively.

Table 1A - Nagpur

Month	Temperature (°C)		Relative humidity (%)		Rainfall
	Max.	Min.	Max.	Min.	(mm)
June - 99	36.7	25.7	72.3	47.5	82.8
July - 99	31.4	24.6	82.9	67.5	265.0
Aug. - 99	30.5	23.7	86.8	69.0	335.0
Sept. - 99	29.9	23.7	88.1	75.6	234.0
Oct. - 99	31.8	21.1	83.1	55.8	77.0
Nov. - 99	31.1	15.6	72.0	37.4	-
Dec. - 99	28.2	11.4	70.5	32.0	-
Jan. - 2000	29.7	11.6	65.5	26.3	-
Feb. - 2000	29.5	15.0	60.3	31.8	18.0

Table 1B - Coimbatore

Month	Temperature (°C)		Relative humidity (%)		Rainfall
	Max.	Min.	Max.	Min.	(mm)
Aug. - 99	31.8	22.4	82.5	51.0	21.9
Sept. - 99	33.1	22.2	85.1	44.9	28.0
Oct. - 99	30.0	22.1	94.1	66.2	306.1
Nov. - 99	29.2	19.9	91.2	59.4	104.2
Dec. - 99	27.8	19.2	89.8	57.7	23.2
Jan. 2000	29.8	18.8	89.0	45.7	2.0
Feb. - 2000	31.6	20.7	89.9	48.0	36.9
Mar. -2000	34.5	20.9	86.0	32.2	0.0
Apr. -2000	35.2	23.4	85.4	45.5	19.9

Table 1C - Sirsa

Month	Temperature (°C)		Relative humidity (%)		Rainfall
	Max.	Min.	Max.	Min.	(mm)
Apr. - 99	40.0	19.3	40	16	-
May - 99	39.0	24.3	49	29	39.9
June - 99	38.3	26.9	60	39	62.7
July - 99	35.7	27.8	72	55	94.0
Aug. - 99	36.2	26.9	65	50	-
Sept. - 99	36.0	25.2	71	49	-
Oct. - 99	34.2	18.2	63	35	-
Nov. - 99	29.2	9.3	59	22	-
Dec. - 99	22.5	6.5	81	29	-
Jan. - 2000	17.6	6.3	83	58	0.2
Feb. - 2000	20.0	8.3	80	50	0.2
Mar. - 2000	28.9	12.6	63	41	-

National Cotton Scenario

State-wise area, production and productivity figures for the year of report and the preceding year are presented in Table - 2.

Table - 2 : State-wise cotton area, production and productivity.

Zone/State	1998-99			1999-2000		
	Area (Lakh ha)	Prod. (Lakh bales)	P (Kg/ha)	Area (Lakh ha)	Prod. (Lakh bales)	P (Kg/ha)
North Zone						
Punjab	5.62	5.00	151	4.75	8.00	286
Haryana	5.82	7.00	204	5.10	10.50	350
Rajasthan	6.45	11.50	303	4.65	13.00	475
Central Zone						
Gujarat	16.07	47.50	502	15.16	28.50	320
Madhya Pradesh	5.01	18.75	636	5.14	15.50	513
Maharashtra	31.99	26.50	141	32.54	36.50	191
South Zone						
Andhra Pradesh	12.78	25.00	333	10.15	22.00	368
Karnataka	6.08	8.75	245	6.00	8.00	227
Tamil Nadu	2.43	5.50	385	2.25	5.50	416
Others	0.62	1.25	343	0.72	1.50	354
Total	**92.87**	**156.75**		**86.46**	**149**	
Loose cotton consumed but not counted for in State-wise prod.	--	08.25	--	--	07.00	--
Grand Total	**92.87**	**165.00**	**302**	**86.46**	**156**	**307**

Prod. = Production P = Productivity 1 bale= 170 kg.

Source : Office of the Textile Commissioner, Mumbai.

2. प्रमुख अनुसंधान उपलब्धियाँ

फसल सुधार

नागपुर

अमरीकन कपास के जर्मप्लाज्म बैंक में पचास नई विदेशी व देशी वंशावलियों को सम्मिलित किया गया । इन वंशावलियों में गूलर भार, गूलर/पौध, औटाई प्रतिशत, रेशे की औसत लम्बाई और कपास की प्रति पौध उपज में व्यापक भिन्नता देखी गई ।

तीनों क्षेत्रों में बी. आर. 01 परीक्षणों में अमरीकन व *अर्बोरियम* कपास प्रत्येक की 100 वंशावलियों का मूल्यांकन किया गया और उपज व अन्य गुणों के लिए आशाजनक वंशावलियों की पहचान की गई । स्टेशन परीक्षणों में संवर्धन सी एन एच 152 की चैक किस्म से अधिक उपज प्राप्त हुई और यह संवर्धन नागपुर व कोयंबतूर में क्रमशः 11.64 कु./है. तथा 8.62 कु./है. उपज के साथ तीसरे व चौथे स्थान पर रहा । इस संवर्धन को अखिल भारतीय समन्वित कपास सुधार परियोजना (अ.भा.स.क.सु.प.) के राष्ट्रीय परीक्षणों में सम्मिलित किया गया । पुनरावर्तित परीक्षणों में एल आर ए 5166 को चैक के रूप में उपयोग करते हुए चयनित तीस श्रेष्ठ संवर्धनों का मूल्यांकन किया गया । श्रेष्ठ पाँच संवर्धनों में सी एन एच 1030, 1031, 1032, 1033 व 1034 थे । इन संवर्धनों की उपज चैक किस्म की 11-12 कु./है. की तुलना में 14-18 कु./है. थी । 100 F_1 संकरणों का मूल्यांकन कर एक बेहतर F_1 संयोजन पहचाना गया ।

अमरीकन कपास के किस्म सुधार कार्यक्रम के अंतर्गत अधिक उपज व शीघ्र तैयार होने वाले तीन संवर्धनों जैसे सी आई एच एस 97-7 (22.22 कु./है.), सी आई एच एस 14 (18.20 कु./है.) तथा सी आई एच एस 16 (18.05 कु./है.) को पहचाना गया । एल आर ए 5166 की उपज 15.44 कु/है. थी ।

संवर्धन सी एन एच 2124 को राष्ट्रीय परीक्षण के बी आर 02 (ए) परीक्षण में सम्मिलित किया गया । एक सूखा सहिष्णु संवर्धन जैसे सी एन एच 301 ने बी आर 03 (ए) परीक्षण के अंतर्गत दक्षिणी क्षेत्र में अच्छी (17.62 कु./है.) उपज दी इसलिए इसे बी आर 04 (ए) परीक्षण में सम्मिलित किया गया । दूसरे सूखा सहिष्णु संवर्धन सी एन एच 32 को बी आर 02 (बी) परीक्षण में शामिल किया गया ।

शीघ्र तैयार होने वाले, अधिक तेल की मात्रा वाले संवर्धन सी एन ओ 131 को एन बी पी जी आर, नई दिल्ली में विशिष्ट जर्मप्लाज्म के रूप में पंजीकृत किया गया । एक अन्य शीघ्र तैयार होने और अधिक तेल की मात्रा वाला संवर्धन सी एन एच 2124 कोयंबतूर व नागपुर स्टेशनों पर किए गए परीक्षणों में क्रमशः पहले व तीसरे स्थान पर रहा तथा इसे अ.भा.स.क.सु.प. के राष्ट्रीय परीक्षण (बी आर 02 (ए)) में सम्मिलित किया गया । संवर्धन सी एन ओ 131 जो इस वर्ष बी आर 04 (ए) परीक्षण में अच्छा पाया गया उसे अ.भा.स.क.सु.प. के तीसरे वर्ष के परीक्षणों में शामिल किया गया ।

जी. अर्बोरियम के शीघ्र तैयार होने वाले 140-150 दिनों में और अधिक उपज वाले तीन संवर्धनों जैसे सी आई एन ए 310 (24.86 कु./है.), सी आई एन ए 323 ए (24.9 कु./है.) तथा सी आई एन ए 323 बी (21.52 कु./है.) की पहचान की

गई । चैक ए के एच 4 की उपज 19.4 कु./है. थी । संवर्धन सी आई एन ए 310 को राष्ट्रीय परीक्षण से बी आर 24 परीक्षण में शामिल किया गया । इस वर्ष संवर्धन सी आई एन ए 323 ए को बी आर 22 (ए) तथा सी आई एन ए 323 बी को बी आर 24 में शामिल किया गया । अमरीकन कपास के पाँच बेहतर ओजपूर्ण संयोजनों की पहचान की गई, जिनमें उपयोगी संकर ओज एन एच एच 44 के 4.4 से 61.1 प्रतिशत तथा एल आर ए 5166 के 12.7 से 88 प्रतिशत तक अधिक था । संकर एन एच एच 44 के साथ मूल्यांकन पर संकर सी आई एच एच 103 ने 20.14 कु./है. की उपज दी । इन दो संकरों को मध्य व दक्षिणी क्षेत्र के बी आर 05 (ए)–1 तथा बी आर 05 (बी)–1 परीक्षणों में सम्मिलित किया गया ।

142 जी एम एस व 334 सी एम एस आधारित संकरों के परीक्षणों में 5 जी एम एस संकर जैसे, एन जी एम एस एच 22 (16.38 कु./है.), एन जी एम एस एच 7 (15.22 कु./है.), एन जी एम एस एच 14 (15.01 कु./है.), एन जी एम एस एच 67 (15.65 कु./है.) तथा एन जी एम एस एच 75 (14.96 कु./है.) आशाजनक पाए गए । जी एम एस आधारित 6 अतः *अर्बोरियम* संकरों का मूल्याकन किया गया जिसमें उपयोगी संकर ओज ए के एच 4 से 15.1-57.6 प्रतिशत तथा डी एच 9 से 7.5-47.6 प्रतिशत अधिक था । संकर जी ए ए 99-2 की 20.05 कु./है. की सर्वाधिक उपज आँकी गई ।

जातियों के बगीचे में एक नई जंगली जाति *जी. नेल्सोनी* को शामिल किया गया । वाई 1 व सुधीन के पहले पहचाने गए मेक्रोम्यूटेंट को $एम_4$ व $एम_5$ पीढी में ले जाया गया और अनुकूली जीन–प्ररूप का चयन किया गया ।

राज्यों की माँग के अनुसार आधार बीज बनाने के लिए अँजली के 1.14 कु. और एल आर ए 5166 के 6.0 कु. प्रजनक बीजों की पूर्ति की गई ।

कोयंबतूर

पिछले पाँच वर्षों में सिंचित परिस्थितियों में किए गए समन्वित किस्म परीक्षणों में संवर्धन सी डब्ल्यू आर ओ के 165 की जाँच की गई, जिसमें कपास की औसत उपज 13.55 कु./है. देखी गई । यह उपज सामान्य किस्म एल आर ए 5166 (10.04 कु./है.) से 35% तथा स्थानीय किस्म (10.41 कु./है.) से 30% अधिक थी । इस संवर्धन की 38% उच्च औटाई क्षमता थी । मध्यम रेशे की गुणता वाले इस संवर्धन की कताई क्षमता 30 से 40 काउंट यार्न है । संवर्धन सी डब्ल्यू आर ओ के 165 को अच्छी उपज के आधार पर दक्षिणी क्षेत्र के तमिलनाडु, कर्नाटक व आंध्रप्रदेश राज्यों में जारी करने के लिए पहचाना गया । सी एम एस अली x डी III (1) तथा सी एम एस आर के x एम ने सविता की 22.1 कु./है. की तुलना में 33.6 व 34.1 कु./है. कपास की उपज दी । आनुवंशिक नर बध्य संकरों में जी एम एस जे 34 x 19, जी एम एस 2 x 1, जी एम एस 12 x 19 की उपज सविता की 15 कु./है. की तुलना में क्रमशः 23.8, 23.7 व 23.6 कु./है. हुई । नागपुर व कोयंबतूर में किए गए सामूहिक संकर परीक्षणों में संकर सी सी एच वाई 10555 की 23.3 कु./है. की अधिकतम उपज आँकी गई ।

सिरसा

एक हजार एक सौ अनुरक्षित जर्मप्लाज्म वंशावलियों का विभिन्न गुणों के लिए मूल्यांकन किया गया । अधिकतम उपज वाले स्थानीय संकर ओम शंकर की तुलना में सी आई एस एच एच 6, 8, 14, 19, 18, 16, 45, 43, 32, 56, 60, 68, 79, 95, 100, 101 तथा 103 संकरों की उल्लेखनीय रूप से अधिक उपज देखी गई ।

ओम शंकर की 110 ग्रा./पौध तथा एफ 846 की 65 ग्रा./पौध की तुलना में जी एम एस आधारित संकर सी आई एस एच एच जी 2 (220 ग्रा./पौध) की अधिकतम उपज

हुई, उसके बाद सी आई एस एच एच जी 7 (190 ग्रा./पौध), सी आई एस एच एच जी 18 (172 ग्रा./पौध) तथा सी आई एस एच एच जी 5 (160 ग्रा./पौध) की उपज रही । जी एम एस आधारित संकरों की आटाई क्षमता 32 से 38 प्रतिशत और रेशे की 2.5% स्पान लबाई 24.1 से 29.1 मि.मी. थी ।

कपास पत्ती मोडक रोग अवरोधता, उपज व गुणता के आधार पर विसयोजी पीढियो में से चार सौ एकल पौधों का चयन किया गया ।

आशाजनक विभेदों का प्रदर्शन

विभेद सी आई एस ए 9-3 (2820 कि.ग्रा./है.), सी आई एस ए 9-10 (2463 कि.ग्रा./है.) तथा सी आई एस ए 9-8 (2184 कि.ग्रा./है.) की उपज आर जी 8 (1622 कि.ग्रा./है.) व एल डी 327 (1785 कि.ग्रा./है.) चैक किस्मों की तुलना में उल्लेखनीय रूप से अधिक थी । तीन विभेदा जैसे, सी आई एस ए 40-5, सी आई एस ए 17 व सी आई एस ए 9-17 की औटाई क्षमता 39 प्रतिशत थी जो चैक किस्म एल डी 327 के समान थी । विभेद सी आई एस ए 9-10 की रेशे की 2.5% स्पान लंबाई 19.7 मि. मी. आँकी गई ।

चैक संकरा, ॐ शंकर तथा अंकुर 651 की क्रमशः 2716 कि.ग्रा./है. व 2469 कि.ग्रा./है. उपज की तुलना में संकर सी एस एच एच 98 की उपज सर्वाधिक (3095 कि.ग्रा./है.) हुई, उसके बाद सी एस एच एच 89 (2881 कि.ग्रा./है.) की उपज रही । संकर सी एस एच एच 86 के रेशे की 2.5% स्पान लबाई सर्वाधिक 28.4 मि.मी. रही ।

जी. अर्बोरियम की सर्वाधिक उपज वाली चैक एल डी 327 की तुलना में सी आई एस ए 3, सी आई एस ए 21, सी आई एस ए 34 व सी आई एस ए 46 की उपज 40% से भी अधिक देखी गई । चैक आर जी 8 (1622 कि.ग्रा./है.) तथा एल डी 327 (1785 कि.ग्रा./है.) की तुलना में जी एम एस आधारित संकर संयोजनो सी आई एस ए ए जी 11 (3697 कि.ग्रा./है.), सी आई एस ए ए जी 3 (3497 कि.ग्रा. /है.) तथा सी आई एस ए ए जी 4 (2881 कि.ग्रा./है.) की उपज उल्लेखनीय रूप से अधिक रही ।

बीज प्रौद्योगिकी

कोयंबतूर

बीज को विभिन्न पात्रों में भंडारण के समय नीम की पत्ती के पाउडर व नीम की गिरी के पाउडर में बीज को खराब होने से बचाने की बेहतर क्षमता थी ।

सिरसा

उत्तरी क्षेत्र के संकरों ॐ शंकर, मरुविकास, धनलक्ष्मी, फतेह व कीर्ति में संकरित गूलर जमना, बीज जमना, बीज सूचकांक, अंकुरण व ओज सूचकांक का प्रतिशत 15 अगस्त से 15 सितंबर के दौरान अधिक पाया गया । किस्मों की दूसरी चुनाई की कपास में बीज सूचकांक, अंकुरण व ओज सूचकांक अधिक था । संकरों व किस्मों को कमरे में भण्डारण करने पर नौ माह तक अंकुरण में कोई उल्लेखनीय कमी नही देखी गई । उसके बाद अंकुरण व ओज में धीमी कमी देखी गई । भंडारण किए गए संकरों में 15 माह तक अंकुरण का प्रतिशत प्रामाणिक स्तर से अधिक देखा गया लेकिन किस्मों में यह प्रामाणिक स्तर से कम हो गया । बीज विकास व परिपक्वता के अध्ययन में देखा गया कि प्रफुल्लन के बाद बीज सूचकांक धीरे–धीरे बढा और 60 वें दिन सबसे अधिक हो गया । बीज में नमी का अंश (मात्रा) धीरे–धीरे कम हुआ और 60 वें दिन न्यूनतम स्तर पर पहुँच गया । बीज विकास के 30 वें दिन से विकसित बीज में अंकुरण शुरू हुआ और उस समय अंकुरण बहुत कम था, धीरे–धीरे बढा और सभी किस्मो में लगभग 60 वें दिन

सबसे अधिक देखा गया । यही रुख ओज सूचकांक में भी देखा गया ।

जी. हिर्सुटम व *जी. अर्बोरियम* की क्रमशः एच 777 व एल डी 327 म अन्य की तुलना में बीज सूचकाक, अकुरण प्रतिशत, आज सूचकाक और कुल बीज की उपज अधिक थी ।

फसल उत्पादन

नागपुर

स्थाई खाद परीक्षणों में कपास–ज्वार फसल चक्र तथा संतुलित उवरण महत्वपूर्ण पाये गये । फास्फोरस व पोटाश के साथ नाइट्रोजन के अनुपूरक उपयोग से उपज में उल्लेखनीय सुधार हुआ । सल्फर के लगातार उपयोग से कपास, सरसों व गेहू की उपज में वृद्धि हुई । इसमें मृदा की ऊपरी सतह (0.20 सें.मी.) में उपलब्ध सल्फर की मात्रा बगैर सल्फर उपयोग के खेतों की अपेक्षा अधिक थी । जुताई प्रक्रियाओ से उपज में उल्लेखनीय अंतर नही पाया गया फिर भी मृदा के गुणों में सुधार देखा गया जैसे मृदा में अधिक माइक्रोबियल बायोमास, माइक्रोफोना (निमेटोड) व माइक्रोफाना (अर्थोपोड्स) की अधिक सख्या । अपघटन दर स्थिराक आकलन के लिए अभिलेख रेखीय (लॉग–लीनियर) व अरेखीय (नान–लीनियर) मॉडल का उपयोग किया गया । अरेखीय मॉडल अधिक उपयुक्त पाया गया ।

खरपतवार नियत्रण के लिए प्रोमेट्रिन (1.25 कि.ग्रा. सक्रिय तत्व/है.) का उपयोग किसानों द्वारा की जाने वाली सस्य क्रियाओं के समान अच्छा था और यह 42 दिनों तक खरपतवार नियत्रण के लिए प्रभावी रहा । फसल मे बाद में आने वाले खरपतवारों के नियत्रण के लिए 4-6 पत्ती वाली अवस्था की तुलना मे 8-10 पत्ती अवस्था पर ग्लाईफासेट का उपयोग बेहतर रहा।

पार्श्व के समानातर ड्रिपर्स में एक समानता नहीं थी । पार्श्व के समानातर दबाव की विविधता के कारण लाइन के प्रारभ में जल प्रवाह की गति 75% से अधिक जबकि लाइन के अत मे यह 15% से कम थी । ड्रिपर से निकली पानी की बूँद समानरूप से चारों तरफ (30 सें. मी. व्यास) फैलती है। पानी की बूंद का फैलाव फसल वृद्धि की प्रारंभिक अवस्था में पौधों की आवश्यकता से अधिक होता है ।

किसानों द्वारा सामान्य रूप से अपनाई जाने वाली सस्य प्रक्रियाओं की तुलना में समेकित पोषक तत्व प्रबध (आई एन एम) को अपनाने से, जिसमें *एजोटोबैक्टर क्रोकोकम* (एच टी–57) का उपयोग शामिल है, कपास की उपज 8 % अधिक हुई । पी एस बी तथा वी ए एम के बीज उपचार से उपज में सुधार हुआ । पिछले फसल काल में विकसित प्रोटोटाइप का निर्माणकर परीक्षण किया गया । एल आर ए 5166 की ड्रिल पद्धति से बुवाई की गई । पक्ति से पक्ति के बीच 60 सें.मी. की दूरी में ड्रिल पद्धति से बुवाई संतोषजनक देखी गई किंतु इससे बीज की मात्रा अधिक (20 कि.ग्रा./है.) लगी । इस कमी को दूर करने के लिए होपर बाटम पर छिद्र आकार को 2 सें.मी. से घटाकर 1 सें.मी. किया गया । बीज मीटरिंग प्लेट की डिजाइन के कारण इससे 60 सें मी x 30 सें.मी पर एक समान बीज की बुवाई नही हो सकी । इसमें प्लेट और होपर आधार के बीच में बीज फँसने से प्लेट बद हो जाती है । इस कमी को दूर करने के लिए प्लेट को दुबारा डिजाइन किया गया है । पारंपरिक हाथ द्वारा बुवाई की अपेक्षा इस मशीन की बुवाई क्षमता 6 गुना अधिक है ।

ऐतिहासिक वर्षा के आँकडों का विश्लेषण किया गया। विश्लेषण के इन परिणामों को फसल वैज्ञानिकों के द्वारा फसल प्रबंध व भविष्य के निर्णय जैसे बुवाई की तारीख, उर्वरक उपयोग का समय, फसल संरक्षण की समय सारणी और अतिरिक्त जल के उपयोग हेतु उपयोग किया गया ।

कोयंबतूर

स्थाई खाद परीक्षणों के अंतर्गत सिंचित परिस्थितियों में कपास–कपास और ज्वार–कपास फसल चक्र में सविता की उपज 6.6-8.9 कु./है. तथा सुरभि की उपज 7.2-12.6 कु./है. रही । फसल–पद्धति क्रम में सविता की उपज कपास–कपास की अपेक्षा ज्वार–कपास पद्धति में उल्लेखनीय रूप से अधिक 10.6 कु./है. रही जबकि सुरभि की उपज दोनों पद्धतियों में समान रही । फा. 45, पो. 45–फार्म यार्ड खाद 15 टन के उपयोग से सविता ने ज्वार–कपास व कपास–कपास पद्धति में क्रमशः 11.9 व 5.4 कु./है. की अधिकतम उपज और सुरभि में कपास–कपास व ज्वार–कपास पद्धति में, क्रमशः 11.7 व 13.4 कु./है. की उपज दी । दोनों जीन प्ररूपों व फसल क्रम के लिए, फा. 45–पो. 45–फार्म यार्ड खाद 15 टन का उपयोग बेहतर रहा ।

खरपतवारनाशी प्रोमेट्रिन व गेसागार्ड खरपतवार नियत्रण के लिए समान प्रभावी पाए गए । इनकी (1.0-1.5 कि. ग्रा. क्रियाशील तत्व/है.) कम मात्रा के परिणाम अच्छे रहे लेकिन पेंडिमिथालिन की तुलना में ये खरपतवारनाशी उतने प्रभावी नहीं पाए गए ।

पादप कार्यिकी एवं जैव रसायन

नागपुर

जी. हिर्सुटम की 100 तथा *जी. अर्बोरियम* की 50 वंशावलियों के मूल्याकन से पता चला कि इनके वृद्धि व कार्यिकीय गुणों में विभिन्नता थी । पी के वी 2, एन एच एच 44 व ए के एच 4 में कलियाँ लगने के बाद से लिहोसिन के कम सांद्रता के बहुत बार उपयोग (100 व 300 मि.ली./है.) से वृद्धि में कमी आई लेकिन उपज में सुधार नहीं हुआ । *अर्बोरियम* व *हिर्सुटम* जीन प्ररूपों में फूल लगने के समय नमी प्रतिबल प्रेरण से प्रकट हुआ कि *अर्बोरियम* जीन प्ररूप में कम रंध्री अवरोधता और वाष्पोत्सर्जन दर में अधिक स्थिरता के कारण सूखे के प्रति सहिष्णुता अपेक्षतया अधिक है । पौधे के ऊपरी भाग को तोड देने और विभिन्न पोषक तत्वों के छिडकाव से उपज में वृद्धि नहीं हुई । एल आर ए 5166 व एल आर के 516 की देर से बुवाई करने पर वृद्धि दर में कमी हुई । पत्ती सापेक्ष जल मात्रा के प्रति अधिक स्थिरता प्रदर्शित करने वाली 25 वंशावलियों में पौधों की पहचान की गई । लवणता सहिष्णु जीन प्ररूप पहचाने गए और लवणता उपचार की प्रारंभिक अवस्था में अधिक बायोमास और पत्ती क्षेत्रफल वाले पाए गए । वृद्धि व विकास पर लवणता का प्रभाव 10 dSm^{-1} स्तर तक नहीं पडा । सोडियम की कम सांद्रता पौध की परासरणी क्षमता को बनाए रखने में सक्षम रही और अधिक सांद्रता से पौधों की मेटाबोलिक (उपापचय) क्रियाओं में रुकावट पैदा हुई । पी के वी 081 में आक्सीमिथाइल डेमेट्रान व फेनवलरेट के छिडकाव के 24 घंटे बाद कुल फिनोल्स की सांद्रता तेजी से कम हुई । दूसरी तरफ फेनवलरेट के उपयोग के 24 घंटे बाद रिड्यूसिंग शर्करा की सांद्रता तेजी से बढी । समय के गुजरने के साथ ही गौण मेटाबोलाइट सांद्रता की सामान्य अवस्था पुनः स्थापित हुई ।

कोयंबतूर

विभिन्न जीन प्ररूपों जैसे एल आर ए 5166 व अँजली (दक्षिणी क्षेत्र), सी एन एच पी टी 2 (मध्य क्षेत्र) तथा एच 777 (उत्तरी क्षेत्र) ने 650 ± 50 पी पी एम की बढी हुई सी o_2 की परिस्थिति में उपज व उपज घटकों जिसमें फसल की सक्रिय वृद्धि अवस्था के दौरान प्रकाश–संश्लेषित (फोटोसिंथेटिक) व नाइट्रेट रिडक्टेज एक्टिविटी बढी के लिए अनुकूल प्रतिक्रिया दर्शाई । कपास में अधिकतम प्रकाश संश्लेषण दर व नाइट्रेट

Members of the Scientific Advisory Panel of the NATP Rainfed Ecosystem visiting experimental field

Prof. V. L. Chopra, former Secretary, DARE & DG, ICAR, interacting with the scientists

Shri Sompal, Member, Planning Commission, Govt. of India, keenly observing the field experiment

रिडक्टेज एक्टिविटी के लिए बढ़ी हुए कार्बन डाई आक्साइड का 40° से. पर 650 पी पी एम का स्तर अच्छा पाया गया । सभी जीन प्ररूपों पर किए गए अध्ययनों में बढी हुई सी ओ$_2$ की परिस्थिति में लगाये गए पौधों में सामान्य परिवेश (13.5 गूलर/पौध) की तुलना में उल्लेखनीय रूप से अधिक गूलर (प्रतिपौध 16.2) लगे । जबकि जीन प्ररूपी ने बढी हुई सी ओ$_2$ के प्रति व्यापक भिन्नता दर्शाई ।

जीन प्ररूपों पर किए गए अध्ययनों से प्रकट हुआ कि एल आर के 516, के जी एल 931, एन एम ई 70, सामान्य ओकरा, ए सी 241, एच जी आई पी एस 542, एन एम ई, आर बी सी 37, के 34007, ई सी 126623, अकाला ग्लैडलेस, ग्लैक्स 22/1, एच 777, एल आर ए 5166, आर बी सी 39, सी एन एच 38, सी एन एच पी टी 5 तथा आई सी 1356 जीन प्ररूप सूखे के लिए सहिष्णु थे । रेशे की दैर्ध्यवृद्धि प्रगति में सम्पूर्ण मात्रा की अपेक्षा बीज एव रेशे में अतराश्रयी रिड्यूसिंग शूगर के संचय के मध्य एक अच्छा संबंध था ।

बालवर्म सहिष्णु वरण जैसे बी आर एस 3, बी आर एस 5, बी आर एस 22 तथा बी आर एस 23 में प्रोटेक्टिव सेकडरी मेटाबोलाइट्ज का लगातार अधिक स्तर और पोषक पदार्थो का निम्न स्तर देखा गया ।

कीटनाशक थिमेथोक्जम के 3 ग्रा./कि.ग्रा. व 4.5 ग्रा /कि.ग्रा. बीज की दर के उपयोग से नाइट्रेट रिडक्टेज एक्टिविटी 30-40% तक बढी जबकि इमिडेक्लोप्रिड व कार्बोसल्फान से पौद विकास के साथ क्रियाशीलता उत्तरोत्तर 20-25 % बढी । फफूँदनाशकों के उपयोग से पत्ती की घुलनशील प्रोटीन की मात्रा में लगभग 25-40 % तक वृद्धि देखी गई । जबकि प्रोक्लोराज से उपचारित पौधों में रिड्यूसिंग शूगर के संचय में वृद्धि हुई ।

फसल संरक्षण

नागपुर

जी. हिर्सुटम जर्मप्लाज्म की दस वंशावलियाँ सभी चूसक कीटों और बालवर्म के प्रति सहिष्णु पाई गई । इनमें से चार वंशावलियाँ जे बी डब्ल्यू आर 34, I-81 बी, अम्बेसेडर व संवर्धन 34 लगातार 5 वर्षों से सहिष्णु देखी गई ।

पी डी 0695 के गूलरों से प्रोटीएज इनहिबिटर का कालॅम शुद्धिकरण करके कपास प्रोटीएज इनहिबिटर विशेष एन्टीसीरम बढाने के लिए एन्टीजन के रूप में उपयोग किया गया जिससे प्रोटीएज इनहिबिटर की मौजूदगी के लिए कपास के जर्मप्लाज्म लाइन / वंशावलियों की छँटाई में मदद मिल सके । कपास के जंगली जर्मप्लाज्म पूल में ऐसी जातियाँ हैं जिन्होंने प्रोटीएज इनहिबिटर उत्पन्न करके प्रेरणीय प्रतिरक्षा अनुक्रिया प्रदर्शित की ।

कपास आधारित फसल पद्धति में सस्तुति की गई अरहर की देर से तैयार होने वाली किस्म को पट्टियों में या खेत के चारों तरफ लगाने को उचित पाया गया। कपास की किस्मों की देरी से बुवाई के कारण *पेक्टिनोफोरा गोसिपिएला* से उपज में 45 % की उल्लेखनीय हानि प्रकट हुई ।

कपास के सभी प्रमुख कीडों पर नियंत्रण से कीडों से होने वाले नुकसान को 32.31% तक रोका जा सकता है । इमिडेक्लोप्रिड व थिओमेथाक्जन जैसिड के लिए अधिक प्रभावी पाए गए । डेसिस टेबलेट, इंडोक्सीकार्ड व स्पिनोसेड बालवर्म के लिए प्रभावी पाए गए ।

भारत के विभिन्न भौगोलिक क्षेत्रों से एकत्रित किए गए कपास के कीड़ों पर अवरोधता की जानकारी के लिए

निगरानी की गई । कीटनाशकों के प्रति कुछ लाभदायक कीडों की संवेदनशीलता को समझने के लिए प्रयोगशाला में अध्ययन किए गए । विभिन्न कीटनाशकों, कीटनाशकों + योगवाही कीटनाशकों व क्राई टाक्सिन के प्रति अवरोधता के लिए *हेलियोथिस आर्मीजेरा* को चुना गया । हे. *आर्मीजेरा* पर क्राई 1 ए टाक्सिन के लिए आधारभूत सुग्राह्यता इनडिसेस का निर्धारण किया गया । प्यूटेटिव बी टी कपास के पौधे के चयन के लिए संवेदनशील बायोएसे का विकास किया गया । के. क. अनु. सं. में विकसित प्यूटेटिव ट्रॉंसजेनिक कपास के पौधों को कपास के चार लेपिडोप्टेरान नाशीकीड़ों के प्रति अवरोधता के लिए छॉंटा गया । कीटनाशक अवरोधता प्रबंध योजना को वर्धा जिले के नौ गॉंवों में लगातार दूसरे वर्ष लागू किया गया, इससे प्राप्त परिणामों से ज्ञात हुआ कि कपास की उपज को प्रभावित किए बगैर कीटनाशकों के उपयोग में इस योजना से 90 % की उल्लेखनीय कमी देखी गई ।

पॉंच सुग्राह्य किस्मों से *जेंथोमोनास* ए. पी. वी. *मालवासिएरम* की छः प्रजातियॉं जैसे 3, 5, 8, 10, 15 व 18 पहचानी गई । प्रजाति 10 व 18 अधिक संख्या में पाई गई, पजाब के नमूनों में से प्रजाति 5, 7, 10, 15 व 18 विलग की गई । अमरीकन कपास की सात वंशावलियॉं उग्र प्रजाति 18 के प्रति अवरोधी पाई गई । आगे के मूल्यांकन हेतु अवरोधता व पौध गुणता के मानदंडों के आधार पर 167 एकल पौध छॉंटे गए । उपज के मानदंडों के लिए 13 अवरोधी वरण पहचाने गए ।

1998-99 के खराब कपास के विश्लेषणों में *जेंथोमोनास* ए *पी.वी. मालवासिएरम* व 18 फफूँद जेनेरा की उपस्थिति देखी गई ।

गॉसिपियम अर्बोरियम की सात वंशावलियों में दहिया के प्रति लगातार 10 वें फसल काल में असक्राम्यता देखी गई । ए के एच 4–जी एम टी (दहिया सहिष्णु) वंशावलियों का रेशे की गुणता के लिए मूल्यांकन किया गया ।

फ्यूजेरियम विल्ट के लिए अवरोधी पॉंच संवर्धनों का विकास किया गया । 74 वंशावलियों की जॉंच की गई जिनमें 6 वंशावलियॉं अवरोधी पाई गई ।

जी. हिर्सुटम की 233 जर्मप्लाज्म वंशावलियों में से 2 वंशावलियॉं मायरोथीसियम पत्ती धब्बा के लिए अवरोधी पाई गई, जबकि दहिया के लिए 7 ने असक्राम्यता व 8 ने अवरोधता दर्शाई ।

सी एन एच 911 नामक एक वंशावली अ.भा.स.क.सु.प. के मध्य क्षेत्र के बी आर 02 (बी) परीक्षणों में अच्छी पाई गई और उसे बी आर 03 (बी) परीक्षण के लिए चुना गया ।

जेंथोमोनास ए. पी वी *मालवासिएरम* के दो विरोधी (एन्टागोनिस्ट) पहचाने गए । विभिन्न राज्यों के कपास उगाने वाले क्षेत्रों से *जेंथोमोनास* ए. पी वी *मालवासिएरम* के एक सौ पचास एकल एकत्रित किए गए । अत्यधिक उग्र प्रजातियों में 31.2 के बी प्लाज्मिड था, इसका उपयोग अधिक उग्रता के लिए मार्कर के रूप में कर सकते हैं । *एक्स ए एम* के विभिन्न एकलों से प्लाज्मिड व जीनोमिक डी एन ए फिंगर प्रिंटिंग तथा प्लाज्मिड के पी सी आर एम्पलीफिकेशन के द्वारा जिसमें एक रूढ़ि संश्लेषित प्राइमर के उपयोग से बहुरूपता प्रकट हुई । इसका उपयोग एक्स ए एम की प्रजाति विशिष्ट आण्विक निदान यंत्र के रूप में किया जा सकता है ।

एच एन पी वी का उत्पादन किया गया और विभिन्न राज्य कृषि विभागों को भेजा गया जिससे 15 लाख रु. की प्राप्ति हुई ।

कोयंबतूर

सितबर व जनवरी में एफिड की संख्या अधिक थी । जैसिड की अधिक संख्या दिसंबर–जनवरी में आँकी गई । बालवर्म में हे. *आर्मीजेरा* पूर्वप्रभावी कीट था और इससे दिसंबर के मध्य सप्ताह में फलन अगों में 65.7 % का नुकसान देखा गया और इस अवधि में 3 लार्वा प्रति पौध की सघनता देखी गई । सितबर में कोकसीनेलिड परभक्षी (प्रीडेटर) अधिक था और जनवरी में एफिड पर परजीविता (पेरासिटिज्म) का 50 % तक था ।

बालवर्म अवरोधता (*हेलिकोवर्पा* व गुलाबी बालवर्म) के लिए छाँटे गए *गौसिपियम हिर्सुटम* के इक्कीस संवर्धनों में से पाँच संवर्धन जैसे आर.आर. 1007-123-4, आर आर 1007-124-3, आर सी एच 5266-1-2, सी डब्ल्यू आर ओ के 165 तथा बी आर एस 23 बालवर्म से होने वाले नुकसान के लिए सहिष्णु पाए गए और इनकी उपज एल आर ए 5166 से अधिक थी । हे. *आर्मीजेरा* के लार्वा के प्रकोप और नुकसान के बीच संबंध को देखते हुए एक लार्वा/पौध की नुकसान सीमा को एक लार्वा/ दो पौध करने की आवश्यकता प्रदर्शित हुई जोकि 5 % फलन अगों के नुकसान की वर्तमान हानिसीमा के अनुकूल है ।

इमिडेक्लोप्रिड 600 एफ एस व थिआमेथाक्जन का बीज उपचार चूसक कीटों के नियंत्रण के लिए 45 दिनों तक प्रभावी रहा । एसेटामिप्रिड व थिओमेथाक्जन के घोल का छिड़काव एफिड व जैसिड के लिए प्रभावी रहा । स्पिनोसेड के उपचार से लार्वा का प्रकोप व गूलर नुकसान उल्लेखनीय रूप से कम हुआ इसके बाद इंडोक्साकार्ब प्रभावी रहा । स्पिनोसेड के उपचार से कपास की उपज उल्लेखनीय रूप से अधिक (18.8 से 23.6 कु./है.) थी उसके बाद इंडोक्साकार्ब की उपज (18 से 18.5 कु./है.) थी । संयोजित रसायन जैसे एंडोफास, विराटसुपर, शेरलान व न्यूरेल–डी उनके अकेले यौगिकों व सामान्य की तुलना में प्रभावी नहीं थे ।

कपास में आई आर एम योजना को अपनाने से कीटनाशकों के उपयोग में 4701 से 2665 ग्रा. सक्रिय तत्व प्रति हैक्टर (-43.4%) की कमी आई और फसल सरक्षण में होने वाले खर्च में 7040 से 3401 रु. (-51.7 %) की कमी हुई । इसके साथ ही इससे उपज में 9.17 से 14.72 कु./है. (+ 60 %) की वृद्धि हुई और 7482 से 19,652 रु./है. (+163 %) का शुद्ध लाभ प्राप्त हुआ । इसके अतिरिक्त चूसक कीटों (जैसिड व एफिड) व बालवर्म का नुकसान 10 से 24 % और 17 से 38 % कम हुआ । जबकि आई आर एम अपनाने वाले किसानों के खेतों में न अपनाने वाले किसानों के खेतों की तुलना में परभक्षी 68 % अधिक देखे गए ।

समेकित नाशीजीव प्रबध (आई पी एम) अपनाने वाले गाँवों में कीटनाशकों के केवल 6 छिडकाव जबकि न अपनाने वाले गाँवों में 8 छिडकाव किए गए। आई पी एम न अपनाने वाले गाँवों में कीटनाशकों पर होने वाले 5916 रु. खर्च की अपेक्षा आई पी एम अपनाने वाले गाँव में 5174 रु. खर्च हुए । आई पी एम न अपनाने वाले गाँव की 2010 कि.ग्रा./है. उपज की तुलना में आई पी एम वाले गाँव में 2220 कि.ग्रा./है. की उपज आँकी गई ।

जी. अर्बोरियम जर्मप्लाज्म की दो सौ वशावलियों, *जी. हिर्सुटम* की अनेक दहिया अवरोधी वशावलियों तथा एल आर ए 5166 व अँजली सुग्राह्य किस्मों का *आर. एरिओला* के *अर्बोरियम* व *हिर्सुटम* एकलों के प्रति प्रतिक्रिया के लिए मूल्याकन किया गया । मूल्यांकन से

एकलों में विभिन्नता स्पष्ट थी और विभेदी परपोषी प्रतिक्रिया भी थी ।

अल्टरनेरिया पत्ती धब्बों के नियंत्रण के लिए बेंजोथिओडाइजोल प्रभावी रहा उसके बाद *टी. विरिडी* प्रोक्लोराज तथा *पी. फ्लूओरेसेंस* की विभेद सी एच ए ओ प्रभावी रहे । दहिया के लिए टेबुकोनाजोल, प्रोक्लोराज, कार्बेन्डाजिम, *टी. विरिडी* तथा प्रोपिकोनाजोल बहुत अधिक प्रभावी फफूँदनशक/जैवकारक थे ।

अल्टरनेरिया पत्ती धब्बा अवरोधी वंशावली सी सी एच 727 जिसे सिंचित राष्ट्रीय मूल्यांकन परीक्षणों में मध्य व दक्षिणी क्षेत्र दोनो में अच्छा पाया गया और इसे 2000-2001 के दौरान किए जाने वाले प्राथमिक किस्म परीक्षणों के लिए चुना गया । इस वंशावली ने उत्तरी क्षेत्र में कपास पत्ती मोडक विषाणु के लिए अवरोधता प्रदर्शित की ।

सिरसा

इमिडेक्लोप्रिड 600 एफ एस का 9 मि.ली./कि.ग्रा. बीज की दर से उपयोग जैसिड के लिए प्रभावी पाया गया । इस उपचार (0.89/3 पत्ती) में निम्फ की संख्या कम थी । जबकि इसी रसायन की कम मात्रा (5 मि.ली./कि.ग्रा. बीज) का उपयोग सफेद मक्खी के लिए प्रभावी था । एसेटेमिप्रिड 20 एस पी (10 ग्रा. सक्रिय तत्व/है.) व थिओमेथाक्जान 25 डब्ल्यू जी (50 ग्रा. सक्रिय तत्व/है.) जैसिड व सफेद मक्खी दोनो के प्रबध के लिए प्रभावी थे ।

आई जी आर आर एच 2485 का 250 ग्रा. सक्रिय तत्व/है. का उपयोग बालवर्म के लिए प्रभावी था, जिसमें लाक्यूल का नुकसान 5.2 % देखा गया । अन्य सभी उपचारों जैसे आर एच 2485 (300 ग्रा. सक्रिय तत्व/है.) तथा मैच 5 ई सी (30 ग्रा. व 60 ग्रा. सक्रिय तत्व/है.) में बालवर्म का प्रकोप चेक (दुर्सबान 20 ई सी, 500 ग्रा. सक्रिय तत्व/है.) की तुलना में अधिक था ।

मैच 5 ई सी से उपचारित प्लाटों में कपास की उपज अधिक थी । मैच की 30 ग्रा. सक्रिय तत्व व 60 ग्रा. सक्रिय तत्व से उपचारित प्लाटो में उपज क्रमशः 15.27 कु./है. तथा 11.77 कु./है. थी । डार्बी व रगारी गाँवों के प्रत्येक 10 किसानों को आई आर एम प्रदर्शन के अंतर्गत कपास के शत्रु व मित्र कीडों को पहचानने हेतु प्रशिक्षण दिया गया । उन्हें पूरे फसल काल में फसल संरक्षण से संबंधित तकनीकी मार्गदर्शन दिया गया । डार्बी व रगारी गाँवों के प्रतिभागी किसानों ने कीटनाशकों के क्रमशः 4 व 5 छिडकाव किए । इसमें प्रतिभागी किसानों ने डार्बी व रगारी गाँवों में क्रमशः 13.75 से 20.75 कु./है. और 16.25 से 20.25 कु./है. कपास की उपज प्राप्त की । इन गाँवो के गैर प्रतिभागी किसानों ने क्रमशः 12.0 से 14.25 कु./है. तथा 11.5 से 15.5 कु./है. की उपज प्राप्त की । डार्बी व रगारी गाँव के प्रतिभागी व गैर प्रतिभागी किसानों के लागत लाभ का प्रतिशत क्रमशः 1:2.5 तथा 1:2.0 और 1:2.8 व 1:2.0 था । 5 तथा 1:2.0 और 1:2.8 व 1:2.0 था ।

कपास के पत्ती मोडक विषाणु और सफेद मक्खी के प्रकोप के लिए छाँटी गई को 1531 वंशावलियों में से 1205 वंशावलियों में पत्ती मोडक रोग 5.88 से 100 प्रतिशत था जबकि सफेद मक्खी का प्रकोप 0.07 से 1.13 प्रति पत्ती था । 1998 की तुलना में 1999 में मई व जून के दौरान अधिक तापमान में कमी, अधिकतम व न्यूनतम सापेक्ष आर्द्रता में अधिकता, चमकीली धूप का कम समय और अधिक वर्षा का होना ही संभवतः अधिक रोग प्रकोप का कारण था । स्थानीय संवर्धन को मादा के रूप में व सी एल सी यू वी अवरोधी वंशावलियों को नर के रूप में लेकर 115 नए

सकरण बनाये गये और इसके एफ$_1$ का 2000-2001 के फसल काल में मूल्यांकन किया जाएगा । फसल काल में उगाए गए 41 एफ$_2$ में से 88 आशाजनक बीमारी रहित एकल पौधों का चयन किया गया । 32 (बी सी$_1$) वंशावलियों में आवर्ती जनक के साथ प्रतीप संकरण किए गए । बुवाई की तारीखों के लिए किए गए परीक्षणों से प्रकट हुआ कि पहली बुवाई की तारीख (3 मई) में एच एस 6 किस्म में कपास की उपज में उल्लेखनीय रूप से अधिक कमी (68.3 %) देखी गई जबकि दूसरी बुवाई की तारीख (28 मई) में किस्म एफ 846 में कपास की उपज में अधिक (70.9 %) कमी देखी गई । किस्म आर एस टी 9 मे बुवाई की दोनों तारीखों में कपास की उपज में न्यूनतम कमी देखी गई । कुछ स्यूडोमोनास प्रेपरेशन्स तथा विभिन्न तापमानों पर विषाणु कम कर देने वाले प्रेपरेशन्स के परीक्षण से ज्ञात हुआ कि सभी तापमानों में पत्ती मोड़क रोग के प्रभाव में कमी हुई । जड़ गलन रोग के लिए अवरोधी 62 वशावलियाँ छाँटी गई । जड़ गलन का सबसे कम (11.8 %) प्रकोप वी वी 770 में देखा गया उसके बाद वशावली पी एच 36 ए (14.3 %) तथा 1143 ई सी (16.7 %) में थी । कपास की सर्वाधिक उपज वंशावली प्लेनस (19.4 कु./है.) में देखी गई इसके बाद 2225/92 तथा 770/102 (13.4 कु./है. प्रत्येक) में देखी गई । जड़ गलन प्रभावित खेतों में विभिन्न रसायनों व जैव कारकों के लिए किए गए परीक्षणों में कार्बेंडाजिम बीज उपचार में न्यूनतम जड गलन देखा गया और उसके बाद थाईफ्लुजेमिड तथा कार्बेंडाजिम से बीज उपचार और मृदा में जिंक सल्फेट के अनुप्रयोग का संयोजन रहा ।

फसल काल के दौरान एफ$_4$ से 13 और एफ$_3$ से 10 सकरणों का वरण किया गया । बी सी$_4$ पीढ़ी में सोलह प्रतीप संकरणों को फिर से आवर्ती जनक से प्रतीप संकरण किया गया । इसी प्रकार बी सी$_3$ पीढी में तेरह (13) प्रतीप संकरणों को आगे बढाने के लिए आवर्ती जनक के साथ प्रतीप संकरण किया गया ।

अर्थशास्त्र

नागपुर

तीन राज्यों के पाँच जिलों के 300 से अधिक किसानों से एकत्रित की गई जानकारी के आधार पर बारानी कपास की कम उत्पादकता की प्रक्रिया से संबंधित रूपरेखा तैयार की गई ।

फ्लो चार्ट से नीति निमार्ताओं को कपास की कम उत्पादकता के दुश्चक्र का ज्ञान होता है और इस दुश्चक्र को तोडने के लिए संस्थागत हस्तक्षेप की किस स्तर और प्रकार की आवश्यकता है ।

वर्ष 1999-2000 के दौरान सिरसा से इकठ्ठे किए गए ऑकड़ों से उद्घाटित हुआ कि बालवर्म का प्रकोप, अप्रभावी रसायन, समय पर नहर के पानी का न मिलना, असमान्य पावर सप्लाई, श्रमिकों की अनुपलब्धता, ऋण की असुविधा, रसायनों का अनुचित उपयोग तथा पत्ती मोडक विषाणु अधिक उत्पादकता के लिए मुख्य रुकावटें हैं ।

कोयंबतूर

अंतः हिर्सुटम संकरों में सविता लगाने वाले किसानों ने 1.48 रु. का शुद्ध लाभ प्राप्त किया जबकि आर सी एच 2 व ब्रम्मा लगाने वालों ने क्रमशः 11 व 15 पैसे प्रति एक रुपया लागत का लाभ प्राप्त किया । अध्ययनों से पता लगा कि सविता संकर अधिक क्षमता वाला है और इसकी अनुकूलनशीलता बढ़ रही है । कपास के बीज उत्पादक किसानों के लिए गर्मियों में बीज उत्पादन कार्यक्रम लाभदायक है ।

ग्रीष्म कपास के विपणन में निवेश व उत्पादन दोनों वितरण प्रणाली में बहुत कमजोर सबध है । केला के खेतों में कपास की फसल लेना लाभदायक देखा गया है ।

3. Progress of Research
A. Research Highlights

CROP IMPROVEMENT

Nagpur

The upland cotton germplasm was enriched by fifty new exotic and indigenous accessions, which exhibited wide variability for boll weight, bolls/plant, G.O.T., mean halo length and seed cotton yield/plant. Superior lines for these characters were identified.

In Br 01 trial, 100 accessions each of upland and *arboreum* cotton were evaluated in three zones and promising accessions for yield and other characters were identified. Culture CNH 152 outyielded check in the common station trial and recorded seed cotton yield of 11.64 q/ha and 8.62 q/ha at Nagpur and Coimbatore ranking third and fourth respectively. This culture has been entered in AICCIP national trial. In a replicated trial, thirty elite cultures were evaluated using LRA 5166 as check . The five top performing cultures were CNH 1030, 1031, 1032, 1033 and 1034. Their seed cotton yield ranged from 14-18 q/ha against 11-12 q/ha of check. Based on evaluation of 100 F_1 crosses, one superior F_1 combination was identified.

In the varietal improvement programme of upland cotton, three high yielding and early maturing cultures viz. CIHS 97-7 (22.22 q/ha) CIHS 14 (18.20 q/ha) and CIHS 16 (18.05 q/ha) were identified. The yield of LRA 5166 was 15.44 q/ha. Culture CNH 2124 was entered in Br 02 (a) national trial. One drought tolerant culture, i.e, CNH 301 gave good performance in Br 03 (a) in south zone (17.62 q/ha) and hence was promoted to Br 04 (a). Another drought tolerant culture CNH 32 was entered in Br 02 (b) trial.

The early maturing, high oil culture CNO 131 was registered with NBPGR, New Delhi, as an unique germplasm. Another early, high oil culture CNH 2124, which topped in station trials at Coimbatore and was third highest yielder at Nagpur station trial, was entered in Br 02 (a) AICCIP national trial. Also the culture CNO 131, which showed good performance in Br 04 (a) during the current season, was promoted in the AICCIP trials for third year's testing.

In *G.arboreum,* three early maturing (140-150 days) and high yielding cultures viz. CINA 310 (24.86 q/ha), CINA 323 A (24.9 q/ha) and CINA 323 B (21.52 q/ha) were identified. The yield of check AKH 4 was 19.4 q/ha. The culture CINA 310 has been promoted from national trial to Br 24. The culture CINA 323 A in Br 22 (a) and CINA 323 B in Br 24 were entered this year. In upland cotton, five superior heterotic combinations were identified in which useful heterosis ranged from 4.4 to 61.1 per cent over NHH 44 and from 12.7-88.0 per cent over LRA 5166. The best hybrid CIHH 103 recorded seed cotton yield of 20.14 q/ha of NHH 44. These two hybrids were entered in Br 05 (a)-1 and Br 05 (b)-1 in central and south zones.

In all, 142 GMS and 334 CMS based hybrids were tested and five superior GMS hybrids viz. NGMSH 22 (16.38 q/ha), NGMSH 7 (15.22 q/ha), NGMSH 14 (15.01 q/ha) NGMSH 67 (15.65 q/ha) and NGMSH 75 (14.96 q/ha) were found promising. Six GMS based *intra-arboreum* crosses were evaluated in which useful heterosis ranged from 15.1-57.6 per cent over AKH 4 and from 7.5-47.6 per cent over DH 9. The hybrid GAA 99-2 recorded the highest seed cotton yield of 20.05 q/ha.

One new wild species i.e. *G.nelsonii* has been added to the species garden. The macro mutants of Y1 and Suvin identified earlier were advanced to M_4 and M_5 generations and adaptable genotypes were selected.

Breeder seed of Anjali (1.14 q) and LRA 5166 (6.0 q.) were supplied to the states, as per indents, for production of foundation seed.

Coimbatore

Culture CWROK 165 was tested in the coordinated varietal trial under irrigated conditions for the past five years and recorded a mean yield of 13.55 q/ha and was superior over the common check LRA 5166 (10.04 q/ha) by 35 per cent and over the local check (10.41 q/ha) by 30 per cent. The culture was characterized by high ginning outturn of 38 percent. With a medium staple quality, the culture is capable of spinning 30s to 40s count yarn. Based upon its yield superiority, culture CWROK 165 was identified for release in the South Zone. The CMS Ali x D III (1) and CMS RK x M gave a seed cotton yield of 33.6 and 34.1 q/ha compared to Savita's 22.1 q/ha. In the case of genetic male sterile hybrids GMS J 34 x 19, GMS 2 x 1, GMS 12 x 19 gave an yield of 23.8, 23.7 and 23.6 q/ha respectively compared to Savita's 15 q/ha. In the common hybrid trial conducted at two locations viz., Nagpur and Coimbatore, hybrid CCHY 10555 recorded the highest yield of 23.3 q/ha.

Sirsa

One thousand and hundred germplasm accessions maintained were evaluated for different characters. Hybrids CISHH 6, CISHH 8, CISHH 14, CISHH 19, CISHH 18, CISHH 16, CISHH 45, CISHH 43, CISHH 32, CISHH 56 CISHH 60, CISHH 68, CISHH 79 CISHH 95, CISHH 100, CISHH 101 and CISHH 103 recorded significantly higher seed cotton yield over the highest yielding local check, Om Shankar.

The highest yield of seed cotton was recorded by the GMS hybrid CISHHG 2 (220 g/plant) followed by CISHHG 7 (190 g/plant), CISHHG 18 (172 g/plant) and, CISHHG 5 (160 g/plant), as compared to 110 g/plant, 65 g / plant of Om Shankar and F 846 respectively. The ginning outturn of GMS based hybrids ranged from 32 to 38 per cent and the 2.5% span length from 24.1 to 29.1 mm.

Four hundred single plants have been selected from segregating generations on the basis of CLCuV resistance, yield and quality.

Demonstration of promising strains: The strain CISA 9-3 (2820 kg/ha), CISA 9-10 (2463 kg/ha) and CISA 9-8 (2184 kg/ha) significantly out yielded the check varieties RG 8 (1622 kg/ha) and LD 327 (1785 kg/ha). Three strains viz., CISA 40-5, CISA 17 and CISA 9-17 gave 39 per cent ginning outturn, at par with the check variety LD 327. The highest 2.5% span length of 19.7 mm was recorded by the strain CISA 9-10.

The hybrid CSHH 98 gave the highest seed cotton yield of 3095 kg/ha followed by CSHH 89 (2881 kg/ha) as compared to 2716 kg/ha and 2469 kg/ha of Om Shankar and Ankur 651, respectively (Check hybrids). The highest 2.5% span length of 28.4 mm was recorded by the hybrid CSHH 86.

The *G.arboreum* entries CISA 3, CISA 21, CISA 34 and CISA 46 recorded more than 40% increase over the highest yielding check variety LD 327. The GMS based cross combinations CISAAG 11 (3697 kg/ha), CISAAG 3 (3497 kg/ha) and CISAAG 4 (2881 kg/ha) significantly out yielded the check varieties RG 8 (1622 kg/ha) and LD 327 (1785 kg/ha).

SEED TECHNOLOGY

Coimbatore

Neem leaf powder and neem kernel powder had higher efficiency in arresting seed deterioration, when stored in different containers.

Sirsa

Among hybrids, Om Shankar, Maruvikas, Dhan Laxmi, Fateh and Kirti percentage of crossed boll setting, seed setting, seed index, germination and vigour index were found higher during the period 15th August to 15th September. In varieties, the seed index, germination and vigour index were higher from second picking.

Significant reduction in germination was not noticed upto nine months when hybrids and varieties were stored under room condition. After that, a gradual decline in germination and vigour was observed. The germination above certification level was noticed upto 15 months of storage in hybrids, but in varieties the germination percentage reached below certification standard. In seed development and maturation study, the seed index increased gradually and reached maximum at 60th day after anthesis. The seed moisture

content declined gradually and at 60th day reached at minimum level. The developing seed started germinating at around 30th day of seed development, when the germination was very low which increased gradually and was observed maximum at around 60th day in all the varieties. Similar trend was observed for vigour index also.

In both, *G.hirsutum* and *G.arboreum,* seed index, germination percentage, vigour index and total seed yield were higher in H 777 and LD 327 as compared to others tested.

CROP PRODUCTION

Nagpur

Permanent manurial trials have highlighted the importance of rotating cotton with jowar and balance fertilization. Supplementing N with P and K resulted in significant improvement in yields. With continuous S application, yield of seed cotton, mustard and wheat was increased. Also the available S content in the top soil (0-20 cm) was higher than no S applied plots. Tillage treatments did not result in any significant yield differences. However, qualitative improvements of soil attributes were noticed such as higher soil microbial biomass, higher numbers of microfauna (nematodes) and microfauna (arthropods). Log linear and non linear models were used to estimate the decomposition rate constants. The non linear model was found to give a better fit.

Prometryne (1.25 kg a.i./ha) was as good as the farmers practice and effectively controlled weeds for 42 days. Application of glyphosate, with a protective hood, is better at 8-10 leaf stage than 4-6 leaf stage for controlling late season weeds

Uniformity of drippers along the lateral was found to vary from 75% more than rated discharge at the beginning of the line to 15% less at the end of the line due to pressure variations along the laterals. The water front of a single dripper advanced uniformly in all directions (rad. 30 cm). The advance in the initial stages of crop growth was more than that required by plants.

The INM packages containing *Azotobactor chrococcum* (HT -57) produced seed cotton yield 8% in excess of the farmers practice. Seed treatment with PSB and VAM also resulted in positive improvement in yield.

The prototype developed and fabricated last season was put to trial. LRA 5166 was drilled and planted. Drilling at 60 cm row to row spacing was satisfactory except that the seed rate was found higher at 20 kg/ha. This was rectified by reducing the hole size at hopper bottom to one cm from the earlier two cm. Planting of seed at 60 cm x 30 cm could not be achieved uniformly as the design of seed metering plate resulted in choking of plate due to seeds getting stuck between hopper base and the plate. The plate has been redesigned to remove the lacuna. The field coverage of the machine was six times more than the manual dibbling practice.

The historical rainfall data base has been analyzed. The results of analysis can be utilized by crop scientist pertaining to management and crop planning decisions such as: sowing date, time of fertilizer application, sowing date, plant protection schedule, utilization of excess rainfall, etc.

Coimbatore

In the permanent manurial experiment in cotton-cotton and jowar - cotton rotation under irrigated conditions, the seed cotton yield ranged between 6.6-8.9 q/ha in Savita and 7.2-12.6 q/ha in Surabhi. Among the cropping sequence, Savita in jowar-cotton produced significantly higher yields of 10.6 q/ha than in cotton-cotton system. But Surabhi produced similar yields in both systems. The maximum seed cotton yields of 11.9 and 5.4 q/ha in jowar-cotton and cotton- cotton system, in the case of Savita were recorded in P45-K45-FYM 15 t and the variety Surabhi recorded the highest yields of 11.7 q and 13.4 q/ha in P45-K45-FYM 15 t in cotton-cotton and jowar-cotton systems respectively. In both the genotypes and cropping sequences, P45-K45-FYM 15 t proved its superiority.

Weedicide Prometryne and Gesagard were found equally effective in controlling weeds. Lower doses of 1.0 - 1.5 kg. ai/ha gave better results. But compared to Pendimethalin, these herbicides were found to be not so efficient.

PHYSIOLOGY AND BIOCHEMISTRY

Nagpur

A wide range of variability was observed for growth and physiological attributes in 100 *G.hirsutum* and 50 *G.arboreum* lines. Low concentration multiple applications of Lihocin (100 and 300 ml/ha) from squaring onwards in PKV 2, NHH 44 and AKH 4 suppressed growth but did not improve yield. Moisture stress induction at flowering in *arboreum* and *hirsutum* genotypes indicated that *arboreum* genotype had relatively better drought tolerance mechanism due to maintenance of lower stomatal resistance and higher stability in transpiration rate. Detopping with foliar application of different nutrients did not enhance yield. Late plantings in LRA 5166 amd LRK 516 tended to decrease growth rates. In 25 lines, plants showing higher stability to leaf relative water content were identified. Salinity tolerant genotypes were identified and were found to produce higher biomass and leaf area at early stages under salinity treatment. Salinity did not affect growth and development till 10 ds m^{-1} level. Sodium at lower concentration enabled the maintenance of the osmotic potential of the plant and at higher concentrations inhibited plant metabolic activities. In PKV 081, total phenol concentration decreased very rapidly immediately after 24 h of spray of oxymethyl demetron and fenvalerate. On the other hand, reducing sugar concentration showed a very steep increase after 24 hr of fenvalerate application. The normal states of the secondary metabolite concentration was restored with passage of time.

Coimbatore

Genotypes adapted to South zone (LRA 5166 and Anjali), Central zone (CNHPT-2) and North zone (H-777) responded favourably to elevated CO_2 atmosphere of 650 ± 50 ppm in terms of yield and yield components with increased photosynthetic and nitrate reductase activity during active growth phases of the crop. Elevated carbon dioxide level of 650 ppm at 40°C was found optimum for maximum photosynthetic rate and nitrate reductase activity in cotton. Plants grown under elevated CO_2 atmosphere produced significantly more bolls per plant (16.2) than plants grown under ambient control atmosphere (13.5) irrespective of the genotype studied. However, the genotypic response to elevated CO_2 varied widely.

Studies on drought showed that genotypes - LRK 516, KgI 931, NME- 70, Normal Okra, AC-241, HGIPS-542, NME, RBC-37, K-34007, EC 126623, Acala glandless, Glx . 22/1, H-777, LRA 5166, RBC -39, CNH-38, CNHPT-5 and IC-1356 were tolerant.

There existed a relationship between the differential reducing sugar accumulation in fibre and seed than the absolute quantity with the fibre elongation process. Reducing sugars have a vital role to play in the fibre elongation process.

The bollworm tolerant selections viz., BRS 3, BRS 5, BRS 22 and BRS 23 were seen to possess consistently higher levels of protective secondary metabolites and lower levels of nutritional substances, thus explaining the underlying mechanism in their tolerance to bollworms.

It was seen that the insecticides Thiomethoxam at 3g/kg and 4.5 g/kg enhanced the activity of Nitrate Reductase to an extent of 30-40%, while Imidacloprid and Carbosulfan enhanced the activity progressively with development of the seedlings by 20-25%. Around 25-40% increase was seen in soluble protein content of leaf due to application of fungicides, carbendazim and prochloraz, while enhanced accumulation of reducing sugar was seen in prochloraz treated plants.

CROP PROTECTION

Nagpur

Ten *G.hirsutum germplasm* lines were found to be tolerant to all sucking pests and bollworms, of which four viz. JBWR 34, I-81B, Ambassador and Culture 34 showed consistent results for the last 5 years.

Column purified protease inhibitor from bolls of PeeDec 0695 was used as antigen to raise cotton protease inhibitor specific antiserum to facilitate screening of the cotton germplasm lines for the presence of protease inhibitors. Wild cotton germplasm pool has species that show an inducible defense response by producing protease inhibitors.

Recommendation of late variety redgram as strip or border crop in cotton based cropping system was confirmed. Yield levels of cotton cultivars signified a 45% loss due to *Pectinophora gossypiella* due to delayed sowing.

By controlling all the major pests of cotton, loss can be avoided to the extent of 32.31%. Imidachloprid and thiomethoxam were found to be most effective against jassids. Decis tablet, Indoxacarb and Spinosad were found to be effective against bollworms.

Resistance monitoring was carried out on cotton pests collected from different regions in India. Laboratory studies were carried out to understand the sensitivity of some beneficial insects to insecticide. *Helicoverpa armigera* was selected for resistance to various insecticides, insecticides + synergists and Cry toxins. Baseline susceptibility indices were determined for cry 1A toxin on *H.armigera*. A sensitive bioassay was developed for the screening of putative Bt. cotton plants. Putative transgenic cotton plants developed at CICR were screened for resistance with four lepidopteran insect pests of cotton. Insecticide resistance management strategies were implemented in nine villages in Wardha for the second successive year indicated drastic reduction in insecticide use by 90% with no negative impact on yields.

Six races viz., 3,5,8,10,15, and 18 of X.a.pv. *malvacearum* have been identified from five susceptible cultivars. Races 10 and 18 were most predominant. Races 5,7,10,15 and 18 have been isolated from Punjab samples. Seven lines of upland cotton were observed to be resistant against the virulent race 18. One hundred and sixty seven single plant selections have been made based on their resistance and plant quality parameters for advancing further evaluation. Thirteen resistant selections have been identified for their yield contributing parameters.

In the analysis of bad seed-cotton lots of the 1998-99, the presence of a total number of 18 fungus genera and X.a. pv. *malvacearum* was observed.

The immunity of seven *Gossypium arboreum* germplasm lines to grey mildew was confirmed for the tenth consecutive crop season. The AKH4 GMT (Grey mildew tolerance) lines were evaluated for fibre quality.

Five resistant cultures to Fusarium wilt were developed. Of the seventy four germplasm lines tested, nine showed resistance.

Out of 233 *G.hirsutum* germplasm lines, two were found resistant to Myrothecium leaf spot while seven showed immunity and eight resistance to grey mildew.

One line namely CNH 911 performed well in Br 02(b) trial of AICCIP (Central Zone) and has been promoted to Br 03(b).

Two antagonists for *Xam* were identified. One hundred and fifty isolates of *Xam* were collected from cotton growing zones of different states. Highly virulent races contained a plasmid of 31.2 kb, which can be used as a marker for higher virulence. Plasmid and genomic DNA finger printing and PCR amplification of the plasmids from different isolates of *Xam* using a custom synthesised primer revealed polymorphism, which can be exploited to generate *Xam* race specific molecular diagnostic tools.

Resource Generation

HNPV was produced and supplied to various State Departments of Agriculture generating revenue worth Rs.15 lakhs.

Coimbatore:

Aphid population was high in September and January. High population of Jassid was recorded in December - January. Among the bollworms, *H. armigera* was the predominant pest and a maximum of 65.7% damage on fruiting bodies was recorded during the middle week of December and a larval density of three per plant was observed during this period. Coccinellid predator was high during September and the parasitism on aphid was up to 50% during January.

Of the twenty one cultures of *Gossypium hirsutum* screened for bollworm resistance (*Helicoverpa* and pink bollworm), five viz.. RR 1007-123-4, RR 1007-124-3, RCH 5266-1-2, CWROK-165 and BRS 23 were found tolerant to bollworm damage and gave higher seed cotton yield over LRA 5166. Larval incidence and damage relationship of *H.armigera* showed the need to lower the existing larval threshold of one larvae per plant to one larva for two plants, which corresponds to

the existing threshold of 5% fruiting bodies damage.

The seed dressing chemical Imidachloprid 600 FS and Thiomethoxam remained effective, against sucking pests up to 45 days. The sprayable formulation of Acetamiprid and Thiomethoxam were effective against aphid and jassid. Larval incidence and boll damage were significantly less in Spinosad treatments followed by Indoxacarb. Seed cotton yield was significantly higher in Spinosad (18.8 to 23.6 q/ha) followed by Indoxacarb (18 to 18.5 q/ha). The combination products Endophos, Viratsuper, Sherlone and Nurelle-D were not effective as compared to their individual compounds and control.

The adoption of IRM strategies in cotton resulted in significant reduction in usage of insecticides from 4701 to 2665 g.a.i/ha (-43.4%) and plant protection cost from Rs. 7040 to Rs. 3401 per ha (-51.7%). In addition, it recorded an increased seed cotton yield from 9.17 to 14.72 q/ha (+60%) and net returns from Rs. 7482 to Rs. 19,652 per ha(+163%). Besides, the sucking pests (jassid and aphid) and bollworms damage were less by 10 to 24% and 17 to 38%, while predators were higher by 68% in participating farmers' fields as compared to non-participatory farmers' fields.

In the IPM village there were six rounds of insecticide sprays as compared to eight sprays in the non-IPM village. The cost for insecticide in IPM village was Rs.5174 as compared to Rs. 5916 in non-IPM village. The IPM village registered an yield of 2220 kg/ha as compared to 2010 kg in non-IPM village

Two hundred *G.arboreum germplasm* lines along with several grey mildew resistant *G.hirsutum* lines and the susceptible cultivars LRA 5166 and Anjali were evaluated in pots for their reaction to *arboreum* and *hirsutum* isolates of *R. areola.* The investigation indicated variations among the isolates and also the differential host reaction.

Benzothiodiazole followed by *T. viride,* Prochloraz and the CHAO strain of P. *fluorescens* were effective in controlling *Alternaria* leaf spot against grey mildew, Tebuconazole, Prochloraz, Carbendazim, T.*viride* and Propiconazole were the most effective fungicides/ bioagent.

Alternaria leaf spot resistant line CCH 727 that was entered in the Irrigated National Initial Evaluation Trial, performed well both in the Central and South zones and hence advanced to the Preliminary Varietal Trial during 2000-2001 season. It has also shown resistance to Cotton Leaf Curl Virus disease in North zone.

Sirsa

Imidachloprid 600 FS at the rate of 9 ml/kg of seed was found effective against jassids with less nymphal population (0.89/3 leaves), whereas the same chemical was effective against whitefly at lower dose (5 ml/kg of seed). The sprays of Acetamiprid 20 SP (10 g a.i./ha) and Thiomethoxam 25 WG (50 g ai/ha) were effective in the management of both jassid as well as whitefly.

The IGR RH 2485 at the rate of 250 g ai/ha was found effective against bollworms, which recorded 5.2% damage in loculi basis. The bollworm incidence in all other treatments viz RH 2485 (300 g a.i./ha) and Match 5 EC (30 g and 60 g a.i./ha) were more than the standard check (Dursban) 20 EC, 500 g a.i./ha). The seed cotton yield was more in plots treated with Match 5 EC i.e. 15.27 q/ha in 30 g a.i/ha and 11.77 q/ha in 60 g ai./ha treatments.

Ten farmers each from Darbi and Rangari villages, were selected and given training on identification of insect pests and natural enemies under IRM demonstration. They were given technical guidance on crop protection throughout the crop season. The participants' fields were given 4 and 5 sprays in Darbi and Rangari respectively, and the yields were 13.75 to 20.75 q/ha and 16.25 to 20.25 q/ha seed cotton. The non-participatory farmers obtained 12.0 to 14.25 q/ha and 11.5 to 15.5 q/ha respectively. The Cost: Benefit ratio of participatory and non participatory farmers in Darbi was 1:2.5 and 1:2.0 and Rangari was 1:2.8 and 1:2.0 respectively.

Of the one thousand five hundred and thirty one lines screened against cotton leaf curl virus disease and whitefly incidence, 1205 showed leaf curl disease ranging from 5.88 to 100 per cent, whereas whitefly incidence varied from 0.07 to 1.13 per leaf. Lower maximum temperature, higher maximum and minimum relative humidity, less bright sunshine hours and more rainfall prevailing during May and June in 1999 as

compared to 1998 probably led to higher disease incidence. One hundred and fifteen fresh crosses involving local cultures as females and CLCuV resistant lines as males were attempted during 1999-2000 season and F_1s will be evaluated during 2000-2001 crop season. Eighty eight promising disease free single plant selections were made from 41 F_2 crosses raised during the season. Back crosses (BC-2) with recurrent parents were made in 32 (BC-1) lines. The date of sowing experiment showed that in first planting date (3rd May), maximum and significantly higher seed cotton yield reduction was observed in variety HS-6 (68.3%) whereas in the second sowing date (28th May) variety F846 showed maximum reduction in seed cotton yield (70.9%). Variety RST9 showed minimum reduction of seed cotton yield in both planting dates. Testing of attenuated virus preparation at different temperatures and some *Pseudomonas* preparations revealed reduction in leaf curl incidence in all the treatments.

Of the sixty two germplasm lines screened against root rot disease, minimum incidence was noted in line VV-770 (11.8%) followed by PH-36 A (14.3%) and 1143 EC (16.7). The maximum seed cotton yield was recorded in Plains (19.4 q/ha) followed by 2225/92 and 770/102 (13.4 q/ha each). In testing of different chemicals and bio-agents under root rot sick field, carbendazim seed treatment showed minimum root rot incidence followed by thifluzamide and carbendazim seed treatment in combination with soil application of $ZnSo_4$.

Thirteen crosses were selected from F_4 populations and ten crosses were selected from F_3 population during the crop season. Sixteen back crosses in BC_4 generation were further back crossed with their recurrent parents. Similarly thirteen back crosses in BC_3 generation were further advanced by back crossing with their recurrent parents.

ECONOMICS

Nagpur

A schematic representation of the mechanism of low productivity of rainfed cotton was designed using the field level information collected from over 300 farms in five districts across three states. The flow chart offers policy planners an understanding of the vicious circle of low productivity and the levels and nature of institutional intervention required to break it. The data collected from Sirsa district during 1999-2000, revealed the incidence of bollworm, ineffective chemicals, non-availability of canal water on time, erratic power supply, non-availability of labour, tied-up credit, improper use of chemicals and leaf curl virus as the major constraints to higher productivity.

Coimbatore

Among the intra-*hirsutum* hybrids, farmers cultivating Savita earned a net profit of Rs.1.48 whereas farmers cultivating RCH-2 and Bhramma earned a profit of 11 paise and 15 paise per rupee invested, respectively. The study shows that Savita hybrid is having more potentiality and its adaptability is encouraging. Seed Production Programme during summer is a profitable venture for the seed producing cotton farmers. Marketing is the weakest link both in input and output delivery system of summer cotton. Cotton as a catch crop in the banana field is a profitable venture.

4. Usable and transferable technologies and recommendations for extension worker

Nagpur

A simple scouting method for *H. armigera* has been developed and validated in farmer field conditions. The study indicated that one egg per plant cannot be equated to one larva per plant or 10% damage to fruiting parts. One larva per plant could be correlated to eight-ten damaged squares or 1-2.5 damaged bolls. This in terms of percentage could be 25-30% if squares are considered or 5-10% if bolls are counted. Larval and egg threshold scouting was also found to be cumbersome and individual farmer dependent, instead of searching for larvae, farmers can score plants as having a larva if it has 2-3 flared-up squares on a sympodia.

- Resistance management strategies have been devised and are available in the form of technical bulletins in Hindi, Marathi and English published by CICR. The information published are user friendly and can be used by extension workers and farmers.

- **Potential of *Trichoderma viride* for cotton disease management:** Technology for use of *Trichoderma viride* has been standardised for management of cotton diseases. *T.viride* used as foliar spray was found to control rhizoctonia root rot by *Rhizoctonia bataticola,* , *Colletotrichum spp.,* Fusarium wilt by *Fusarium oxysporum* f. sp. *Vasifectum,* Rhizoctonia wilt by *Rhizoctonia solani,* bacterial blight by *Xanthomonas axonopodis* pv *malvacearum,* fungal leaf spot of anthrancnose by *colletotrichum gossypii,* Myrothecium leaf spot by *Myrothecium roridum* and Alternaria leaf spot by *Alternaria macrospora.*

The Hyphae of antagonist grow around mycelia and spores of pathogenic fungi and kill them by release of hydrolytic enzymes. *T.viride* also shows antagonism to bacterial diseases. *T.viride* formulation has been standardized and can be used as spray or seed treatment. *Trichoderma* biofungicide thus formulated is viable for two years under room conditions.

Sirsa

Hybrid Seed Production

Hybrid seed production technology has been standardised. The farmers are being trained in seed production of hybrids Omshankar and LHH-144.

IPM & IRM Technologies.

The technologies were successfully demonstrated under farmer field conditions. The IPM module used was as follows:

- growing of resistant/tolerant genotypes
- chemical seed treatment for delaying the first insecticide application.
- avoiding the use of broad spectrum organo phosphates such as moncrotophos, acephate etc., especially as early season sprays.
- use of endosulphan at early stages of crop development.
- use of safer and bio insecticides like neem and npv or bt.
- rational and sensible use of insecticides.

5. Transfer of Technology

A. EXTENSION

Nagpur

Krishi Mela

A Krishi Mela was organised under the cotton Front Line Demonstration (FLD) programme on Dec.12, 1999. The Mela was inaugurated by Dr. V K Patil, Vice Chancellor, Indira Gandhi Krishi Vishwa Vidyalaya, Raipur. Dr. Patil, in his inaugural address, emphasized that research Institutes should ensure that low-cost technologies like Integrated Pest Management, Insecticide Resistance Management, biofertilisers, seed production etc., reach farmers speedily.

Former Minister of Maharashtra Shri. Sunil Kedar, who presided over the function, urged the CICR to provide quality seeds and improved production technologies to boost cotton production and productivity in the region.

Dr. M S Kairon, Director, CICR, Nagpur in his introductory remarks, highlighted the rising popularity of seed production launched by the Institute under the seed village programme.

Farmers from the adopted villages - Sawangi, Deoli, Amgaon, Banwari, Kaldongri and Rui under FLD programmes participated in the Mela.

Field Day

Sirsa

CICR Regional Station, Sirsa conducted a Front Line Demonstration on its hybrid cotton Om Shankar, at village Rangari of Sirsa district. A field day was organised on August 4, 1999 to demonstrate efficient and low cost plant protection measures as well as crop husbandary practices for this hybrid. Sixty five cotton farmers from different villages participated in this programme. Dr. A J Tamhankar, Senior Entomologist of Nuclear Agriculture & Research Centre, Mumbai was the chief guest. Dr. Tamhankar spoke about low-cost plant protection techniques as a component for lowering cost of cultivation under uncertain climate. Dr. T P Rajendran, Senior Scientist, CICR, Nagpur spoke on alternative pest management strategies including use of 10% Neem seed Kernel extract, 1% Neem oil and Biocontrol agents such as Trichogramma, HNPV etc. Dr. D Monga, I/c Head, of the Station, shared information regarding the wide spread of cotton leaf curl virus and the efforts of CICR researchers to contain the spread of this disease.

IPM and IRM Demonstrations

The IPM and IRM module were successfully implemented in Rangari and Darbi villages of Sirsa district. There were five participatory farmers with an area of 60 acres of land in each village. The selected

Dr. Mangala Rai, DDG (CS), ICAR, in discussion with the scientists in the glass house

Shri M. B. Lal, Advisor, TMC, Ministry of Textiles, Govt. of India, in discussion with Director, CICR

RAC members interacting with the scientists in the net house

farmers were given training on identification of insect pests and natural enemies and technical guidance on crop protection throughout the season. There was reduction in the number of insecticidal sprays in participatory farmers fields. The participatory farmers used 4-5 sprays as compared to 6-7 sprays used by non-participatory farmers. There was better management of *Helicoverpa armigera* in the fields of participatory farmers. The participatory farmers in Darbi and Rangari village harvested 5.5 to 8.3 q/acre and 6.5 to 8.7 q/acre seed cotton yield, respectively, while the non-participatory farmers realised 4.8 to 5.7 and 4.6 to 6.2 q/acre, respectively. The cost-benefit ratio realised by participatory and non-participatory farmers of village Rangari was 1:2.8 V/s 1:2.0, whereas in village Darbi, it was 1:2.5 V/s 1:2.0.

CICR Participated in Krishi Expo 2000

CICR participated in Krishi Expo 2000 organised by Indian Trade Promotion Organisation, with involvement of Ministry of Agriculture, at New Delhi, from January 25 to February 1, 2000. Krishi Expo. 2000 was inaugurated by the Hon'ble Union Minister for Agriculture, Sh. Nitish Kumar, on January 25th, 2000.

Effective environments as demonstrated are those characterised by the presence of friendly pest and disease management technologies and improved cotton cultivars. Live demonstrations of pest management using HNPV were also organised at the mela. Other aspects such as the importance of quality seed, information on cotton leaf curl virus disease and improved crop management practices were demonstrated through posters. The exhibition was visited by the Hon'ble Union Minister of State for Agriculture (AHD & DARE) Shri Hukum Dev Narain Yadav and Secretary, DARE & Director General, ICAR Hon'ble Dr. R S Paroda. CICR stall was also visited by large number of farmers, representatives of farmers' organisations from different parts of the country and Agriculture students.

B. TRAINING

Training Course on Insecticide Resistance Management for North India

A training course on 'Practical Aspects of Insecticide Resistance Management' was organised by CICR at the Regional Station, Sirsa on the June, 19, 1999. Shri. K. Arya, Additional Secretary, Ministry of Agriculture, Govt. of India, inaugurated the course. Dr. M S Kairon, Director , CICR , Nagpur delivered the keynote address on cotton production technology.

The major objective of the course was to transfer the technology of Insecticide Resistance Management of cotton pests to extension workers and industry personnel, so that a common pest management programme can be implemented all over the country. Other objectives of the training course were:

- To create awareness about problems in pest management arising due to insecticide resistance, and
- To impart training on utilising the information on resistance for better pest control and resistance management. Apart from imparting the latest techniques of 'IRM', the course also served as a forum for active interaction, brainstorming and programme finalisation for its implementation, countrywide.

Ten technical personnel from the insecticide and seed industry and about 20 representatives from the State Departments of Agriculture and KVK participated. One hundred and twenty five villages in Haryana, Punjab, and Rajasthan are currently being adopted by four pesticide companies and CICR for implementation of complete package of

insecticide resistance management.

National Training Course On Integrated Cotton Production Technology

A National Training Course on Integrated Cotton Production Technology was organised at CICR, Nagpur during September 22 - 29, 1999. The course was sponsored by the Directorate of Extension, Ministry of Agriculture, Govt. of India, aiming at the transfer of latest cotton production technology from CICR to officers of various states. The course was inaugurated by Dr. M L Madan, Vice Chancellor, Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola on Sept. 22, 1999. In his inaugural speech, Dr. Madan reminded that the first green revolution of India has come through food crop like wheat and rice, but the second revolution would come through cash crop like cotton. He further, stated that indiscriminate importing of agricultural technology may not give desired results due to differences in soil, climatic patterns, technological stage and socio-economic conditions.

The Guest of Honor, Dr. K. R. Krishna Iyer, Director, Central Institute for Research on Cotton Technology, Mumbai emphasized that proper cotton processing is equally important for making cotton competitive in the international markets.

Dr. M S Kairon, Director, CICR, said that more efforts were needed to reduce the cost of production and increasing productivity of cotton at farmer's fields and thus the extension agencies have a big challenge before them, in terms of proper and timely steps to meet such an objective.

Eighteen senior level officers from Maharashtra, Karnataka, Andhara Pradesh, Madhya Pradesh, Tamil Nadu, Punjab and West Bengal participated in the said course.

Training Programme on IPM and IVLP

A training programme on Integrated Pest Management (IPM) and Institute Village Linkage Programme (IVLP) for farmers was organised by CICR, Regional Station, Coimbatore on November 25, 1999. Dr. R S Paroda, Secretary, DARE and Director General, ICAR, was the Chief Guest and Dr. S. Kannaiyan, Vice Chancellor, TNAU, Coimbatore was the president of function.

Dr. Paroda, complimented the scientists for having increased the hybrid cotton area to 40% and stressed that it should be increased up to 50% to achieve stability in production. He further mentioned the need for integrating pest management and nutrition management technologies and wanted more research work on low cost technologies.

Dr. Kannaiyan emphasised complementarity between scientists and farmers and more research on bio-pesticides to conserve and augment natural enemies.

Dr. K Venugopal, Project Coordinator and Head of Station, outlined the present cotton scenario in the country.

During the function, cotton seeds of high yielding variety 'Surabhi' was distributed to two project farmers. A Pamphlet on IRM was released by Dr. R S Paroda.

D. RESEARCH PAPERS PRESENTED IN SEMINARS/ SYMPOSIA/ CONFERENCES AND PUBLISHED IN THE FORM OF ABSTRACT

AUTHOR(S)	TITLE OF THE PAPER & ABSTRACT NO.	PRESENTED AT	VENUE & DATE
Chakrabarty PK Sheoraj	Molecular basis of pathogenicity of *Xanthomonas axonopodis* pv. *Malvacearum* and use of cloned pathogenicity genes as diagnostic tools.	National Symposium on Role of Resistance in Intensive Agriculture	DWR, Karnal Feb.15-17, 2000
Gajbhiye HL Singh Gulbir	Information processing behavior of extension personnel in orange growing tract of Mid-West. p. 103.	International Symposium On Citriculture	Nagpur Nov.23-27, 1999.
Gokte-Narkhedkar N Sheoraj	Dynamics of plant parasitic nematodes associated with cotton in Nagpur region. pp.26	National Seminar on Nematological Research in India : Challenges and Preparedness for the New Millennium.	Kanpur Dec. 17, 1999
Kairon MS Ramasundaram p Venugopalan MV	Cotton Production in India. Problems and Prospects for the new millenium	International Seminar on Cotton and Its Utilisation in the 21st Century.	CIRCOT, Mumbai Dec.10-12, 1999
Monga D Sheo Raj	Status on the cotton leaf curl virus disease in India.	International Seminar On Cotton and Its Utilisation in the 21st Century.	CIRCOT, Mumbai Dec.10-12, 1999
Mukewar PM Kairon MS	Recent advances in seed health testing of cotton	National Symposium on Seed Science and Technology.	Mysore Aug. 5-7, 1999
Prakash AH	*In Vitro* fibre production from isolated ovular fibre cells of cotton genotype LRA 5166.	National Seminar on Recent Advances in Plant Biology - An Inter-Disciplinary Approach to Unravel Plant Functions.	CPCRI Kasargod, Feb. 3-5, 2000.
Prasad J Majumdar G	Present practices and future needs for mechanisation of cotton picking in India.	Indo-Uzbek Workshop on Agriculture Research	CIAE, Bhopal Nov.15-16, 1999

AUTHOR(S)	TITLE OF THE PAPER & ABSTRACT NO.	PRESENTED AT	VENUE & DATE
Punit Mohan Singh P Singh VV Waghmare VN	Agro-biodiversity and intellectual property rights.	National Seminar on Regulatory Measures and Crop Improvement Policy Implications.	Rahuri Dec. 23-24, 1999
Raju AR Meshram MK Chakrabarty M	Local isolates of Bio-inoculants in advance sown hybrid cotton. pp.661-662	International Conference on Managing Natural Resources for Sustainable Agriculture Production in the 21st Century.	New Delhi Feb. 14-18, 2000.
Ramamoorthy K	Impact of cotton technology - A case study. p.27	Workshop on 'Impact of Agriculture Research'.	Hyderabad Feb.10-11, 2000
Shanmugham K Venugopal K	Fertilizer application to cotton status and its long term effect to soil and soil fertility.	Indo-Uzbek Workshop on Agricultural Research	CIAE, Bhopal Nov. 15-16,1999
Singh J Kairon MS	Effects of S on yield and nutrient uptake by irrigated cotton and sunflower grown on alluvial soil.	National Seminar on Development in Soil Science.	TNAU, Coimbatore Nov. 26-30, 1999
Kairon MS Majumdar G	Status of cotton mechanisation in India and Uzbekistan	Indo-Uzbek Workshop on Agricultural Research.	CIAE, Bhopal Nov. 15-10, 1999
Singh J Venugopal MV Kairon MS	Effects of cotton based cropping systems and nutrient management on the productivity and soil fertility of rainfed vertisols.	International Conference on Managing Natural Resources for Sustainable Agricultural Production in 21st Century	New Delhi Feb. 14-18, 2000.
Singh VV Punit Mohan Singh SB	Improving the competitiveness of cotton through effective manipulation of genetic resources.	International Seminar on Cotton and Its Utilisation in The 21st Century.	CIRCOT, Mumbai Dec. 11-12, 1999.
Singh VV Punit Mohan Singh SB	Genetic diversity in cotton its utilisation and conservation	International Conference on Managing Natural Resources for Sustainable Agricultural Production in the 21st Century.	New Delhi Feb. 14-18, 2000.
Surendra Kumar Singh VV Monga D Tuteja OP Meena RA Jay Kumar P	Conservation and evaluation of *G.arboreum* germplasm for yield and quality.	International Conference on Managing Natural Resources for Sustainable Agricultural Production in 21st Century.	IARI, New Delhi. Feb. 14-18, 2000

AUTHOR(S)	TITLE OF THE PAPER & ABSTRACT NO.	PRESENTED AT	VENUE & DATE
Venugopal K Natarajan K	Pest control and its long term effect on quality of cotton and ecological impact.	Indo-uzbek Workshop on Agricultural Research.	CIAE, Bhopal Nov. 15-16, 1999.
Venugopal K Gopalakrishnan N Gururajan KN Natarajan K	Recent trends and practices of cotton cultivation in India.	International Seminar on Agriculture	Chennai Dec. 8-12, 1999
Venugopal K Natarajan K Gururajan KN	The problem of stickiness and immature fibres in cotton	International Seminar on Cotton and Its Utilisation in 21st Century	CIRCOT, Mumbai Dec.10-12, 1999
Venugopal K Gopalakrishnan N Gururajan KN Prakash AH	Cotton agronomy under rainfed conditions to enhance productivity	National Seminar on 'Strategy for Increasing Cotton Production and Productivity in 21st Century.	CICR , Nagpur Jan. 20-21, 2000
Venugopal K	Cotton as a source of oilseed in meeting the demands for vegetable oil in India.	National Seminar on Oilseeds and Oils Research and Development Needs in the Millennium.	Hyderabad Feb. 2-4, 2000
Venugopal K Gopalakrishnan N Gururajan KN	Sustainability of production potential of cotton based cropping system. pp.947-949	International Conference on Managing Natural Research for Sustainable Agricultural Production in the 21st Century.	New Delhi Feb. 14-18, 2000
Waghmare VN Ramasundaram P Rajendran TP Kairon MS	Approaches to increase lint production in cotton (*Gossypium* spp.)	International Seminar on cotton and its utilisation in 21st century.	CIRCOT, Mumbai, Dec. 10-12, 1999.

2. INSTITUTE COMMITTEE/ COUNCIL MEETINGS

Research Advisory Committee

Research Advisory Committee (RAC) of the CICR was reconstituted with following members:-

Dr. V N Shroff, Ex Dean, College of Agriculture, Indore - Chairman

Dr. Amir Singh, Ex-Head, Division of Seed Technology, IARI, New Delhi Member

Dr. P V Sane, Ex-Director, NBRI, Lucknow- Member

Dr. M B Lal, Former Chairman & Managing Director , CCI, Mumbai - Member

Shri. Sanat Mehta Member

Dr. K C Jain, Asstt. Director General (CC), ICAR, Krishi Bhavan, New Delhi - Member

Dr. M S Kairon, Director, CICR, Nagpur - Member

Sheoraj, Principal Scientist & Member Secretary

The second meeting of the 2nd Research Advisory Committee was held on Dec. 27 & 28, 1999 under the Chairmanship of Dr. V N Shroff. The members, Dr. P V Sane and Mr Sanat Mehta could not attend the meeting.

Two minute silence was observed to pay respect for the departed souls of Dr. N L Bhale, Chairman, RAC.

Dr. V N Shroff, Chairman, RAC in his opening remarks, expressed his deep regard and close association with Dr. N L Bhale. He stated that cotton is a very important cash crop and major foreign exchange earner in the country. To survive in the global competitive market, more emphasis is to be given to basic research for which CICR has to design the work programme. Biotechnology research (like genetically modified organisms) has been found to be quite effective, but all these need to be utilised in a big way only after intensive investigations.

Mr. M B Lal gave a very comprehensive account of the present market demand about cotton fibres. There should be a close interaction between research workers, market and end users to know what is suitable from the trade point of view . Mr. Lal emphasised that long staple *hirsutum* varieties should have mean fibre length of 29-30 mm, micronaire value between 3.8-4.2 with fibre strength 26-27 g tex. Likewise in *barbadense* type (DCH32), it should have fibre length 36-37 mm and micronaire 3.5-3.8, strength 28-30 g tex. In the absence of quality as mentioned, Indian textiles prefer to import long staple cotton. Hence, it was emphasised that cotton research workers should address to the needs of the trade.

Sh Amir Singh opined that basic input seed for which special efforts need to be made for multiplication of quality seed.

Dr. K C Jain , ADG (CC), ICAR emphasised the need for restricting the number of cotton varieties in cultivation. This will help in maintaining quality parameters. He suggested that to streamline release of cotton hybrids/ varieties even from private companies existing Seed Act needs to be amended so as they are brought under the purview of ICAR system.

Dr. M S Kairon, Director, CICR presented overall research achievements of the CICR.

The Action Taken Report on the recommendations of the previous RAC meeting was presented by the Member Secretary. The committee later reviewed the on going research programmes of the Institute and made recommendations.

At the end, it was emphasised that cotton cultivation, cotton trade and textile industry are major source for employment and foreign exchange earning for India. India should continue to dominate in this competitive global trade for which basic research needs to be further strengthened keeping in view special situation obtaining in different agro climatic situation of the country. Need for cotton cultivars with higher production and productivity, even in rainfed situation which tolerate prevailing pest and diseases are long felt need. This is possible only by multidisciplinary and team efforts by all the scientists working on different aspects of cotton.

In global competition, quality norms are becoming stringent for which *Gossypium hirsutum* and *G.barbadense* cottons will have to be retailored with reference to fibre quality. Demand for eco-friendly vis-a-vis organic food and fibre is on increase. India is suitably placed to become a major player in this field too.

STAFF RESEARCH COUNCIL (SRC)

The Annual Staff Research Council meeting of CICR, Nagpur was held on May 24-25, 1999 under the Chairmanship of Dr. MS Kairon, Director, CICR, Nagpur to discuss the results of the work carried out during 1998-99. All the scientists of Nagpur, Dr. K Venugopal, PC and Head, CICR Regional Station, Coimbatore and Dr. R A Meena, Scientist (Sr. Scale) , CICR Regional Station, Sirsa attended the meeting.

Chairman, in his introductory remarks, expressed the opinion that in central zone, main factor for low yield in the season has been the abiotic stress, mainly the shedding and damage of bolls due to unseasonal rains. Therefore, with the change in climatic condition, wide adaptability of plants for adverse situation is desired and work must be strengthened in this direction. Resistance breeding is a very important aspect which demands lot of attention. With the new millenium at the doorstep new demands will be there and there is need to dovetail the research programme as per the specific objectives within a definite time frame to face the international competition from other countries and synthetic fibres.

Result on all the on-going project was presented in detail by respective project leader and associates and discussed. The programmes for the year 1999-2000 were finalised.

During November and December, 1999 experiments were monitored by the Chairman through visits to all the experimental plots and discussion with the respective project leaders and Heads of Divisions/Sections. Laboratory oriented work was also reviewed the same way.

3. SEMINARS / MEETINGS ORGANIZED

Brain Storming Meeting on Cotton Leaf Curl Virus

One day brain storming meeting on the current status of cotton leaf curl virus in north India was organised at CICR, Regional Station, Sirsa on September 23, 1999.

The meeting was chaired by Dr, M S Kairon, Director , CICR, Nagpur and the chief guest was Dr. O P Dubey, Assistant Director General (PP), ICAR. Dr. Anupam Verma, Joint Director (Education) & Dean, IARI, New Delhi, Dr. R N Singh, Director, NCIPM, New Delhi and Dr. K Venugopal, Project Coordinator & Head, CICR, Regional Station, Coimbatore and Scientists from SAUs, ICAR Institutes, officials from State Agril. Dept. and representatives from private companies also attended the meeting.

Dr. M S Kairon, in his introductory remarks appreciated the work done by the scientists and State Agril. Dept in containing the spread of ClCuV in northern cotton belt. He briefed about the development of genotypes resistant to leaf curl. He also requested the entomologists to work on the bio-types of whitefly if they exist. The scientists from PAU, HAU and RAU presented the status of leaf curl virus in their respective states. Dr. Anupam Verma, clarified some of the important points about ClCuV and also gave brief scientific background about the ClCuV symptoms and its vector.

This meeting concluded with the following salient decisions:

- The screening for resistant sources as well as breeding for resistant varieties/hybrids should be given first priority
- The work on the screening of whitefly bio-types through molecular marker will be carried out at CICR Regional Station, Sirsa.

- The meeting recommended growing of *arboreum* varieties viz., HD107, RG8, and LD 327 and other resistant *hirsutum* varieties such as LRA 5166, RS 810, RS 875, LRK 516 and hybrid LHH 144 in the leaf curl prone area.

- It was stressed that seed production programme of ClCuV resistant varieties/hybrids in government and private sector should be taken up on war footing.

Brain storming Meeting on Pink Bollworm

One day brain storming meeting on the current status of pink bollworm was organised at CICR Regional Station, Sirsa on September 24, 1999. The meeting was chaired by Dr. O P Dubey, Asstt. Director General (PP), ICAR and attended by Dr. M S Kairon, Director , CICR , Dr. R N Singh, Director , NCIPM and Dr. K Venugopal, Project Coordinator, AICCIP and Dr. DRC Bakhetia, PAU, Ludhiana and Dr. D N Yadav, Principal Research Scientist, GAU, Anand as special invitees nominated by the ICAR and Scientists from ICAR, SAUs etc.,

Dr. MS Kairon briefed about the situation of pink bollworm incidence in different parts of the country. He informed the house about the increased incidence of this pest in central and southern cotton zone, which should immediately be tackled to check the further escalation of the incidence.

Scientists from Karnataka, Madhya Pradesh, Maharashtra, Andhara Pradesh, Gujarat, Haryana, Rajasthan and Punjab put forth their view points in the discussion. The following points emerged from the discussion

- There is an urgent need to conduct focussed research on bio-ecological aspects with special reference to bio-intensive integrated management of pink bollworm.

- It was also proposed to compile the information available on various aspects of pink bollworm in the country.

NABARD - CICR Workshop on Eco-friendly Pest Management with institutional credit

A workshop on **Eco-friendly Pest Management with Institutional credit** was conducted by National Bank for Agriculture and Rural Development (NABARD), Pune in collaboration with CICR at Central Institute for Cotton Research , Nagpur on November 29-30, 1999 to sensitize bankers and financial institutions of Maharashtra State on the feasibility and business potential of developing entreprenеurships in the production of biological pesticides. NABARD, Pune in collaboration with CICR has developed Bankable Model Schemes for the establishment of Mass Production Units of promising bio-agents. These bio-agents could be integrated in the cotton based cropping system.

Dr. C R Hazra, Agricultural Commissioner, Ministry of Agriculture, Govt. of India inaugurated the workshop. In his address, Dr. Hazra viewed that increased awareness amongst farmers about benefits of biological control could reduce cost of cultivation and environmental degradation. Speaking on this occasion, Dr. S K Goel, Commissioner of Agriculture, Maharashtra state said that the well accepted IPM strategies have gone into hardly one per cent of total agricultural area in the country despite its launch since the 70's. He appreciated that CICR has initiated steps to plug these gaps and promote safer crop cultivation. Shri. Avinash Bakere, Chief General Manager, NABARD, Mumbai stressed on the natural ways of suppressing insects. He called upon the non-governmental organisations to get involved in the production and utilisation of bio-agents in agriculture.

Dr. M S Kairon, Director, CICR presided over the workshop and told the gathering that this workshop is a step forward in increasing awareness about bio-agents based IPM in cotton and other pesticide intensive crops.

National Seminar on ' Strategy for Increasing Cotton Production and Productivity in 21st Century'

National Seminar on **Strategy for Increasing Cotton Production and Productivity in 21st Century** was jointly organised by Central Institute for Cotton Research, Nagpur and Directorate of Cotton Development, Mumbai at CICR, Nagpur on January 21-22, 2000. The seminar was inaugurated by Shri JNL Srivastava, Special Secretary (Agri. & Coop.), Ministry of Agriculture, Govt. of India. Dr. M S Kairon, Director, CICR, Nagpur delivering the welcome address emphasised that insecticide resistance is one of the major problems in cotton production and CICR has developed technology to combat it. He further mentioned that much efforts are needed to be done to prevent spread of cotton leaf curl virus which is at present confined to northern states.

Dr. S K Goel, Agricultural Commissioner, Maharashtra state emphasised the need to extend benefit of new technology to small cotton farmers. He mentioned that reducing cost of cultivation is of prime importance at present.

Dr. C R Hazra, Agricultural Commissioner, Govt. of India, in his presidential address, mentioned that low productivity of cotton is of great concern as economy of small farmers is affected by it.

Some of the salient recommendations that emerged were:

- Development of *desi* hybrids be given more emphasis for the rainfed cotton growing tract.
- For soil and water conservation, 'one farm, one pond' approach should be adopted for rainfed region. For irrigated areas, water management is needed to avoid water-logging.
- A blend of organic manure, bio-fertilizer and chemical fertilizers will serve to realise yield potential and reduce cost of cultivation.
- Fibre properties of *arboreum* cottons should be properly quantified for making them market competitive.
- Integrated crop management should be given more impetus and more trials in different locations be taken up.

Dr. R. S. Paroda, Secretary, DARE & DG, ICAR visiting the CICR stall at Krishi Expo 2000

Shri O. P. Bali, Commissioner of Police, Nagpur Division, addressing the CICR staff.

Members of French delegation interacting with the scientists.

4. राजभाषा गतिविधियाँ

भारत सरकार की राजभाषा नीति के क्रियान्वयन हेतु संस्थान में राजभाषा अनुभाग की स्थापना की गई है। इस अनुभाग में सहायक निदेशक (राजभाषा), हिन्दी अनुवादक एवं हिन्दी टंकक के पद स्वीकृत हैं। वर्तमान में हिन्दी अनुवादक का पद रिक्त है जिसे शीघ्र भरने के संबंध में कार्रवाई चल रही है। इस अनुभाग द्वारा संस्थान के वैज्ञानिकों / कर्मचारियों को हिन्दी में काम करने हेतु प्रोत्साहन देने के लिए विविध गतिविधियों का संचालन किया जाता है।

संस्थान के कुल 127 अधिकारियों/कर्मचारियों में से 55 हिन्दी का कार्यसाधक व 25 प्रवीणता स्तर का ज्ञान रखते हैं। कुल 10 टंककों में से 5 टंकक हिन्दी टंकण व 5 आशुलिपिकों में से 1 हिन्दी आशुलिपि का ज्ञान रखते हैं। अन्यअधिकारियों / कर्मचारियों को प्रशिक्षण देने हेतु रोस्टर तैयार किए गए हैं। संस्थान में हिन्दी के प्रगामी प्रयोग की समीक्षा के लिए गठित राजभाषा कार्यान्वयन समिति की बैठकें आयोजित की जाती हैं।

गत वर्षों की भाँति इस वर्ष भी दि. 14 से 28 सितंबर 1999 तक हिन्दी पखवाड़े का आयोजन किया गया। इसके अंतर्गत विविध स्पर्धाएँ आयोजित की गईं। सभी विजेता प्रतियोगियों को पुरस्कार व प्रमाणपत्र प्रदान किए गए।

संस्थान की वार्षिक गृह-पत्रिका **श्वेत स्वर्णिमा** अंक 9, वर्ष 1999 का प्रकाशन किया गया। **कपास समाचार** नामक समाचार पत्र (तिमाही) का प्रकाशन किया गया। दूरदर्शन व आकाशवाणी में हिन्दी अथवा स्थानीय भाषा मराठी में वार्ताएँ प्रस्तुत की गईं। वार्षिक रिपोर्ट के सारांश का हिन्दी रूपांतर प्रकाशित किया गया। संस्थान के वैज्ञानिकों व तकनीकी अधिकारियों द्वारा हिन्दी में लिखे गए तकनीकी लेख विभिन्न कृषि पत्रिकाओं में प्रकाशनार्थ भेजे गए।

प्रशासनिक कार्यों में भी हिन्दी का प्रयोग बढ़ाने के लिए अधिकतम प्रयास किए गए। कृषि विज्ञान केन्द्र व प्रक्षेत्र अनुभाग में अधिकतम कार्य हिन्दी में किया गया। विभागीय परिपत्र भी हिन्दी में जारी किए गए। हिन्दी में प्राप्त सभी पत्रों के उत्तर हिन्दी में दिए गए।

5. PARTICIPATION IN SEMINARS / SYMPOSIA / CONFERENCES / TRAININGS / MEETINGS

Sr. No.	Seminar/ Symposium/ Conference/ Training/ Meeting	Place & Date	Participant (s)
1.	Annual Group meeting of AICCIP	Nagpur April 15-17, 99	Dr. K Venugopal Dr. K Shanmugham Dr. N Gopalakrishnan Dr. T Gunaseelan Sh. A Kannan Dr. T Surulivelu Sh. K N Gururajan Sh. K Natarajan Dr. A H Prakash Dr. A B Dongre Dr. H L Gajbhiye
2.	Biotechnological applications with relevance to Indian farmers	Pune May 20-21, 99	Dr. A B Dongre Dr. K R Kranthi
3.	NATP Meeting of the rainfed ecosystem.	Hyderabad May 31 - July 1, 1999	Dr. M S Kairon Dr. M R K Rao Dr. K S Bhaskar Dr. P Ramasundaram Dr. M S Yadav
4.	Cotton based interaction workshop meeting of irrigated agro-eco system under NATP	New Delhi June 30- July 1, 1999	Dr. M V Venugopalan Dr. P Ramasundaram Dr. Blaise Er. G Majumdar Dr. A R Raju
5.	Cotton based interaction workshop meeting of irrigated agro-eco system under NATP	Nagpur Oct.25-30,2000	Dr. P Ramasundaram
6.	Short term course on ' Instrumental evaluation of cotton quality'.	Mumbai Aug. 30 - Sept. 99	Dr. A H Prakash
7.	Winter short course on 'Improving skills of extension professionals'.	New Delhi Oct. 21 - Nov. 5, 99	Dr. S M Wasnik
8.	Short course on ' Orientation of Plant Genetic Resources (PGR) policy and emerging intellectual property rights (IPR) issues.	New Delhi Oct. 25- Nov. 3, 99	Dr. V V Singh Dr. Punit Mohan

Sr. No.	Seminar/ Symposium/ Conference/ Training/ Meeting	Place & Date	Participant (s)
9.	Orientation workshop for IVLP TAR (NATP).	Hyderabad Oct.28-31, 99	Dr. K Ramamoorthy
10.	Awareness programme on 'Intellectual Property Rights (IPR)'	Hyderabad Nov. 12-13, 99	Dr. Punit Mohan.
11.	National conference on Conservation of bio-diversity.	Muzaffarnagar Nov. 27-28, 99	Dr. R G Dani
12.	NABARD-CICR workshop on Eco-friendly Pest Management with Institution credit.	Nagpur Nov. 29, 99	Dr. A B Dongre Dr. H L Gajbhiye Dr. K R Kranthi Dr. S B Nandeshwar
13.	Training on Molecular Techniques for DNA finger printing.	New Delhi Nov.29 - Dec.8, 99	Dr. J Amudha
14.	International Seminar on 'Cotton and its utilisation in the 21st century.	Mumbai Dec. 10-12, 99	Dr. M R K Rao
15.	National Workshop on Planning and Management of Agriculture Extension Training.	New Delhi Jan. 12-13, 2000	Dr. H L Gajbhiye
16	National Seminar on 'Strategies for increasing cotton production and productivity in 21st century'.	Nagpur Jan. 21-23, 2000.	Dr. A B Dongre Dr. H L Gajbhiye Dr. P Ramasundaram
17.	A short training course on 'Systems analysis and crop simulation models'	New Delhi Jan. 20-30, 2000	Dr. K B Hebbar
18.	5th Annual Group Meeting of National Seed Project	Jaipur Feb. 15-17, 2000	Dr. K Venugopal Dr. K Rathinavel
19.	Wrokshop on Plant genomics emerging trends and technologies.	Calcutta March 24-25, 2000	Dr. A B Dongre
20.	NATP working on 'Socio-economic analysis and characterisation of cotton of cotton based cropping systems'..	Nagpur March 23-25, 2000.	Dr. P Ramasundaram Dr. Blaise Sh. M Sabesh

6. VISITORS

Name & Designation	Organisation	Date
Nagpur		
Shri. Devendra G Fadnavis Mayor	Nagpur Municipal Corporation, Nagpur	April 5, 1999
Dr. S V Joshi Principal Secretary	Department of Agriculture and Animal Husbandry, Dairy & Fisheries, Govt. of Maharashtra	May 27, 1999
Dr. M B Lal Advisor & Former CMD	Technology Mission on Cotton and Cotton Corporation of India, Mumbai	July 30, 1999
Dr. Mangala Rai Deputy Director General (CS)	Indian Council of Agricultural Research, New Delhi	Aug.17, 1999
Dr. R P Sharma Project Director	NRC on Biotechnology, IARI, New Delhi	Aug. 17, 1999
Dr. R N Singh Director	National Environmental Engineering Research Institute, Nagpur	Aug 18, 1999
Dr. M L Madan Vice Chancellor	Dr. PDKV, Akola	Sept. 22, 1999
Dr. V L Chopra Former Director General	Indian Council of Agricultural Research, New Delhi	Aug. 25, 1999
Shri. O P Bali Commissioner of Police	Nagpur Division, Nagpur	Sept. 28, 1999
Dr. Y S Nerkar Ex. Vice Chancellor	Mahatma Phule Krishi Vidyapeeth, Rahuri	Oct. 5, 1999
Dr. S K Arora Ex. Dean	CCS Haryana Agril. University, Hisar.	Oct. 5, 1999
Dr. C Chandran Commissioner of Land Revenue	Kerala Government	Oct. 5, 1999
Dr. S Nagarajan Project Director	Directorate of Wheat Research, Karnal	Dec. 13, 1999
Dr. K R Solanki Director	NRC for Agro-forestry, Jhanshi.	Dec. 13, 1999

Name & Designation	Organisation	Date
Dr. K Pradhan Ex. Vice Chancellor	Orissa University of Agriculture & Technology, Bhubaneshwar.	Dec. 13, 1999
Shri. Sompal Member	Planning Commission, Govt. of India, New Delhi	Jan. 2, 2000
Shri. Dhammaviriya Mahathero Ex-Chairman	TRIFED, Govt. of India.	Jan. 14, 2000
Dr. S K Sinha Ex. Director	Indian Agricultural Research Instiute, New Delhi	Mar. 1, 2000
Dr. Jean, Christopher Glaszmann Dr. Vincent Dolle Dr. Jean Luc Renad	CIRDA, Montpellier France	Mar. 15, 2000
Dr. B S Hansra, ADG (Ext.)	Indian Council of Agricultural Research , New Delhi	Mar.18, 2000
Coimbatore		
Dr. Mangala Rai Deputy Director General (CS)	Indian Council of Agricultural Research , New Delhi	April 9, 1999& Feb. 24, 2000
Dr. R S Paroda Director General	Indian Council of Agricultural Research , New Delhi	Nov. 25, 1999
Dr. S Kannaiyan Vice Chancellor	Tamil Nadu Agricultural University. Coimbatore	Nov. 25, 1999
Sirsa		
Dr. O P Dubey Assistant Director General (Plant Protection)	Indian Council of Agricultural Research, New Delhi	Sept. 24, 1999
Dr. R N Singh Director	National Centre for Integrated Pest Management, New Delhi	Sept. 24, 1999
Dr. Anupam Varma Dean & Joint Director (Education)	Indian Agricultural Research Institute, New Delhi	Sept. 24, 1999

7. LIBRARY

Addition

The library procured 25 books, 5 back volumes, 82 scientific reports, 54 reprints on cotton and subscribed 45 Indian and 20 foreign journals.

Documentation Service

A. Bibliographic Database on cotton

Library has developed computerised bibliographic database on cotton to provide comprehensive and update information on cotton. About 1340 bibliographic references alongwith abstracts have been stored in it. Documentation services such as current awareness service, SDI service, specific subject search service have been provided by sorting out the database. A documentation bulletin ' Cotton Research Abstracts' is also brought out by using the database.

B. Current Title Service

Library has subscribed current contents with abstracts on disk and provided current title service on cotton.

C. CD-ROM databases Retrieval Service

Library has subscribed CD-ROM databases CROPCD from 1973 to 1998, CABCD from 1973 to 2000, AGRIS and AGRICOLA from 1975 to 2000. Information on cotton and other crops on various aspects are being retrieved and downloaded and provided to the users as per their demand.

D. News paper clippings service

Clipping on various aspects related to cotton from the local, regional and national newspapers was compiled and made available for references. A publication 'Cotton News Bulletin 1998' is also brought out.

8. HUMAN RESOURCE DEVELOPMENT

Nagpur

- Dr. Punit Mohan, Scientist (SS), Division of Crop Improvement, CICR, Nagpur was awarded Ph.D. Degree in Botany on July 28, 1999 by Dr. Bhimrao Ambedkar University, Agra.

- Dr. Punit Mohan participated in the short course on "Orientation of Plant Genetic Resources (PGR) Policy and Emerging Intellectual Property Rights (IPR) issue held at NBPGR, New Delhi. from Oct.25-Nov.3, 1999

- Dr. Punit Mohan participated in orientation training programme on Agro-biodiversity (NATP) NBPGR Regional Station, Akola from Nov. 29 - 30, 1999.

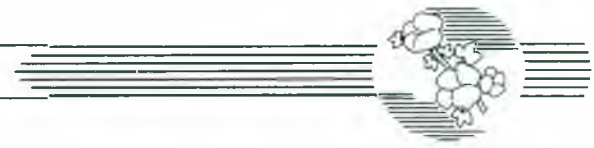
- Dr. S M Wasnik, Scientist (SS), Extension, KVK participated in the winter short course on 'Improving Management Skills of Extension Professionals held at IARI, New Delhi during Oct. 21-Nov. 5, 1999.

- Dr, J Amudha, Scientist, Biotechnology Section, participated in the training programme on 'Molecular techniques for DNA finger printing held at NRC on DNA finger printing , NBPGR, New Delhi from 29th Nov. to 8th Dec. 1999.

Coimbatore

- Dr. A H Prakash, Scientist (SS), participated in a short term course on 'Instrumental evaluation on cotton quality' conducted by CIRCOT, Mumbai from August 30 to September 10, 1999.

- Dr. K Ramamoorthy Sr.Scientist, Agril. Economics in the orientation workshop for IVLP-TAR (NATP) held at Central Research Institute for Dry Land Agriculture, Hyderabad from Oct. 28 31, 1999.



- Dr. P Nalayini, Scientist participated in the training programme on 'Microbial interactions in soil held at centre of advanced studies in Agricultural Microbiology, TNAU, Coimbatore from Feb.1-21, 2000.

9. AWARDS

- Dr. MRK Rao, Head, Plant Physiology & Biochemistry Section was awarded Prof. Dastur Memorial Gold Medal (Physiology) by Indian Society for Crop Improvement, Mumbai.

- Dr. K R Kranthi, Scientist, CICR, Nagpur was awarded Hexamar/ISCI/Award (Plant Protection) comprising of Rs.5000/- (Cash) and citation for contribution to IPM in cotton with addition of new technological component of IRM for efficient management of insecticide resistance.

- Dr. K S Bhasker, Sr. Scientist, Division of Crop Production was awarded, 'Bharat Excellency Award' by the Friendship forum of India, New Delhi for his contribution to Agriculture Research and Extension. Dr. Bhasker was also awarded as best citizen of India by International Publishing House, New Delhi and as Rising Personality of India by International Penguin Publication, New Delhi.

10. PESONNEL AND BUDGET

Name of the Post	Sanctioned Cadre Strength				Post Filled Up			
	NGP	CBE	Sirsa	Total	NGP	CBE	Sirsa	Total
SCIENTIFIC STAFF								
Director (RMP)	1	- -	- -	**1**	1	- -	- -	**1**
P.C. & Head	- -	1	- -	**1**	- -	1	- -	**1**
Principal Scientist, Sr. Scientist Scientist	54	26	5	85	40	17	7	64
TECHNICAL STAFF								
Category I (T-1-3, T-2, & T-1) Category II (T-5, T-4, T-II-3) Category III (T-8. T-7, T-6)	54	39	12	105	46	32	10	88
AUXILLARY STAFF								
Assistant Director (O.L.)	1	- -	- -	1	1	- -	- -	1
ADMINISTRATIVE STAFF								
Administrative Officer	1	- -	- -	1	1	- -	- -	1
Finance & Accounts Officer	1	- -	- -	1	1	- -	- -	1
Asstt Administrative Officer	2	- -	- -	2	2	- -	- -	2
Sr. P A	1		- -	1	1		- -	1
Superintendent	1	1	- -	2	1	1	- -	2
Assistant	7	7	3	17	7	7	3	17
Stenographer II	2	1	1	4	1	1	1	3
Senior Clerk	5	4	2	11	5	4	2	11
Stenographer III	3	- -	- -	3	2	- -	- -	2
Junior Clerk	9	1	2	12	9	1	2	12
SUPPORTING STAFF								
SS. GR.-I To 1V	75	60	24	159	75	49	17	141

FINANCE :

The budget grant and actual expenditure at CICR, Nagpur and its Regional Station, Coimbatore and Sirsa for the year 1999-2000 are furnished below:

Budget Sanctioned and Expenditure

(Amount in Lakhs)

Scheme	Sanctioned	Expenditure
Non-Plan	726.000	725.512
Plan	120.000	119.862
PLAN SCHEME		
NSP Crop	002.344	002.216
Hybrid Cotton Scheme	--	007.460
AICCIP	240.000	240.000
KVK Scheme	028.400	027.163
NARP-IPM	--	000.111
NARP-Biotech.	--	000.073
AP CESS FUND		
Regional Committee	003.500	000.115
PAT Scheme	--	004.563
CO_2 Scheme	007.778	004.335
Transgenic Cotton	--	00.4.971
IRM/IPM Project	006.202	006.202
ENBCHABC	001.491	001.178
NATP PROJECT		
ARIS	--	(-) 000.029
ATIC	038.750	019.140
DHC Cotton Project	014.490	008.672
PLANT Biod. Project	000.990	000.810
CWBPS. Project	020.380	001.518
Bt. Tran. C. Project	044.940	003.917
Leaf Curl Project	001.640	000.570
SEA & CCB Project	003.627	000.292
RAINFED C Project	005.300	--
R DEPOSIT SCHEME		
Front Line Demonstration	004.323	003.298
DBT Scheme	4.906	021.519
NSP III Project	000.400	000.394
IRM/IPM Project	004.652	002.817
NCIPM Scheme	004.866	003.320

Staff Position

SCIENTIFIC

Nagpur

MS Kairon	Director
KD Koranne (Retd. on 31.08.99)	Principal Scientist
Sheoraj	"
SK Banerjee	"
RG Dani (wef 17.11.99)	"
MRK Rao (wef 18.12.999)	"
OM Bombawale (Relieved on 4.6.99)	Senior Scientist
VV Singh	"
PM Mukewar	"
NK Taneja	"
Phundan Singh	"
ST Temburnikar	"
AB Dongre	"
NK Perumal	"
HL Gajbhiye	"
RK Deshmukh	"
KS Bhaskar	"
MK Meshram	"
TV Kathane	"
TP Rajendran	"
Jagvir Singh	"
RC Ukey	Scientist (Sr.Scale)
Suman Bala Singh	"
Mukta Chakraborty	"
MV Venugopalan (Relived on 7.2.2000)	"
SB Nandeshwar	"
SM Wasnik	"
Nandini Gokte	"
CD Ravindran	"
Punit Mohan	"
PK Chakrabarty	"
PR Vijaya Kumari (On depu. wef 01.04.99)	Scientist (Sr.Scale)
KR Kranthi	"
Sandhya Kranthi	"
P Ramasundaram	"
S Vennila	"
Vinita Lakkawar	Scientist
AR Raju	"
Gautam Majumdar	"
VN Waghmare	"
G Balasubramani	"
Blaise	"
KB Hebbar	"
J Amudha	"

Coimbatore

K Venugopal	PC & Head
K Shanmugam	Principal Scientist
T Gunaseelan	Sr. Scientist
KN Gururajan	"
T Surulivelu	"
K Natarajan	"
A Kannan	"
P Chidambaram	"
HK Hanumantha Rao (Retd. On 30.6.99)	"
K Ramamoorthy	"
N Gopalakrishnan	"
SESA Khader	"
B Dhara Jothi	Scientist (Sr Scale)
AH Prakash	"
K Rathinavel	"
P Nalayini	Scientist
S Manickam	"
M Sabesh (joined on 28.1.2000)	"

Sirsa

LS Randhawa (Joined on 15.3.2000)	Head
SL Ahuja (On Deputation)	Sr. Scientist (Sr. Scale)
Dilip Monga	"
RA Meena	"
OP Tuteja	"
SK Verma	Scientist
P Jeyakumar	"

TECHNICAL

Nagpur

NVS Gaur	T-9
PP Bhajani	T-7
VV Katare	T-6
KB Chaudhari	T-6
Prahlad Singh	T-5
RV Nimje	"
PG Ghangare	"
KR Kanherkar	"
MS Yadav	"
MC Gawande	"
DS Naitam	"
BNTule	"
PP Gokulpure	"
KG Dewale	"
RB Bagde	"
BR Rode	"
MT Naphade	"
DJ Mukade	"
CK Shastry	"
NR Tandulkar	"
GC Gajbhiye	"
NP Kate	T-4
RM Lokhande	"
WU Parahate	"
Swati Dixit	T-II-3
DG Bhongale	"
PM Kawalkar	"
DD Kothe	"
BG Meshram	"
RG Dolas	"
GR Kene	T-II-3
RV Salame	"
SP Muchali	"
Asore Mohanlal	"
SA Matikhaye	"
DP Ingle	T-I-3
VP Masurkar	"
JP Patel	"
Prakash Mishra	"
JL Dongre	T2
RT Varchaye	"
MS Kawale	T-1
RT Bhagat	"
SK Wase	"
SN Ingle	"
VV Katole	"
Ram Ratan	T-6 KVK
Gulbir Singh	"
AS Tayade	"
SS Patil	"
UV Galkate	"
Sunita Chauhan	"
PB Deulkar	T-II-3
AS Sherkar	T-1 KVK

Coimbatore

E Appukuttan Menon (Retd on 30.9.99)	T-6
KN Indirakutty	T-6
M Kanagarajan	T-5
SR Govindswami	"
A Ugravelu	"
K Sundaravadivelu	"
G Gunasekaran	"
TS Govindan	"
K Rangaswamy	"
SKPalani	T-4
P Palaniappan	"
R Venkataswamy	T-II-3
Maria Joseph	"
V Muthuswamy	"
KK Balasubramanian	"
K Kaniappan	"

P Balasubramanian	T-II-3
N Palaniappan	T-I-3
V Palaniswamy	"
R Subramanian (Retd on 31.7.99)	"
CK Suryanarayanan	"
VM Mylsamy	"
M Marudhachalam (Retd on 31.12.99)	"
Sundarajan	"
M Krishnan	"
BRX Pushparaj	"
T Seniappan	"
R Raman	"
K Krishnaswamy	T-2
N Venugopal	"
Roche Stephen	T-1
K Chinna Palanisamy	"
S Prabhakar	
R Murugesan	
T Selvarajan T-1	"

Sirsa

SK Sidana	T-5
AK Singh	"
Veer Singh	"
Netrapal Singh	"
Suresh Kumar	"
Mohanlal	T-II-3
Banwari Lal	"
Jai Prakash	"
Purushottam Das	T-1
Rohtash	"

ADMINISTRATIVE

Nagpur

UC Prasad	Administrative Officer
Mithilesh Kumar	F.A.O.
Kumudini Nautiyal	Asstt. Director (O.L.)
Bhanu Narayanan	A.A.O.
SM Sahare	"
Uma Vaidyanathan	Sr. Personal Assistant
VR Salame	Superintendent.
SS Mandape	"
VR Jawalkar	Assistant
KK Joy	"
RK Nair	"
HP Ingle	"
WU Dupare	"
MN Borle	"
Shylaja Sasidharan	"
NV Dhande	Stenographer II
RG Iyer	Jr. Stenographer
MC Tiwari	"
SS Chalkhure	Jr. Stenographer Cum Computer Operator (KVK)
SS Kulkarni	Sr. Clerk
CM Wakodkar	"
RR Kulkarni	"
EAM Ismail	"
AN Khan	"
DN Gudhane	Jr. Clerk
ST Wakade	"
UM Narkhede	"
DJ Mathe	"
NP Tupte	"
NP Wasnik	"
N Ramesh	"
VD Bende	"
SP Kharche	"

Coimbatore

JP Gurubatham	Superintendent
TK Palaniswamy	Assistant
S Palaniswamy	"
V Rathanasabapathy	"
R Palaniswamy	"
G Vairavaswamy	"
R Mayandi	"
M Madaswamy	"
S Natarajan	Sr. Clerk
K Ramalingan	"
Suman Kulkarni	"

AK Mohan	Sr. Clerk
Lakshmi Krihnamurthy	Stenographer-II
Sundaravalli M Kumar	Jr. Clerk

Sirsa

Ved Prakash	Assistant
Narender Kumar	"
Jagdish Kumar	"
Surender Kumar	Stenographer-II
Dilip Singh	Sr. Clerk
Rajbir Singh	"
Richpal Singh	Jr. Clerk
Satbir Singh	"

SUPPORTING

Nagpur

WT Khanpasole	SS .Gr-IV
VH Solanki	SS. Gr-III
MS Panchabai	"
RD Dohare	"
HS Charde	"
SS Maraskolhe	"
HS Sawalkar	"
UK Raut	"
BZ Niswade	"
SU Patil	SS. Gr-II
SS Narkhede	"
RS Kharche	"
PN Avhad	"
AJ Thakur	"
PV Patil	"
Y Asore	"
SV Patil	"
MB Amale	"
SS Lakhe	"
VD Dokrimare	"
SM Shende	"
SG Kadu	"
HS Kanfade	SS Gr. II
BB Kothekar	"
RH Wagde	"
DV Maraskohle	"
DL Nagose	"
SN Lambat	"
EC Bhagat	"
ST Bhoyar	"
WM Uparkar	"
RN Nanwatkar	"
SS Dorle	"
BW Atram	"
DS Ganorkar	"
TG Harkhel	SS.Gr-I
BT Khanpasole	"
IS Kumbhare	"
SM Kumbhare	"
GG Madan	"
SL Gorghate	"
MD Kamble	"
SM Bhalavi	"
BP Gawai	"
UK Borde	"
SS Sardar	"
LR Tekam	"
BP Chandrapure	"
GL Nawaye	"
AR Kamble	"
KR Rokade	"
RB Wagde	"
MB Wagde	"
AB Bhoyar	"
SB Nagdwane	"
ND Ingle	"
CV Nemade	"
BD Shelke	"
Badri Prasad	"
AD Belsare	"
VB Balbudhe	"
VL Rakhade	"
NR Titarmare	"
SS Sahare	"
MB Lute	"

MG Koram	SS.Gr-I
SS Ambarte (Expired on 16.11.99)	"
GN Hataghare	"
DW Thool	"
CS Wagde	"
HS Masram	"
SS Kharche	" (KVK)
SN Gorghate	" (KVK)
TD Parate	"
LS Kanfade	"
RG Ramtake	"

Coimbatore

N Arumugham	SS. Gr-IV
M Shanmugham	"
Kalaichelvan	"
N Marudachalam	"
M Palaniswamy	"
V Palani	"
C Palaniswamy	"
K Arumugham	"
M Palaniswamy	"
K Natarajan	"
K Maran	SS. Gr -III
C Swaminathan	"
N Chinnaswamy	"
S Palaniswamy	"
P Subramaniam	"
R Kansaswamy	"
V Raman	"
R Pannerselvam	"
Periya Pappa	SS.Gr-II
N Subramanian	"
Rami Rangan	"
R Palaniammal	"
R Arumugham	"
P Chidambaram	"
L Doraiswamy	"
K Rangaswamy	"
L Karuppuswamy	SS.Gr-II
R Doraiswamy	"
N Narayanan	"
S Esakki	"
R Ramaswamy	"
SV Palaniswamy	"
D Yellappan	SS.Gr-I
K Rajamanickam	"
A Manickaraj	"
Pappa Maran	"
A Dhanalakshmi	"
R Subalakshmi	"
P Marudathal	"
Marammal Chinnaswamy	"
M Palaniammal	"
R Sakunthala	"
BLR Kannan	"
R Nagaraj	"
William Raja	"
R Lekshmi	"

Sirsa

Ramkanwar	SS.Gr-IV
Piara Singh	"
Lal Chand	SS.Gr.III
Bir Singh	"
Rohtash	"
Bharto	SS.Gr-II
Satwati	"
Goma	"
Ami Lal	"
Bakhtawari	SS.Gr-I
Ahok Kumar	"
Sarbati (Retd on 31.3.2K)	"
Ramesh Chander	"
Bahadur Singh	"
Darshan Lal	"
Urmila	"
Bhaghwanti	"

6. General

1. RESEARCH PUBLICATIONS

A RESEARCH/REVIEW PAPERS PUBLISHED IN JOURNALS / NEWS LETTERS

AUTHOR (S)	TITLE	JOURNAL
Ahuja SL Tuteja OP	Variability and association analysis for chemical components imparting resistance in *Gossypium hirsutum.*	J. Cotton Res. & Dev., 2000 14 (1):19-22.
Ahuja SL Tuteja OP	Association studies among yield and some physiological parameters in cotton (*G.hirsutum L)* under irrigated and stress environments.	J. Cotton Res. & Dev., 2000 14 (1):102-106.
Dani RG	Genetic improvement of seed oil content following indirect selection for earliness and fibre yield in cotton.	Adv. Plant Sci., 1999, 12(II):479-492
Kranthi KR Kranthi S Ali S Banerjee SK	Resistance to Cry1AC in a laboratory selected strain of *Helicoverpa armigera.*	Current Science, 2000, 78 (8) : 1000-1004.
Kranthi KR Ali S	Baseline toxicity of spinosad on the cotton bollworm, *Helicoverpa armigera,* (Hub) in India.	Resistance Pest Management, 2000. Vol.12,

AUTHOR (S)	TITLE	JOURNAL
Kranthi KR Kranthi S Dongre AB Kairon MS	A brief review on transgenic cotton	J. Indian Soc. Cot. Improvement, 2000.
Kranthi S Kranthi KR Lavhe NV	Geographical variation in susceptibility of *Earias vittella* to Cry toxins.	Crop Protection, 1999, 18 : 551-555
Meena RA Rathinavel K Deshmukh RK Tuteja OP	Storage potential of tetraploid and diploid cottons under ambient conditions.	Seed Research, 1999, 27 (1): 125-127
Meena RA Monga D Tuteja OP Verma SK	Seed quality in cultivars and picking in cotton.	J.Cotton Res. & Dev., 2000, 14:15-18.
Monga D Ahuja SL Sheoraj	Germplasm screening to locate resistance to bacterial blight in *G.hirsutum* cotton.	J.Cotton Res. & Dev., 2000, 14:114-116.
Mukewar PM Raj S	Seed-borne infections of Anthracnose pathogen *Colletotrichum capsici* in cotton.	J.Cotton Res & Dev., 2000: 14(1):119-122.
Mukewar PM	Disease free seed production of cotton hybrids in India.	Hybrid Cotton News letter, 1999, 8(1) : 2.
Nandeshwar SB Dongre AB Moghe Sandhya Kairon MS	*In-vitro* culture of cotton - a review.	J. Indian Soc. Cot. Improvement, 1999; 27(2) : 79-94.
Narula AM Monga D Chauhan MS Sheoraj	Cotton leaf curl virus disease in India: the challenge ahead.	J. Cotton Res. & Dev, 1999, 13:129-138.

AUTHOR (S)	TITLE	JOURNAL
Perumal NK	Studies in the effect of nitrogen level.	Ind. J Plant Physiology,1999, 4: 65-67.
Perumal NK Rao MRK Kathane TV Meshram MK Taneja NK Venugopalan MV Ajai Dubey PK Basu AK	Canopy spectral reflectance in cotton in relation to yield.	Ind. J Plant Physiology, 1999, 4: 63-64.
Punit Mohan Kairon MS	Bollrind toughness and thickness in cotton- a mechanical barrier for bollworms.	Adv. Plant Sci, 1999, 12(11): 603-606
Punit Mohan Kairon MS	Nectar glands and honey bee pollinator in cotton (*Gossypium*).	Adv. Plant Sci., 1999, 12(11) : 625-26
Punit Mohan Kairon MS	Boon and bane of gossypol toxicity.	J.Cotton Res. & Dev. 2000, 14(1): 107-110
Punit Mohan Mukewar PM Kairon MS	Resistance to grey mildews (*Ramularia areola Atk.*) in cotton.	Internatinal Plant Genetic Resources NL, 1999, 30:16
Raju AR Meshram MK Chakrabarty M	Nitrogen fixing bio inoculants for rainfed cotton.	Biofertilisers News Letter, 1999,
Ramamoorthy K	Credit and marketing linkages among the cotton farmers of Warangal.	Ind. J Agrl. Mktg, 1999; 13(2): 85-91
Rathinavel K Dharmalingam C	Optimization of seed hardenning treatment for cotton cv. LRA 5166 (*Gossypium hirsutum* L.)	J Cotton Res. & Dev., 1999, 4(1): 22-25.
Rathinavel K Dharmalingam C	Effects of seed pelleting on elite seedling production in cotton cv. MCU7 (*Gossypium hirsutum*)	Crop Research, 1999; 18(1) : 137-141

AUTHOR (S)	TITLE	JOURNAL
Rathinavel K Dharmalingam C	Comparative efficacy of seed treatment on the maintenance of viability and vigour in cotton (*Gossypium hirsutum* L.)	Neo Botanica, 1999; 7(1): 7-18
Singh JV	Control of weeds in cotton fields through herbicides	J. Cotton Res. & Dev., 1999 13(2): 197-201
Singh JV Mannikar ND	Response of cotton to applied P over different soil P fertility gradients in rainfed vertisol.	J. Cotton Res. & Dev. 2000, 14(1):55-57
Singh P Namboodiri R	Performance of some male sterility based inter-specific diploid hybrids.	Hybrid Cotton News Letter, 1999; 7(1):
Vennila S Deshmukh RK	Effects of breeding system on leaf hopper and bollworm resistance in cotton hybrids.	J. Cotton Res. & Dev., 1999, 13(2): 126-128
Vennila S Banerjee SK Kairon MS	Early season sucking pest control effects on cotton fruiting and bollworm infestation.	J. Cotton Res. & Dev., 2000, 14 (1): 68-72
Vennila S Sheoraj Kairon MS	Survival and development of *Helicoverpa armigera* (hubner) on wild species of *Gossypium*.	J. Cotton Res. & Dev. 2000 14 (1): 129-130.
Venugopalan MV Pundarikakshudu R	Long term effect of nutrient management and cropping system on cotton yield and soil fertility in rainfed vertisols.	Nutrient cycling in Agroecosystem, 1999; 55:159-164

B. PAPERS PUBLISHED IN NEWS PAPERS/SOUVENIRS/MAGAZINES

AUTHOR (S)	TITLE	JOURNAL
Kairon M S Ramasundaram P Venugopalan M V	Cotton : Agenda for new millennium	Hindu Survey of Indian Agriculture 2000. 109-112.
Mukewar PM	*Kapas Ki Phasal Ke Mukhya Rog Aur Unka Prabandh.*	Kapas Samachar, 1999, 3(3): 6
Raju AR	*Prattisagulo Adhikothpathiki nutana melakuvalu* (New ways of cotton cultivation for higher yields).	Annadata, 1999, July, 58-61
Ramamoorthy K	Cotton farmers' suicide-traders lobby mainly responsible	The Hindu, 1999, September 15
Ramamoorthy K	Cotton based socio-economic experiments in Attapady tribal tract of Kerala.	State Bank of India, Monthly Review, 1999, Vol. XXXVIII: 1134-1152.
Ramamoorthy K	Cotton production An economic analysis	Naveena Velanmai, (Tamil)-2000, January issue.
Ramamoorthy K	Sixteen important crop nutrients for enhancing yield.	Naveena Velanmai, (Tamil)-2000, March issue.
Ramamoorthy K	Cotton ryots need institutional support.	Indian express 1999, September 13.
Singh, Mahendra	*Kapas Ke Reshe Ki Gunata Rakhane Ke Liye Enhnye Apnanye*	Kapas Samachar, 1999 3(4): 1&8
Singh, Mahendra Nautiyal, Kumudini	*Kapas Ki Phasal Ke Anek Upyog*	Kapas samachar, 1999, 4(1) : 5-6

C. PAPERS PUBLISHED IN BOOKS

AUTHOR (S)	TITLE	BOOK
Hazra CR, Lal MB, Kairion MS, Ramasundaram P, Venugopalan MV, Basu AK Vithal	Technology Mission on Cotton	Hand Book of Cotton in India (Eds. V Sundaram et al.), (Published by Indian Society for Cotton Improvement, 1999. 526 - 548.
Kairon MS Kranthi KR	Non-insecticidal methods in cotton pest management : A critical re-appraisal.	Non-pesticidal management of cotton and pigeonpea (Eds.M S Chari, MA Qayum, NK Sanghi and MV Shastri), published by MANAGE, Hyderabad, 1999, 33-36.
Kairon MS Kranthi KR	Biotechnology for the cotton farmer-problems and prospects.	Biotechnological application, Relevance to the Indian Farmer, published by Pune District Agricultural Development Foundation, 1999: 24-26.
Ramasundaram P	Economic Analysis of cotton cultivation	Hand Book of Cotton in India (Eds. V Sundaram et al.), Published by Indian Society for Cotton Improvement, Mumbai, 1999; 269-282
Rao MRK Deshmukh RK	Cotton physiology	Hand Book of Cotton in India (Eds. V Sundaram et al.), (Published by Indian Society for Cotton Improvement, 1999, 168-182.

AUTHOR (S)	TITLE	BOOK
Sheoraj Meshram MK Chakrabarty PK	Major diseases of cotton, their management options and strategies.	IPM systems in Agriculture (Eds. RK Upadhyay, KG Mukerji and OP Dubey), Vol.6 Cash Crops, Aditya Books Pvt. Ltd., New Delhi, 1999; 123-164.
Singh P Narayanan SS	Cotton Improvement Procedures	Hand Book of Cotton in India (Eds. V Sundaram et al.), Published by Indian Society for Cotton Improvement, Mumbai, 1999; 41-56
Singh VV Punit Mohan Narayanan SS	Cotton Genetic Resources	Hand Book of Cotton in India. (Eds V Sundara et al.), published by Indian Society for Cotton Improvement , Mumbai, 1999; 18-40
Sivanappan RK Venugopal K Tarhalkar PP	Water Management in cotton including micro- irrigation.	Hand Book of Cotton in India (Eds. V sundaram et al.), published by Indian Society for Cotton Improvement, Mumbai; 1999; 142-158.
Venugopal K Gururajan, KN Gopalakrishnan N	Cotton production practices for maximizing yield of cotton in India.	Hand Book of Cotton in India (Eds. V Sundaram et al.). published by Indian Society for Cotton Improvement, Mumbai, 1999; 104-122.

Agricultural Economics and Extension

Nagpur

P1-94/1-ICR-E10/0430: **Economics of Cotton Cultivation in India** (P.Ramasundaram and H.L.Gajbhiye).

The information collected from more than 310 farms in the rainfed districts of Yavatmal, Adilabad, Khandwa, Khargone and Dhar districts in the previous years were used to workout the mechanism of low productivity in rainfed cotton. The framework of the mechanism is as shown in the fig. 15. The vicious circle of low productivity-low yield-low income-low profit-low investment-low productivity has to be dented at weak links in the chain by institutional interventions to boost the cotton yield in rainfed situations. While the uncontrollable constraints are few and can be brought under the ambit of suitable insurance programme, the controllable constraints are many and man made and are quiet relaxable with effective policy interventions, proactive community approach supplemented by individual initiative.

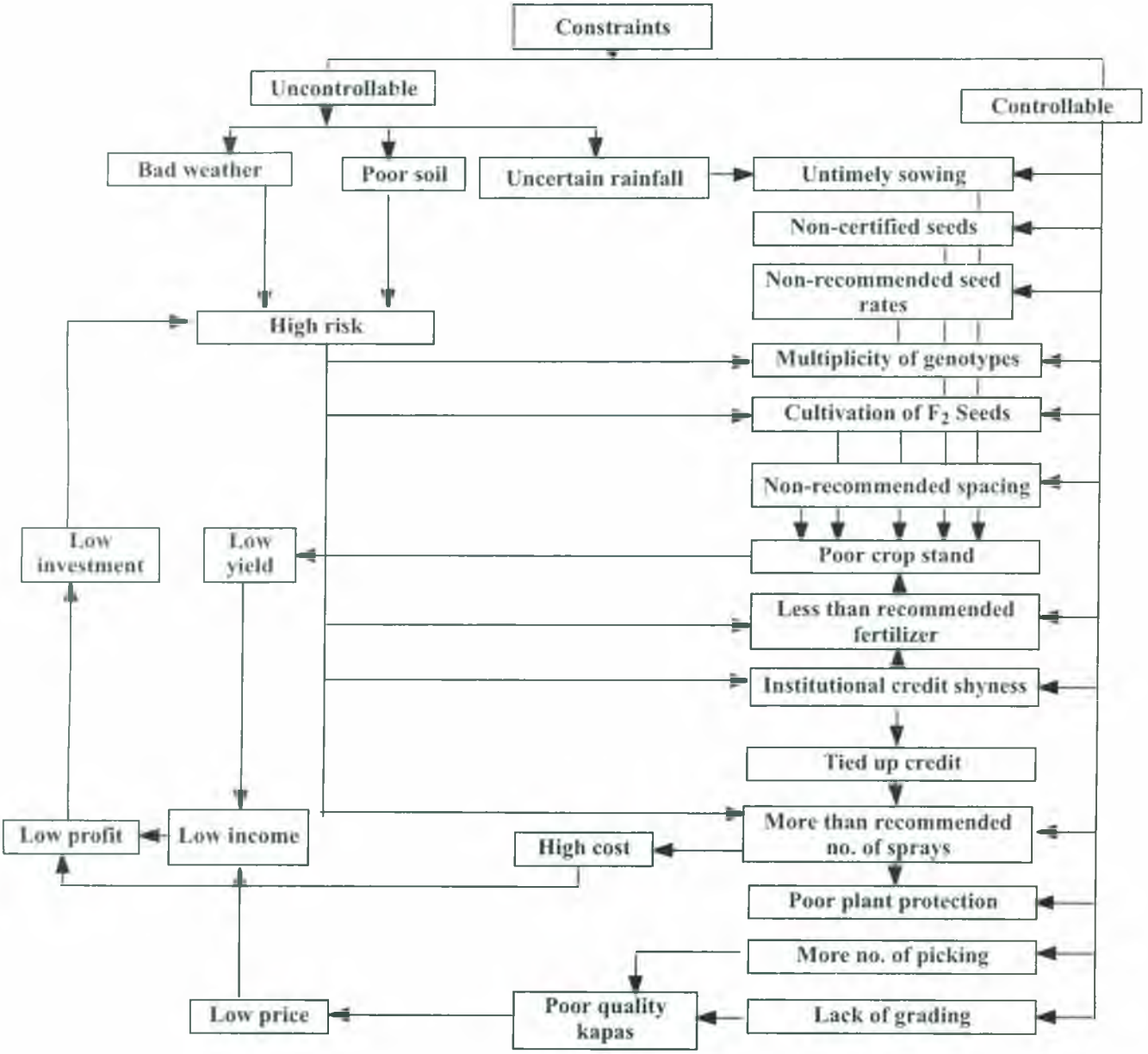
Field data collected through a limited survey in the district of Sirsa, in Haryana during September, 1999 and covering the crop period 1998-99 revealed that the average yield level has decreased from 25.52 q/ha ten years before to 11.82 q/ha in the current year but the paid out cost and the share of plant protection expenditure in the total cost in this period has doubled. The major constraints reported were the incidence of pests, especially boll worm (62%), poor quality/ineffective chemicals (51%), non-availability of canal water on time (48%), non-availability of power supply (48%), non-availability of labour (45%), tied-up credit (39%), non-availability of quality seeds (37%), improper use of chemicals - mixing/cocktailing chemicals on own or at the advice of the dealers - (35%) and loss due to leaf curl virus (12%), though seem to be less in magnitude is undoubtedly increasing. The percentage of hirsutum area to total cotton area has increased from 72 to 87 and the corresponding share of desi area has decreased from 28 to 12.5 leaving the rest 0.5 to hybrids in the past ten years span. Reduction in desi area and increase in loss due to leaf curl virus may have to be taken note of till totally immune hirsutm lines to the disease are introduced.

Coimbatore

Economics of summer cotton cultivation in Tamil Nadu (K. Ramamoorthy).

Tamil Nadu cultivates cotton in about 2.5 lakh hectares, of which 49% is rainfed and the rest is irrigated. The productivity of the state is 379 kg lint/ha. The yield of rainfed cotton is estimated at 205 kg lint/ha. Winter irrigated cotton yield is 383 kg lint/ha and summer irrigated cotton yield is 385 kg lint/ha. In the summer cotton area, 78% is occupied by MCU.5, 12% by MCU.7, 5% by LRA 5166 and the rest by others. Thirunelveli and Madurai district farmers incurred a loss of 35 paise per rupee invested on summer cotton cultivation. Namakkal farmer incurred a loss of six paise and Erode district farmer incurred a loss of eight paise per rupee invested. The study revealed that the farmers are not following the principle of balanced nutrition. The adoption of integrated crop management practices are very low in all the summer cotton growing districts. The level of risk estimated among the summer cotton farmers revealed that Thirunelveli and Madurai districts farmers face high risk and the Namakkal farmers face low level of risk.

*Fig:*15 *Mechanism of Low Productivity in Rainfed Cotton*



Seed Production Programme during summer is a profitable venture. As for each rupee invested in seed production (MCU.5) the farmers earned a net profit of 71 paise, the per day per hectare profit for the seed producing farmer was Rs.145/= whereas per day profits were Rs. 746/= and Rs.585/= respectively for the seed processing companies and the seed retailers. However, when compared to hard work and risk faced by the farmer, the farmer's per day profit was comparatively very less than that of seed processing companies and seed retailers.

Cotton is being cultivated in the banana field as a catch crop in and around Vayalur tract of Trichy district. In the catch crop, there is no preparatory cultivation, less fertilizers, pesticides and labour costs.

Therefore, the net profit for every one rupee invested was Rs.1.35 against 53 paise from the conventional summer cotton.

The COBB-DOUGLAS production function fitted for the MCU.5 summer cotton revealed that weeding cost variable has negative influence on yield where as the total man-days invested on cotton production has shown positive influence on the yield. In order to improve the weeding labour efficiency, we have to go for the labour saving equipments.

The major constraints identified in the summer cotton cultivation are a) credit gap b) poor quality of inputs c) inadequate marketing system d) improper nutrition management e) lack of integrated crop management f) unhealthy crop rotation and g) poor social infrastructure and lack of social engineering. Marketing is the weakest link both in input and output delivery system of summer cotton.

Evaluation of cotton production technologies through Institute Village Linkage Programme (IVLP) (K. Ramamoorthy).

In order to evaluate the existing cotton hybrids against new hybrids/varieties, an evaluation study was conducted in the IVLP village. In rainfed TCHB-213 hybrid cotton cultivation, farmers earned a net profit of two paise per every rupee invested whereas the irrigated TCHB 213 farmers incurred a loss of two paise per rupee. The DCH-32 farmers have incurred a loss of 10 paise per rupee invested. The study shows that DCH 32 is better than TCHB 213 under irrigated condition, whereas under rainfed condition TCHB 213 is better than DCH 32.

Among the intra-hirsutum hybrids, farmers cultivating Savita earned a net profit of Rs. 1.48 whereas farmers cultivating RCH.2 and Bhramma, respectively, earned a profit of 11 paise and 15 paise per rupee invested. In the cultivation of LRA 5166, the sample famers have incurred a loss of 58 paise and 45 paise respectively from irrigated and rainfed LRA 5166. Savita hybrid is having more potential than LRA 5166 and its adoptability is encouraging.

Extension

Nagpur

A study on technological adoption behavior of cotton growers: structural perspective (Hemchandra Gajbhiye).

This study is initiated to understand the adoption pattern of the technologies related to use of 1. Biological control agents and 2. Appropriate time of spraying of insecticides as a part of Integrated Pest Management Strategy. This study is being conducted under the theoretical framework of "Market and Infrastructure Perspective" proposed by Lawrence A. Brown. All concept have been defined and operationalized and the sampling frame prepared.

Longitudinal studies on structure of agriculture in cotton based farming system (Hemchandra Gajbhiye).

This project is initiated to study the structural changes brought by technology in agriculture in cotton based farming system. The critical perspective will be used for the study. All major concepts were identified and operationalized. These include farm size, farm income, farm infrastructure, labor process, gender issues, quality of life on farm, farm debt, and nature and reaction to crisis on farm.

Plant Physiology And Biochemistry

Nagpur

P1-85/2-ICR-F 60 / 0430: **Physiological evaluation of cotton germplasm under rainfed conditions** (MRK Rao and N K Perumal).

During the year, 100 *G.hirsutum* lines and 50 *G.arboreum* lines were evaluated for 20 growth and physiological attributes. Inspite of excess rainfall during the early flowering phase, the growth and yield attributes expressed well.

A wide range of variability was in existence for all the parameters in both the species including the green pigment status, relative water content, leaf area/plant, leaf area index, harvest index, nitrate reductase activity, specific leaf area, specific leaf weight in addition to the growth attributes. Many lines have recorded improved harvest index values as compared to the earlier year. Correlation studies indicated significant correlation between yield and the growth characteristics viz., height, leaf area and biomass. Harvest index, biomass and leaf area have a highly positive correlation with yield, in that order. Almost a similar pattern was evident in *G.arboreum* lines also. Nitrate reductase activity was evaluated in a few selected lines. Inspite of existence of variability, it has not shown any discernible association with other characteristics.

Few plant type association were mapped for their morpho-frame to elucidate the variability vis-a-vis the performance of the cultivars in respect of yield and growth attributes. In both the species, wide variability was recorded.

Ad-hoc trial - **Growth regulation in cotton.**

Low concentration multiple application of a growth retardant

The chemical (Lihocin 10 AS)was tested at the concentrations of 150 ml/ha and 300 ml/ha sprayed three times at 10-15 day intervals from squaring stage onwards. In all the three varieties/hybrids tested viz., PKV-Hy-2, NHH-44 and AKH-4, the chemical has brought about considerable growth suppression but failed to elicit any positive impact on yield. The treated crop looked green, and compact with turgid leaves. The senescence process was delayed and the crop duration got extended. Apparently under rainfed situation growth suppression as a tool to improve productivity has some limitations.

Three more chemicals 1) Plantozyme 2) Aahar and 3) Mahashakti (mostly nutrient combinations) were tested for their efficacy to improve yield under rainfed conditions. Plantozyme as a foliar spray has led to some yield improvement while others had no impact on yield.

P1-89/ICR-F60/0430 : **Physiological studies on abiotic stress with particular reference to heat and drought in cotton** (N K Perumal and M.Chakrabarty).

a. Four cotton genotypes belonging to *G.arboreum* L. and *G.hirsutum* L. were grown under pot house conditions and moisture stress was inducted during flowering.

Treatment effects : The moisture stress inducted at

flowering significantly increased leaf temperature and stomatal resistance, whereas the transpiration rate, leaf relative water content and leaf water potential showed a conspicuous decline. Biomass production during stress and its subsequent recovery were significantly reduced by the inducted stress. There was also significant yield reduction. The nitrate reductase activity had a decline during stress and showed improvement after recovery.

b. Genotype response: The *arboreum* genotype showed relatively higher moisture stress tolerance since this genotype maintained relatively lower leaf temperature. This may be due to higher stability in transpiration rate coupled with lower stomatal resistance noticed in this genotype. Such physiological responses in the *arboreum* genotype possibly led to comparatively effective leaf cooling as a better drought tolerance mechanism. Besides, higher root-shoot ratio and biomass recovery in the *arboreum* genotype were observed. Yield stability was maintained in this genotypes. In the *hirsutum* lines, the yield stability was marked in LL 11

c. Diurnal changes in leaf water potential and leaf relative water content measurements clearly indicated that the *arboreum* genotype has maintained comparatively lower levels of LRWC and WP as compared to the rest of the genotypes. The specific decline of WP and LRWC between 9.30 and 11 am. may be possibly due to enhanced transpirational trends and was conspicuous in the *arboreum* line.

d. Studies on detopping and foliar spray of naphthalene acetic acid (20 and 40 ppm) and suphala (1 and 2 per cent) in cv LRA 5166 and LRK 516 at boll development stage, did not bring out any significant difference in growth and physiological attributes.

e. In the date of sowing experiments (July 1999 to June 2000), sowing of LRA 5166 and LRK 516 was made in 1st and 15th of every month. The study indicated that the growth, development and production of fruiting parts tended to decline in late plantings.

Physiological and Biochemical basis of salinity tolerance in cotton (K B Hebbar, M V Venugopalan and MRK Rao).

Thirty two derivatives of wild species and 20 advanced germplasm lines were screened for their salinity tolerance at 0, 5, 10, 15 and 20 dS m^{-1} NaCl concentrations. Some of the derivatives viz., Rai 1, Rai 15A, Rai 16, Rai 17, Rai 18, Rai 19 and Rai 29 showed less reduction in yield both under control and salinity treatment whereas Rai 3, Rai 4A, Rai 4B, Rai 7A, Rai 13 and Rai 24 showed drastic reduction in yield with salinity treatment. Similarly, advanced germplasm lines like Khandwa 3, Badnawar, JK 345, showed less reduction in yield at 20 dS m^{-1} whereas Vikram, DCI 122, Soubhagya had a drastic reduction in yield. The tolerant genotypes were found to have a faster biomass and leaf area production at early growth stages under salinity treatment.

Cotton plants grown in water culture were subjected to 0,5,10,15 and 20 dS m^{-1} of sodium chloride. Salinity did not affect plant height, leaf area, square and boll number and plant biomass upto 10 dS m^{-1} beyond which i.e. at 15 and 20 dS m^{-1} they were drastically reduced. Sodium accumulation in roots and leaves showed a linear increase upto 10 dS m^{-1} beyond which it was pleateued. Contrarily root K remained stable at all salinity levels and leaf K content declined sharply at 5 and 10 dS m^{-1}. This suggested that Na accumulated in the leaf might have compensated for the reduction in leaf K to maintain osmotic potential upto 10 dS m^{-1}. Surprisingly, plants at 15 and 20 dS m^{-1} did not accumulate any additional sodium and accumulation of both Na and K was on par with plants grown at 10 dS m^{-1} NaCl. Relative water content of these plants also did not differ significantly from the control plants. Inspite of maintenance of higher relative water content, the stomatal resistance increased sharply and leaf area and biomass reduced drastically, suggesting that root originated signals as regulators of stomatal conductance and inhibited metabolic activities at higher salinity

level. When K deficient plants were supplied with Na at very low concentration, the leaf area, plant biomass, and leaf relative water content increased, while the stomatal resistance decreased similar to the addition of K. Higher concentration of Na, however, reversed all these processes further confirming that Na at lower concentration enabled the maintenance of the osmotic potential of the plant and at higher concentration inhibited plant metabolic activities.

Amongst Na and Cl, sodium was found to be more deleterious in causing damage on the plants. Cl at lower concentration stimulated both vegetative as well as reproductive growth of the plant (Table 17).

Table 17 :Response of K deficient plant to different concentrations of K, Na and Cl

	0 mM	2.5 m M	5 m M	7.5 m M	10 m M	CD (at 5%)
Pl. ht (cm)						
K	43	55	57	66	72	10.5
Na		57	54	50	37	10.9
Cl		52	56	57	50	8.3
LA (cm^2)						
K	504	1676	1795	1869	2126	203
Na		1509	1157	1048	525	343
Cl		785	1089	1103	-	251
Leaf dry wt. (g)						
K	2.65	6.3	8.0	8.3	9.05	3.25
Na	-	3.7	2.2	1.55	1.20	1.04
Cl		3.5	4.6	4.9	-	1.76
Shoot dry wt. (g)						
K	4.4	19.65	19.20	21.75	26.15	3.84
Na		9.05	6.55	5.55	3.50	1.62
Cl		13.31	15.22	14.10	9.68	3.26
Fr. part dry wt. (g)						
K	0.70	4.25	5.35	5.55	7.50	2.84
Na		2.75	1.65	1.05	0.50	1.25
Cl		3.61	3.06	3.15	-	0.82
Root dry wt. (g)						
K	1.7	9.55	8.45	8.15	8.55	1.44
Na		2.70	2.65	2.30	1.75	0.84
Cl		3.80	4.50	1.89	-	1.98

Adhoc trials: **Effect of insecticides on secondary metabolites in cotton** (M Chakrabarty).

Two different insecticides (oxymethyl demeton and fenvalerate) were sprayed on PKV 081 at 45 DAS and 70 DAS. Two different doses of each insecticide were used. Leaf samples at regular intervals (24 h, 48 h, 96 h, 120 h and 144 h) after the spray of insecticides were analyzed for total phenol and reducing sugar content. Results indicated that total phenol concentration decreased very rapidly immediately after 24 h of spray and after that it started increasing at a very slow rate. At 144 hr. the sprayed plants almost showed a value close to the unsprayed control (Fig. 11). With different doses of insecticides the decrease in total phenol content was also different.

On the other hand, reducing sugar concentration showed an increase after 24 h of insecticides application and with Fenvalerate (0.1% and 0.2%) a steep increase was observed. With passage of time, the increase was narrowing down (Table 18).

The plant defense system needed almost 144 h to restore to the normal condition.

Fig. 11 : Changes in total phenol content as influenced by two different insecticide

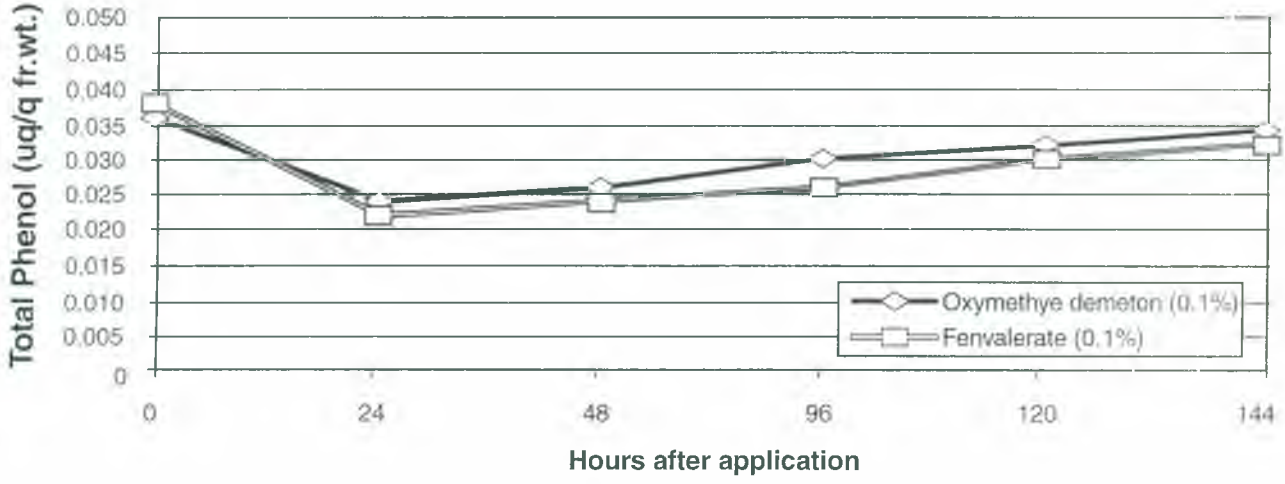


Table 18. Per cent increase in reducing sugar content as an after effect of insecticide application

Time	Metasystox		Fenvalerate	
(hr.)	0.1%	0.2%	0.1%	0.2%
24	17.80	26.70	37.80	52.10
48	16.40	26.40	34.70	46.90
96	15.70	23.30	31.60	41.70
120	13.00	19.90	29.60	39.60
144	12.30	17.80	26.50	30.20

Coimbatore

P1-92/1-ICR-F60/0430: **Response of elevated carbon dioxide on physiology and productivity attributes of cotton genotypes** (S.E.S.A. Khader and N. Gopalakrishnan).

The impact of elevated CO_2 (650 ± 50 ppm) on physiological and biochemical attributes were evaluated in ten genotypes of cotton adapted to different latitudes.

A. Photosynthetic rate

At initial stages of growth (30 days after sowing), the photosynthetic rate was lower (16.8 mol CO_2 m^{-2} sec^{-1}) irrespective of the CO_2 atmosphere and increased significantly by 60th day (24.2 mol CO_2 m^{-2} sec^{-2}). This rate of photosynthesis was maintained until 90 days and declined significantly by 120 days (16.2 mol CO_2 m^{-2} sec^{-1}). Irrespective of the genotypes, plants grown under elevated CO_2 atmosphere photosynthesized at a higher rate by 10-15% upto 90 days after sowing. For instance, in plants grown under elevated CO_2 atmosphere, photosynthesis was at the rate of 25.8 μ mol CO_2 m^{-2} sec^{-1} on 60th day compared to 22.6 μ mol CO_2 m^{-2} sec^{-1} in plants grown under ambient atmosphere. However, by 120th day, there was a marginal decline in the photosynthetic rate in plants grown under elevated CO_2 atmosphere than the plants grown under ambient conditions (Table 19).

Although all genotypes responded favorably to elevated CO_2 atmosphere, the magnitude of difference with their respective control was varying. The South zone and North zone genotypes responded more favorably to elevated CO_2 atmosphere than the Central zone varieties. Among the varieties, H-777 recorded maximum rate of photosynthesis (30.8 mol CO_2 m^{-2} sec^{-1}) followed by LRK 516 and LRA 5166 at 60th day after sowing under both elevated and ambient atmosphere.

B. Nitrate reductase activity

The nitrate reductase activity was comparatively lower during the initial stages of crop growth and increased significantly at later stages upto 90 days after sowing. By 120th day, the activity started declining irrespective of the varieties and the atmosphere in which the plants were grown. Elevated CO_2 atmosphere had a profound effect on nitrate reductase activity at all stages of growth and attained its peak activity by 60 to 90 days. The difference between elevated and ambient grown plants was more during this period.

Even in the last stage (120 days after sowing) plants grown under elevated CO_2 atmosphere maintained higher rate of nitrate reductase activity unlike the photosynthetic rate where a decline was observed. Irrespective of the stage of the plant and the atmosphere in which the plants were grown, genotypes like H-777, LRA 5166 and LRK 516 exhibited higher rate of nitrate reductase activity.

C. Response of cotton genotypes to elevated CO_2 atmosphere

Cotton genotypes adapted to South zone (LRA 5166, LRK 516, 70 E and KDCAKD), North zone (H-777, CSH 683-1 and CSH 683-6) and Central zone (CNHPT-2, CNHPT-5 and CNH-38) were grown under elevated CO_2 atmosphere of 650 ± 50ppm throughout the cropping season. Yield and yield components were recorded at maturity stage.

Plants grown under elevated CO_2 atmosphere produced significantly more bolls (16.2) than plants grown under ambient control atmosphere (13.5) irrespective of the genotype studied. However, the genotypic response to elevated CO_2 varied widely. For instance, CNH-38 recorded only 8% increase in boll number, while genotypes like CNHPT-2, KDCAKD, LRK 516 showed 27 to 29% increase in boll number. Similarly, elevated CO_2 atmosphere increased the boll size in terms of weight by 7% than control grown plants. The increase was appreciable in LRA 5166, LRK 516,

70E and CNHPT-2. However, when total yield was evaluated, the effect of elevated CO_2, on total kapas weight per plant was 30% more compared to ambient grown plants regardless of the genotypes studied.

The total dry matter produced was significantly more in genotypes like LRA 5166, LRK 516, CNHPT-5, CNH-38 and H-777 ranging between 100-126 g/plant, while genotypes like KDCAKD, 70 E, CSH 683-1 and CSH 683-6 produced less dry matter between 88 to 94 g/plant. Similar trend was observed in plants grown under elevated CO_2 atmosphere. Irrespective of the genotypes studied, a 22% increase in dry matter production was recorded in plants grown under elevated CO_2 atmosphere.

Harvest index values appeared to be higher for South zone varieties in general and CNHPT-2 of the Central zone. The influence of elevated CO_2 on harvest index was significantly more for genotypes like LRA 5166, LRK 516 and CNPHT-5, while genotypes like CNHPT-2, CNH-38 and H-777 were not favorably influenced. It is seen that LRA 5166 and LRK 516 of South zone, CNHPT-2 of Central zone and H-777 of North zone respond significantly to elevated CO_2 atmosphere in terms of yield and yield components.

Table 19. Effect of Elevated CO_2 on Ps Rate of Cotton (mol CO_2 m^{-2} sec^{-1})

ZONE	Variety	30 DAS		60 DAS		90 DAS		120 DAS	
		Amb.	EL.CO_2	Amb.	EL.CO_2	Amb.	EL.CO_2	Amb.	EL.CO_2
South	LRA 5166	16.40	18.20	24.20	27.10	24.85	27.40	18.20	17.05
	LRK 516	17.30	20.00	25.30	29.10	25.42	27.22	18.70	16.60
	KDCAKD	15.60	16.70	22.60	25.10	23.35	26.90	16.72	15.92
	70 E	15.30	17.10	22.60	25.30	23.40	25.10	17.50	14.60
Central	CNHPT-2	15.50	16.50	21.40	24.20	21.80	25.10	15.45	14.60
	CNHPT-5	16.10	17.00	20.90	23.70	21.50	24.20	14.92	14.42
	CNH-38	16.00	18.10	22.70	26.10	23.60	25.10	16.32	14.22
North	H 777	18.00	20.80	26.40	30.80	26.92	28.45	19.93	16.60
	CSH 683-1	15.70	16.70	21.00	23.10	21.72	24.85	15.83	14.72
	CSH 683-6	15.20	16.40	22.20	24.80	23.50	24.95	16.08	15.37
	Mean	**16.00**	**17.70**	**22.60**	**25.80**	**23.61**	**25.93**	**16.97**	**15.41**
	CD at 5%	**1.3**		**1.8**		**1.9**		**1.7**	

* Amb Ambient atmosphere; EL.CO_2- Elevated CO_2 atmosphere

P1-95/1-ICR-F60/0430 : **Identification and utilisation of adaptive response to abiotic stress in cultivated species of cotton** (S.E.S.A. Khader, N. Gopalarishnan, K. Venugopal and K.N. Gururajan).

Forty two elite cotton *(G.hirsutum)* genotypes were screened for drought tolerance by various methods like wilting per cent, relative water content, water use efficiency and hysteresis curve. Varieties identified as tolerant or susceptible in one method did not show the same trend in another method. Hence the data obtained from the above screening techniques were sorted and ranked on five-point scale and accordingly classified as tolerant and susceptible for individual parameters. The cumulative points secured by each genotypes from various screening methods were tabulated and then the top ranking varieties were classified as highly tolerant and genotypes with very low points were termed as

susceptible. From the study, genotypes like LRK Kgl 931, NME-70, Normal Okra, AC-241, HGIPS-542, NME, RBC-37, K-34007, EC 126623, Acala glandless, Glx 22/1, H-777, LRA 5166, RBC-39, CNH-38, CNHPT-5 and IC-1356 were classified as drought tolerant genotypes while DS-59, K-3475, JK-97, GS-625, Sarada, HLS-329, Supriya, PMC and Kgl 54620 were termed as susceptible.

P1-95/2-ICR-F-25/0430 : Physiology of fibre growth and development (A. H. Prakash, S. E. S. A. Khader, N. Gopalakrishnan, K. B. Hebbar and V. N. Waghmare).

In vivo studies

Six cotton genotypes with varying staple length viz., G 27 (Short staple), LRA 5166 and NHH 44 (Medium staple), MCU 5VT (Long staple) and Suvin (Extra long staple) were utilized for fibre development studies. During the peak flowering period, the flowers were tagged for one week to get uniform experimental material and only these tagged flowers were used for all further experiments. The bolls were analysed from five days after anthesis (DAA) till 60 DAA (boll bursting) at five days interval, for both physiological and biochemical constituents.

Biochemical analysis

Developing seeds and fibres were analysed for reducing sugar, soluble proteins and total phenols. As the seeds and fibres could not be separated, the whole ovule was used for analysis on fifth DAA and at later dates seeds and fibres were analysed separately.

In general, seeds possessed less amount of reducing sugars than that of fibres. The developing seeds of G 27 showed higher reducing sugars initially with 7.14 mg/g FW on 15th DAA and 18.02 mg/g FW on 25th DAA, and at maturity it was 0.68 mg/g FW . The developing seeds of LRA 5166 and hybrid NHH 44 had 5-6 mg/g FW on 20 DAA and later increased to 19-20 mg/g FW by 30 DAA. The seeds of Suvin showed very less reducing sugar content till 20 DAA and later marginally increased to 11.79 mg/g FW by 35 DAA.

In contrast, the developing fibres showed higher reducing sugar content initially. The reducing sugar content in G 27 was 10.35 mg/g FW on 15 DAA and to 38.47 mg/g FW by 30 DAA and later declined to 2.16 mg/g FW at maturity. When the ratio of seed to fibre sugar content was worked out, it was found that the fibres accumulated only 1-2.1 times the quantity till 25 DAA to the seed sugars. The maximum was at 30 DAA and later gradually reduced and was 3.18 times at maturity. The pattern of reducing sugar content in the developing fibres of genotypes LRA 5166 and hybrid NHH 44 was similar. There was a higher content of 41.8 at 10 DAA and later reduced to 18 mg/g FW by 20 DAA and at maturity it was 1.3 to 2.3 mg/g FW. The fibres of Suvin showed 22.7 mg/g FW at 15 DAA and by 25 DAA it was 60 mg/g FW. Later the sugar content was maintained at 35-40 mg/g FW till 40 DAA and then gradually reduced to 0.9 mg/g FW at maturity.

Past three year studies showed that the fibre initials are visible to the naked eye by 2^{n} ^{d}DAA and the elongation process would prolong for 15-20 DAA. Then the secondary growth is observed and this prolongs till 35-40 DAA, later the maturity sets in.

Hence, the reducing sugar accumulation in relation to fibre elongation was studied. In G 27, even though the seed had 7.14 mg/g FW, the fibre sugar was only 10.4 mg/g FW and it worked out to 1: 1.45 at 15 DAA. This indicates that the sugar content in fibres was on par with seeds and this was also reflected on the elongation process. The fibre elongation was 3, 5 and 12 mm at 5, 10 and 15 DAA. At the end of elongation period the fibre length was 20 mm only.

In LRA 5166 and NHH 44, the fibres maintained a steady 3.5-4.5 times higher reducing sugars throughout the elongation period. The fibre elongation was 5, 13 and 28 mm at 5, 10 and 15 DAA. By 25 DAA, the fibre length was 30 mm. In Suvin, the fibre cells had seven times higher sugars than seeds during the effective elongation period. The corresponding fibre elongation also was higher with 5, 11.5 and 24.6 mm at 5, 10 and 15 DAA. By 35 DAA the fibre length was 38 mm (Fig-12,13).

Fig. 12 : Relationship between reducing sugar accumulation and fibre elongation in G 27

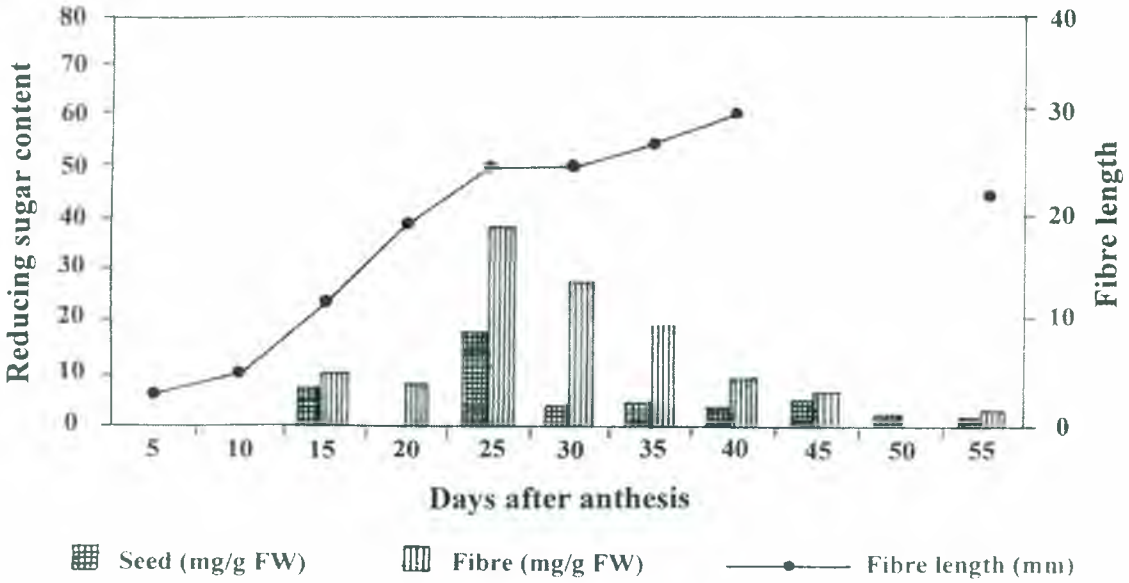
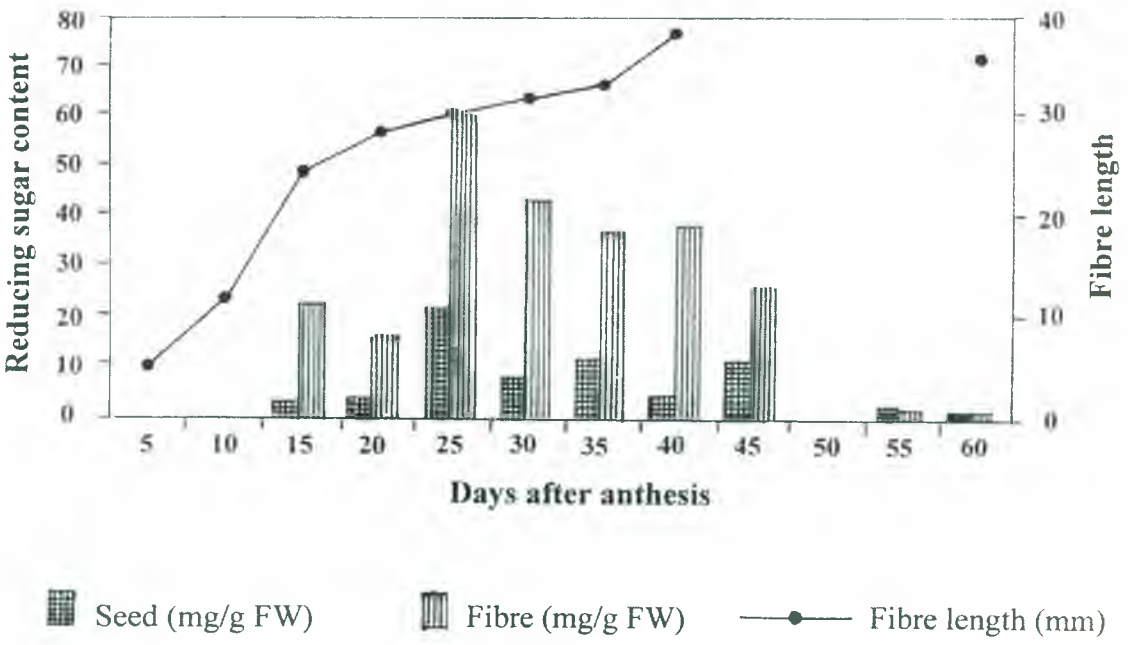


Fig. 13: Relationship between reducing sugar accumulation and fibre elongation in Suvin



There was a good relationship observed between the differential reducing sugar accumulation in fibre and seed than the absolute quantity, with the fibre elongation process (Table 20). From this study it was confirmed that reducing sugars has a vital role to play in the fibre elongation process.

Table 20 : Seed to fibre ratio of reducing sugar content in four cotton genotypes

Days after anthesis	G 27	LRA 5166	NHH 44	Suvin
15	1.45	3.70	N.A.	7.34
20	N.A.	3.57	3.55	4.19
25	2.13	4.76	3.03	2.76
30	8.66	3.24	4.36	5.50
35	5.07	3.00	3.00	3.12
40	2.59	2.25	5.59	8.15

There was a gradual accumulation of soluble proteins in the seeds from 5 DAA till 30 DAA and then slightly reduced, in the six genotypes tested. Similar trend was observed in the fibre proteins also. The genotype G 27 accumulated very high seed phenol at 15 DAA and later it was maintained at 3-4 mg/g FW till 30 DAA. Then there was a gradual reduction and was 2.26 mg/g FW at maturity. The genotypes LRA 5166 and NHH 44 maintained moderately around 2-4 mg/g FW till 20 DAA, but Suvin, an extra-long staple genotype had 2-3.5 mg/g FW till 20 DAA. Later the phenol content reduced and at maturity it was lowest. An exactly opposite trend was observed in fibre. The fibres of Suvin had higher phenols followed by G 27. The least was observed in LRA 5166 and NHH 44. Very high phenolics coupled with lesser seed to fibre reducing sugar content, IAA oxidase and Peroxidase activity might have hampered the elongation process in G 27.

In vitro ovule culture

Unfertilized (one day prior to anthesis) and fertilized ovules (three days after anthesis) was found best suited for studies on fibre development through ovule culture. Through suitable manipulation of culture medium and hormonal combinations there was good improvement of fibre elongation. In case of unfertilized ovules, the fibres elongated upto 12mm. The fibre length of 17 mm was achieved in case of fertilsed ovules.

Ad hoc trial: **Callus induction and growth: A measure of apparent stress tolerance to screen cotton genotypes for drought tolerance** (A H. Prakash).

One hundred and twenty genotypes were screened for drought tolerance during the past three years. The techniques used were germination studies, pot culture studies and callus induction studies. During the current year, 40 *hirsutum* genotypes were screened for drought tolerance.

From the germination studies using Polyethylene Glycol (PEG 6000) as stress inducer, the stress levels were 0.0, -0.2, -0.4, -0.6, -0.8 and 1.0 Mpa of stress. The cotton seeds were soaked 12 hours prior to stress induction and only sprouting seeds were utilized for germination to reduce the experimental error of using non viable seeds. It was found that none could tolerate a stress level of 0.6 Mpa of stress.

Simultaneously, hypocotyl segments from aseptically germinated seedlings of these 40 genotypes were cultured on callus induction medium. The results were similar to that of germination studies. None of the genotypes formed callus when the stress level was above 0.6 Mpa. There was significant variation in callus induction with LRA 5166, NHH 44, Arogya, Sahana, RCH 5267-1-6 and RCH x L 35-1-2 showing better callus formation at stress levels of 0.2 and 0.4 Mpa of PEG stress.

The work done during the previous year showed that under pot culture studies, genotypes LRA 5166, CWROK 165-1, Anjali, KDCAKD, IC 379, K 34007 and NHH 44 had exhibited higher tolerance than other cultures. Under all the three methods tested, the cultures LRA 5166, Arogya, NHH 44, IC 379 and RCH x L 35-1-2 were consistently found tolerant to drought stress. These genotypes had better adaptation to stress.

P1-97/1-ICR-F60-0430: **Studies on developmental biochemistry of cotton pest/disease interaction** (N. Gopalakrishnan, T. Surulivelu, K. Natarajan and P. Chidambaram).

Biochemical aspects of cotton plant metabolism vis-a-vis the molecular interaction brought about by different seed treatment insecticides, insecticide sprays, fungicidal and biocontrol agents were studied.

Interaction of seed treatment insecticides on plant metabolism in early growth stage

It was seen that Thimethoxam at 3g/kg and 4.5 g/kg enhanced the activity of Nitrate Reductase to an extent of 30-40%, while Imidacloprid and Carbosulfan enhanced the activity progressively with development of the seedlings by 20-25%. The marked increase observed in the activity of NR was also reflected in enhanced soluble protein content of leaves to the tune of 20%, explaining the healthy status of young leaves due to the seed dressing chemicals. In addition, the chemicals were observed to enhance the gossypol and total phenols content up to 45 days (Fig.14).

Influence of insecticidal sprays on cotton plant metabolities

There was characteristic rise in the leaf NR activity and soluble protein content after two rounds of application of certain insecticides. Similarly, the levels of phenols in leaves were higher in Oxydemeton methyl and Monocrotophos treated plants, while only moderate rise was observed due to Endosulfan spray as compared to control . Noticeable increase to an extent of 30-40% in gossypol content was seen due to systemic insecticides spray, revealing the effect of insecticides on plant metabolism.

Effect of fungicides on cotton phytochemicals

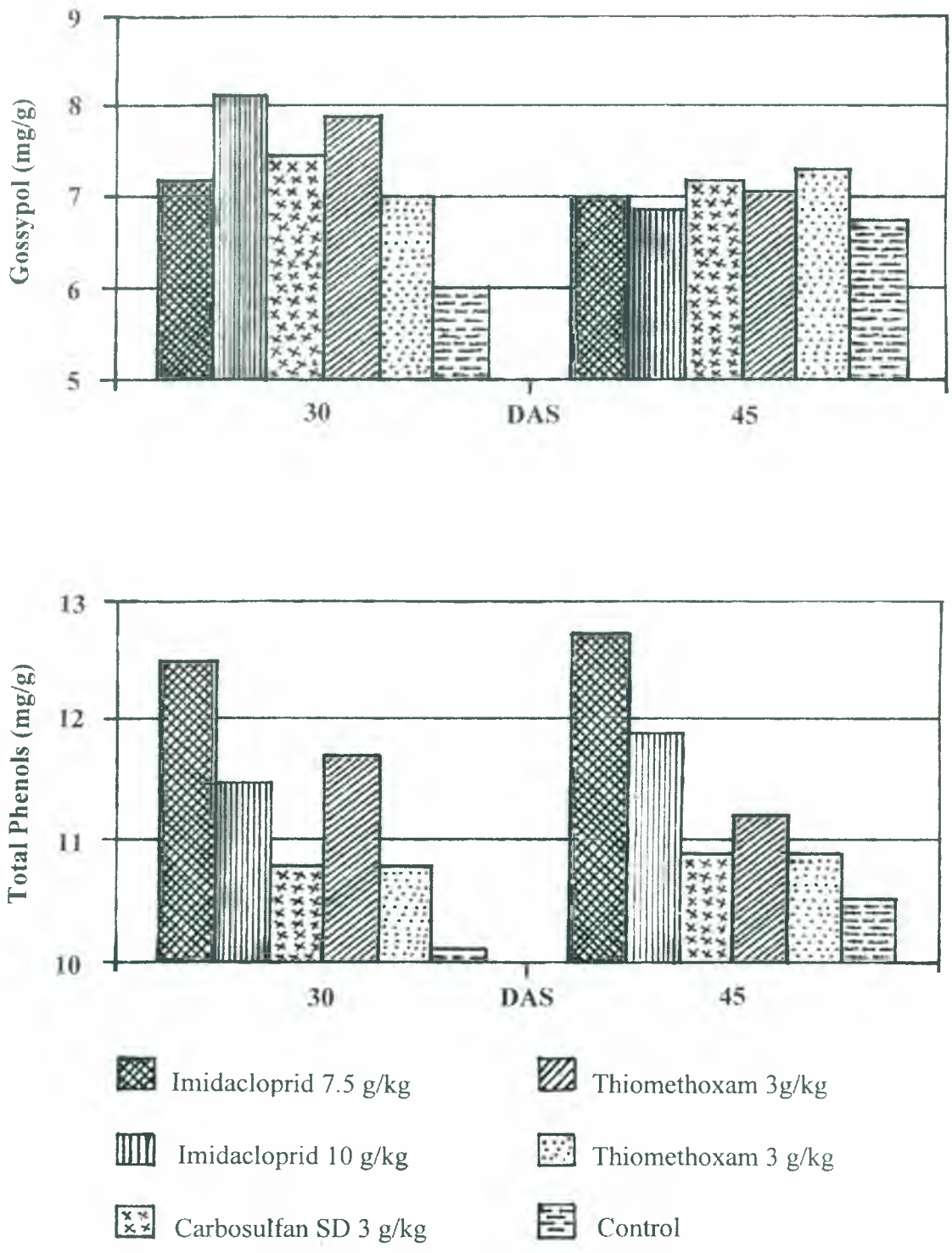
Around 25-40% increase was seen in soluble protein content of leaf due to application of Carbendazim and Prochloraz, while enhanced accumulation of reducing sugar was seen in Prochloraz treated plants. The effect of Carbendazim was more pronounced as regards the overall phytochemical accumulation was concerned.

P1-89/1-ICR-F60/0430 : **Studies on biochemical mechanisms of resistance to bollworms of cotton** (N. Gopalakrishnan and T.Surulivelu).

Biochemical characterization of popular varieties / hybrids, advanced breeding materials and elite germplasm lines has been done with a view to elucidate the metabolic role of phytochemical substances in the resistance mechanism to bollworms of cotton.

Most of the *G.arboreum* genotypes studied possessed uniformly higher levels of condensed tannin (5-8 O.D. units/10 mg) in squares during early growth stages and at 80 DAS, the content remained around 8-11 O.D. units per ten mg. The moderately bollworm tolerant genotypes viz., CWROK 165, RBC 37, RBC 39, F5 x Ali, Abhadita and Surabhi had better distribution of gossypol and condensed tannin in squares during early stages of growth. However, the temporal distribution pattern of condensed tannin and gossypol in case of susceptible genotypes was not uniform. Higher levels of condensed tannin was seen in 5, 10 and 15 day old bolls and boll rinds in case of tolerant *G.hirsutum* germplasm lines like HGIPS 542, IC 379, HGIPS 625 and RBC 37. The pattern of temporal distribution of phenolics followed closely that of gossypol and tannin in genotypes belonging to *G.arboreum* and tolerant *G.hirsutum* lines. The unfavorable environment offered by the rise in levels of anti-nutritional secondary metabolite, catechin in young bolls of *G.arboreum* lines and derivatives of wild species offer scope for further exploitation.

Fig. 14 : Effect of seed treatment chemicals on biochemical metabolites in leaves of young plants of cv. LRA 5166



The bollworm tolerant selections viz., BRS 3, BRS 5, BRS 22 and BRS 23 were seen to possess consistently higher levels of protective secondary metabolites and lower levels of nutritional substances, thus explaining the underlying mechanism in their tolerance to bollworms (Table 21). Similarly, genotypes derived from wild species background have been identified to possess higher constitutive levels of secondary metabolites in squares and young bolls with lesser incidence of bollworms.

Table 21 : Plant biochemical nutrients and secondary metabolites in squares of cotton genotypes

Genotype	Protein (mg/g)	Reducing sugar(mg/g)	Cond.Tannin (Abs.units per 10 mg)	Phenols (mg/g)	Gossypol (mg/g)
BRS 3	143.3	15.7	5.9	23.1	12.9
BRS 5	140.3	14.4	6.1	24.1	12.4
BRS 22	159.0	14.5	5.3	22.4	11.7
BRS 23	145.3	15.4	5.9	19.1	13.3
LRA 5166	192.3	20.0	3.7	16.2	9.0
MCU 5 VT	200.3	20.7	3.5	17.5	9.3
KHANDWA 2	195.0	20.4	3.6	17.8	8.7
C.D.5%	11.9	0.7	0.5	0.9	0.6

B. Projectwise Salient Achievements

Crop Improvement

Nagpur

P1-86/1-ICR-F30/0430 : **Collection, conservation, evaluation, documentation and utilisation of genetic resources** (V.V.Singh and Punit Mohan).

In *G. hirsutum*, over fifty new collections received from abroad and collected from different centres in the country were grown for multiplication and evaluation. They showed wide genetic variability for boll weight (1.4 to 5.4 g), boll number/plant (1.0 to 31.0), GOT (30.0 to 44.1%), mean halo length (14.0 to 28.0 mm) and seed cotton yield/plant (2.6 to121.4 g.). Superior lines included Pakistan-2, Stam 72 and GISV-25/1699 for boll weight, AKH 8940 and GISV-12 for boll number, Senegal, Stam 72, NH 572 and U-772 for ginning outturn. SLF-19 CC, PIL 8 Mian (99) and Senegal for mean halo length, and PH 92/260 and NH 572 for yield/plant. About 2530 accessions of *G. hirsutum* were grown for maintenance.

Over 320 working collections, classified into 12 groups based on various characters, were grown for seed distribution. Germplasm Field Day was organised between 16-18 December, 1999, in which Scientists from SAU's (6) and private sector (42) participated.

Multilocation evaluation of 100 accessions each of *G. hirsutum* and *G. arboreum* was done in Br 01 at Sirsa (Irrigated), Nagpur (Rainfed) and Coimbatore (Irrigated). Ten best genotypes for individual economic characters were identified at each location.

In the Institute Common Trial, culture CNH 152 recorded seed cotton yield of 11.64 q/ha at Nagpur and 8.62 q/ha at Coimbatore and ranked third and fourth, respectively. This entry was sponsored in the National Trial this year (2000-2001).

In station trial, out of thirty CNH cultures evaluated, five superior high yielding cultures viz., CNH 1030, 1031, 1032, 1033 and 1034 were identified among the best performances. In these five cultures, the seed cotton yield varied from 14 q. to 18 q/ha, as compared to the checks (11-12 q/ha).

In *G. hirsutum*, 110 F_1 cross combinations were evaluated for their heterotic potential and one superior F_1 combination was identified. In order to incorporate important desirable characters of elite donor germplasm such as bollworm tolerance, jassid resistance, high boll weight and good agronomic features into local cultivars, 10 crosses were effected among selected genotypes. Out of ten F_3 progenies of coloured cotton, four F_4 progenies were advanced for further testing / screening and selection purposes.

In *G. arboreum*, seven new germplasm lines were collected from Malwa region. One thousand one hundred ninety lines of *G. arboreum* and 460 lines of *G. herbaceum* were grown for seed increase. In *G.arboreum*, 10 elite genotypes each for seed cotton yield - 6536, 30850, 30875, 79/BH 11, 9505 NLL, 1882, 7735, 7526, 7444, 1946 and boll weight 30807, Desi-MLL, 1768, 30785, 30820 BLL, 30828, 30855, 8410-2, 1395, 7444 and Mean halo length Desi-1, MLL, 30800, 7038, 1768, 30794, 30807, 1173 WR NLL, 30802, 30834 and 6164 were identified. In *G. arboreum*, two

genotypes, one belonging to race *bengalense* (G 135-49) and another belonging to race *cernuum* (30805) were registered with NBPGR as Indian Genetic Resources INGR 00017 and INGR 00018 respectively.

P1-86/2-ICR-F30/0430 : **Studies on impro- vement of rainfed *hirsutum* cotton for yield, new characters and fibre quality suited to modern processing techniques (open end spinning)** (P.Singh).

Out of seven cultures evaluated in replicated trials, three, viz. CIHS 97-7 (22.22 q/ha), CIHS 14 (18.20 q/ha) and CIHS 16 (18.05 q/ha), were found promising. All these have high GOT (39% and above), earliness (150-160 days) and belong to medium staple group. The yield of the check cv. LRK 516 was 15.44 q/ha.

Two cultures viz. CIHS 11 and CIHS 12 were evaluated in the Institute Common Trial. Culture CIHS 11 stood second at Nagpur centre (11.89 q/ha). The yield of the check cv. LRA 5166 was 9.10 q/ha.

Two new early maturing cultures (140-150 days) viz. CIHS 17 and CIHS 18 were identified. The yield of these cultures was at par with check variety LRK 516.

More than 100 single plant selections were made in the segregating populations (F_2-F_6) on the basis of high yield, synchronous boll opening, earliness, good fibre strength and length.

P1-86/3-ICR-F30/0430 : **Studies on heterosis in conventional tetraploid and diploid cottons** (P. Singh).

Three types of hybrids, viz. Intra-*hirsutum*, intra-*arboreum*, conventional and intra-*arboreum* GMS based crosses were evaluated. In upland cotton, out of 35 F_1, five top heterotic combinations were identified in which useful heterosis over NHH 44 ranged from 4.4-61.1% and from 12.7-88.8% over LRA 5166. The best hybrid i.e., CIHH 103 recorded seed cotton yield of 20.14 q/ha against 12.50 q/ha of check NHH 44. Two intra-*hirsutum* hybrids, viz. CIHH 101 and CIHH 102 were evaluated in larger plots. These hybrids recorded yield of 14.10 and 13.20 q/ha against 12.50 q/ha of NHH 44. These two hybrids have been entered in Br 05 (a)-1 and Br 05 (b)-1 in the coordinated trial in the central and south zones.

In *G. arboreum*, 46 conventional hybrids were evaluated and five superior heterotic combinations were identified. In these five crosses, useful heterosis ranged from 114.0-158.3% over AKH 4 and from 30.7-57.7% over DH 9. The best hybrid i.e. AAH-51 recorded seed cotton yield of 22.77 q/ha.

Six GMS based intra-*arboreum* crosses were evaluated in which useful heterosis ranged from 15.1-57.6% over AKH 4 and from 7.5-47.6% over DH 9. The best hybrid (GAA 99-2) recorded seed cotton yield of 20.05 q/ha.

In upland cotton, three kg., seed each of two hybrids, viz. CIHH 101 and CIHH 102. was produced and one hundred new crosses were made. Twenty two GMS based crosses were effected in *G. arboreum*.

P1-86/4-ICR-F30/0430 : **Studies on improve ment of rainfed *arboreum* cotton for yield, new characters and fibre quality** (P. Singh).

Out of seven cultures evaluated in a replicated trial, three viz. CINA 310 (24.86 q/ha), CINA 323 A (24.9 q/ha) and CINA 323 B (21.52 q/ha) were found promising. The yield of check variety AKH 4 was 19.4 q/ha. CINA 310 stood second in South Zone (10.39 q/ha), fifth in Central Zone (8.89 q/ha) and third on all India basis (8.80 q/ha). It has been promoted from Br 22 (a) to Br 24. CINA 323 A in Br 22 (a) and CINA 323 B in Br 24 have been entered this year.

Two new high yielding and early maturing cultures viz., CINA, 329 and 330 with superior medium staple and good boll opening were identified. Also, 11 long staple cultures (26-29 mm) were identified, purified and multiplied.

On the basis of high yield, medium and superior medium staple length, good fibre strength, earliness, synchronous and good boll opening, 65 single plant selections each in white and brown linted genotypes were made. Some dwarf and naked seeded plants with

good fibre strength were also selected.

Common Station Trial

In a Common Institute Trial, 19 advanced cultures were tested at Nagpur, Coimbatore and Sirsa. Four cultures at Nagpur (CNH 152, CNHP 33, COE 2124 and CIHS 11), three at Coimbatore (CCH 41431, COE 2124 and XIAX), and four at Sirsa (CNH 1025, CNH 152, COE 2124 and COE 2123) outyielded the check. The yield of check LRA 5166 was 9.10, 9.31 and 11.49 at Nagpur, Coimbatore and Sirsa respectively.

Fifteen new entries with three checks (LRA 5166, Surabhi and Anjali) were tested separately in medium deep soil under organic and inorganic conditions. Genotypes T 13 (14.60 q/ha) and T 14 (14.45 q/ha) under inorganic conditions and genotypes T 11 (15.88 q/ha) and T 16 (13.84 q/ha) under organic conditions out yielded the checks LRA 5166, Anjali and Surabhi.

P1-88/1-ICR-F30/0430 : **Genetical and anatomical studies on drought tolerance in cotton (*G.hirsutum*).** (Suman Bala Singh and N.K. Perumal).

Twenty five crosses in F_1, 18 in F_3 and 23 in F_6 generation were tested under rainfed and irrigated trials. Crosses P8 x EL 5000, P3 x A72-62, P1 x EL500, P8 x A 72-62 and P6 x AV 3469 in F_3 recorded seed cotton yield of 6 quintals/ha under rainfed and 10-14 q/ha under irrigated conditions. Drought susceptibility index was also low for three crosses indicating that they can be exploited further for selection of drought tolerant segregants. Similarly, in F_6, B 58-1290 x P2, Texas 1050 x P2, B 58-1290 x P3, LL 56 x P3 and LL 56 x P2 were good yielders under rainfed as well as irrigated conditions and recorded low drought susceptibility index.

Out of single plant selections tested, 10 were at par with LRA 5166 and 14 with PKV 081. SPS 31 and SPS 36 were the best selections and recorded seed cotton yield of 1308 kg/ha and 1210 kg/ha respectively.

Two cultures were sponsored in AICCIP trial. CNH 301 was tested in Br 03 (a) trial of South Zone and ranked first. It recorded 1762 kg/ha seed cotton yield with 49.1 and 19.9% increase over the zonal and local check respectively. It has been promoted to Br 04 (a) trial.

Culture CNH 32 was sponsored in National Trial Br 02 (b) which has been promoted to Br 03 (b) in Central and South Zones. New Culture CNH 380 has been entered in AICCIP National Trial.

In the Institute Common Trial, culture CNH P 33 ranked first at Nagpur and recorded seed cotton yield of 11.94 q/ha.

In 25 lines, leaf relative water content was measured on control and moisture stress inducted plants and plants showing higher stability to LRWC were identified.

P1-86/1-ICR-F50/0430 : **Conservation of wild species of *Gossypium* and introgressive hybridisation for the improvement of cultivated cottons** (Vinita Gotmare, M.K.Meshram, S. Vennila, K.B.Hebbar and G. Balasubramani).

In the species garden, 25 wild species, races and perennials as well as sterile interspecific hybrids and synthetic polyploids are maintained. Recently, seeds of one more species viz. *G. nelsonii* was obtained. A new duplicate wild species garden with 25 species, six *G. arboreum* races, four *G. hirsutum* races and fourteen perennials has been established.

In the derivatives of (*G. arboreum* x *G. australe*) 2, fertilised ovules at different stages were examined for gossypol gland density. It varied from 25 to 52 per unit area, while in *G. arboreum* it was 30 and zero in *G. australe*. Segregants were also backcrossed with *G. australe* and *G. bickii* but few seeds were obtained. Selfing and intermating between selected plants were done to recover stable lines with delayed morphogenesis of gossypol gland.

For identification of CMS/GMS sources, 16 crosses involving 14 wild and two cultivated species were evaluated in non-replicated trials. Observations

were made to locate new sources of male sterility and on other economic characters. However, no male sterile plant was found in F_1 of these crosses.

Colchicine treatment was given to two sterile interspecific hybrids for induction of colchiploidy viz.

- *G. arboreum* x *G. raimondii*
- MCU 5 x (*G. thurberi* x *G. raimondii*)

Single plant selection of elite plants with big bolls, prolific bearing and desirable characters were made in the following derivatives :

- (*G. hirsutum* x *G. raimondii*)2 x (*G. barbadense* x *G. thurberi*)2
- (*G. hirsutum* x *G. raimondii*)2 x *G. hirsutum*

Oil content estimated using NMR in 22 wild species and six races, ranged from 11.22 to 24.82%.

P1-95/ICR-F25/0430 : **Induced mutations for improving adaptability and yield attributes with reference to *G. barbadense* cv. Suvin and *G. arboreum* cv. Y1** (V.N.Waghmare and K.N.Gururajan).

In all, 43 progenies selected based on yield performance, ginning outturn and reduced plant height in M_3 were evaluated in M_4 generation. The selected progenies were grown in multiple rows. Observations for economic characters were recorded. Greater range of genetic variability was observed for all the characters studied in comparison to control. Maximum variability was observed for number of bolls per plant followed by number of monopodia, seed cotton yield per plant and ginning outturn. The data also reveals presence of enough variability for most of the characters within and between progenies indicating release of residual variability in M_4 generation as well, thus providing scope to exercise intra and inter progeny selection. Based on yield performance and ginning outturn, inter and intra progeny selection was carried out and about 33 progenies were selected.

The F_1's between macro-mutants and varieties (Y1, K10 and AKA 8401) were grown which resembled to normal varieties used in the crosses, indicating recessive type character.

Single plant progenies of the Suvin mutants evaluated for their performance and adaptability in M_5 generation showed range of polygenic variability for economic characters. Maximum variability was observed for seed cotton yield per plant followed by number of bolls per plant, plant height, number of sympodia and ginning outturn.

P1-84/2-ICR-F30/0430 : **Genetic improvement of cotton seed oil content and quality, with earliness and fibre productivity** (R.G.Dani).

- The early, high oil (EHO) culture CNO 131 was registered as germplasm material in the National Bureau of Plant Genetic Resources, New Delhi.
- Two EHO cultures were entered in AICCIP trials for 2000-2001 as follows :
  1. CNO 131 was retained for third year in Br 04 (a)
  2. CNH 2124 was entered in Br 02 (a) in National Trial.
- High performance of one EHO culture was recorded in Station Trials at Nagpur and Coimbatore. COE 2124 was the highest average yielder (based on two locations average).
- Three EHO cultures viz. COE 25, COE 26 and COE 27 were entered in 2000-2001 season's Institute Common Trial to be conducted at Nagpur, Coimbatore and Sirsa.

Ten new advance elite EHO cultures were developed. Sixty five new crosses were attempted (High linoliec/oleic acid parents x early cultures). One thousand single plant selections were advanced. Oil content analysis of current season's seed were done in 138 samples. DNA Fingerprinting (RAPD profiles) was performed in two advanced cultures viz. ES 12 and ES 13. Some unique banding patterns have been identified, which will be correlated with morphological attributes.

Crosses will soon be analysed for full segregant analysis, for possible marker identifications, corresponding to earliness and higher oil content and index. Five best EHO lines were identified according to high oil percentage (24.0 to 24.7%) and oil index ranging from 1.70 to 1.88% respectively with LRK 516 as check which recorded an oil percentage of 22.7 and oil index of 1.50 respectively.

Five high promising EHO lines viz. 10 Es, 13 Es, 2 Es, 5 Es and 12 Es were identified during 1999-2000 with LRK 516 as check.

Five high yielding lines, viz. F 11 8c, 25 Sc, 12 ES, F11 19B, F12 3c, were identified with LRK 516 as check, which gave a seed cotton yield of 910 kg/ha and above.

Several high performers were identified in HS Series. Top five EHO lines, according to oil percentage, are 3 HS (24.9%), 2 HS (24.4%), 5 HS (24.0%), 4 HS (23.8%) with LRK 516 as check (which recorded an oil percentage of 22.7%).

Performance of top five early cultures under rainfed condition in the year 1999-2000 is given in the following Table 3.

Table 3: Performance of top five early cultures

Cultures	Yield (kg/ha)	Yield (g/pl.)	GP (%)	% of 1st picking
5 HS	1010.41	36.83	36.51	73.88
8 HS	965.27	37.06	42.54	79.13
9 HS	913.18	37.57	35.07	72.62
14 HS	744.73	28.60	39.87	73.65
4 HS	640.62	23.35	39.04	79.40

Three new advance EHO cultures viz. 9 ES, 16 HS, 1 HS having higher span length and oil content were identified in 1999-2000 with LRK 516 as check.

- Five new F_1 combinations viz. 8 x 9, 2 x 8, 1 x 8, 6 x 8 and 3 x 9 involving high oleic/linoleic acid donor sources and early cultures as parents have shown higher fibre length (mm), with high percentage of oil, which are being advanced for further evaluation.

P1-88/3-ICR-F30/0430 : **Morphological and genetical studies of gossypol glands in cotton** (Punit Mohan, P. Singh, Mukta Chakrabarty and R.G.Dani).

Screening of germplasm for gossypol gland density

Eighty accessions of *G. arboreum* and nine of *G. hirsutum* were evaluated for gossypol gland density and distribution pattern. The distribution pattern of glands was observed as scattered and non-punctuate spots on the surface of young leaf, bracteole, calyx, corolla, ovary and young boll.

The magnitude of variability of gland density ranged from 38.56 to 108.23 on ovary, 4.65 to 19.10 on calyx, 9.72 to 18.29 on leaf and 6.55 to 18.21 on cotyledonary leaf surface in the genotypes of *G. arboreum*. The higher gland density was observed on the surface of various flower parts in the genotypes viz. Desi BLL, Comilla, C-Indore, Bisnoor and BDN 5900.

Screening of germplasm for glandless characters

Anatomical studies of seed were conducted to examine the glandless character. The radial longitudinal sections of seed kernel showed complete glandless area in the following germplasm lines of *G. hirsutum* : SA 1710, SA 564 A, SA 1520, SA 1521, SA 1710 B, SA 1713, SA 1619, SA 1706 and SA 1522. Glands were not visible on the surface of leaf, calyx, bracteole, stigma, style and ovary in the above germplasm lines.

Coimbatore

P1-75/2-ICR-F-30/0430: **Development of high yielding intra *hirsutum* hybrids** (K.N. Gururajan and S. Manickam).

Hybrid CCHY 10555 recorded the highest yield of 13.3 q/ha in the common trial. The hybrid recorded the highest yield both at Nagpur (8.2 q/ha) and Coimbatore (18.4 q/ha).

Among 13 promising hybrids tested with Surya, Savitha and NHH 44 as checks, hybrid V 96 x V 72 recorded the highest yield (20.7 q/ha), followed by V 105 x M55 (19.1 q/ha). The best check Surya recorded a mean seed cotton yield of 16.0 q/ha. Hybrid V 105 x M55, recorded the highest ginning out turn of 40 %.

In the third trial, of 110 hybrids tested along with the parents and checks , 21 recorded significantly higher yield than the best check Surya. RFF 4 x RFM 2 recorded the highest yield (17.5 q/ha) with a high ginning outturn of 40%.

In the initial evaluation hybrid trial, 64 were tested with the respective parents and common checks. Hybrid L4 x T7, recorded the highest yield of 17.8 q/ha and was superior to the best check Surya by over 32 % though the yield differences were not significant.

P1-89/2-ICR-F30/0430: **Breeding new *G. hirsutum* varieties with new plant types-Development of medium staple varieties** (K.N. Gururajan and S. Manickam).

In the coordinated irrigated varietal trial, culture CWROK 165 recorded the highest seed cotton yield (15.6 q/ha) for the second consecutive year in the South Zone and a five years mean yield of 13.55 q/ha and was superior over the common check LRA 5166 (10.04 q/ha) by 35 percent and over the local check (10.41 q/ha) by 30 percent (Table 4).

Table 4 : Overall performance of Culture CWROK 165 in AICCIP trials

	Mean Seed Cotton Yield (q/ha)					
CULTURE / Year	1995-96	1996-97	1997-98	1998-99	99-2000	Grand Mean
No. of trials	5	5	4	7	6	
CWROK 165	11.97	14.90	14.37	11.59	14.92	13.55
LRA 5166(Zonal Check)	10.43	10.65	8.66	9.87	10.57	10.04
Local Check	10.34	10.46	7.77	10.63	12.88	10.41
% inc. over the checks						
LRA 5166(Zonal Check)	+14.8	+39.9	+65.9	+17.3	+41.2	+35.0
Local Check	+15.8	+42.5	+85.0	+9.0	+15.8	+30.1

The culture was characterized by high ginning outturn of 38 per cent. With a medium staple quality, the culture is capable of spinning 30s to 40s count yarn. Based upon its yield superiority, culture CWROK 165 was identified for release in the South Zone states.

In the Coordinated Rainfed Varietal Trial (South Zone) also, culture CWROK 165 recorded the highest yield of 10.5 q/ha, but was only marginally superior to the local check (10.4 q/ha). Culture M5KD 26 (8.8 q/ha) was however inferior to the local checks. However, both the cultures were found to be superior to the common check LRA 5166 (6.4 q/ha).

In the National Varietal Trial, two medium staple varieties CCH 727 and CSH 1071 were tested at 19 locations. In the Central Zone, culture CCH 727 (10.8 q/ha seed cotton yield; 37.2 per cent ginning outturn) ranked fifth and was promoted to the Preliminary Varietal Trial. However, in the South Zone, both the cultures viz., CCH 727 (14.5 q/ha) and CSH 1071 (14.9 q/ha) have been promoted to the Preliminary Varietal Trial, because of their yield superiority over the check variety LRA 5166 (13.2 q/ha).

In the Institute common varietal trial conducted both at Nagpur and Coimbatore, Culture 41431(10.3

q/ha) and CCH 526612(9.50) were superior to the common check variety LRA 5166 (8.7 q/ha) and have been entered in the National Varietal trial.

In the station trial, 32 cultures were tested along with LRA 5166 and Anjali as checks. Four cultures recorded significantly high yield than the best check variety LRA 5166 (10.2 q/ha). Culture NCH (M 5x1412) 45 recorded the highest yield of 16.9 q/ha, followed by RCH 5267-26 (15.59 q/ha), M5 KD 93-3 (15.0 q/ha) and (RCH x L) 8133 (14.8 q/ha).

In another trial, 14 cultures were tested along with LRA 5166 as control. Three cultures viz., RR 1007 124-3 (13.4 q/ha), RR 1017-6121 (13.3 q/ha) and RR 1007-123-4 (12.1 q/ha) were significantly superior to the check variety LRA 5166 (6.6 q/ha). Culture RR 1007-124-3 recorded the highest ginning out turn of 41.3 per cent.

P1-89/3-ICR-F30/0430:**Development of high yielding and high spinning extra long staple cotton** (S. Manickam and K. N. Gururajan).

In *G. hirsutum*, crosses were effected between good agronomic types like MCU5, HLS 72, VRS selections and several other genotypes. The performance of the promising progenies is furnished in Table 5.

Table 5. Variability in long staple *G. hirsutum* genotypes

Sr. No	Cross	No. selected	Bolls/plant		Ginning %	
			Mean	Range	Mean	Range
1	L (RCH x T13)	34	33.0	17-60	35.1	32-40
2	VRS x LSDC 3	16	27.9	10-42	33.8	27-40
3	VRS (T13 x VRS) VLV	12	24.1	15-48	32.6	30-37
4	VRS x HLS	13	32.8	12-72	32.8	31-35
5	HLS 72 (T13 x VRS)	9	35.4	20-49	35.3	34-37
6	HLS 72 (T13 x VRS) VLV	8	22.9	13-39	34.6	31-40
7	LSDC2 x LSDC3	10	28.3	23-38	35.9	35-37
8	MCU5 VT (C)	3	39.0	29-45	31.0	29-33

In the *G. barbadense* improvement work, five intra-*barbadense* hybrids were evaluated with Suvin as the check. The hybrids viz., B1 x B5 (7.0 q/ha) and B4 x B5 (6.5 q/ha) were statistically superior to Suvin in yield and ginning out turn.

P1-89/1-ICR-F30-0430: **Development of extra long staple and high spinning hybrids of interspecific origin with wider adaptability** (S. Manickam and K.N. Gururajan).

Nine interspecific hybrids were tested along with CDHB 1, TCHB 213 and DCH 32 as checks. Two hybrids viz., V 105 x B4 (11.1 q/ha) and NGP 8 x P 23 (10.4 q/ha) were found to be statistically superior to the popular hybrids TCHB 213 (6.5 q/ha) and DCH 32 (5.8 q/ha). However, they were on par with the hybrid CDHB 1 (10.1 q/ha). Hybrid NGP 8 x P 23 recorded the highest ginning out turn of 35.7 %.

Ad hoc Project : **Maintenance and evaluation of cotton germplasm** (S. Manickam).

In Br-01 trial, two sets each of 100 accessions of *G. hirsutum* and *G. arboreum* were evaluated for yield, quality and reaction to pest and diseases, along with

local check varieties viz., LRA 5166 and K 10, respectively for *G. hirsutum* and *G. arboreum*. The set I comprised accessions of 1997-98 evaluated consecutively for the third year and the set II comprised accessions of 1999-2000 evaluated for the first year. The accessions were also screened for reaction to jassids, *Alternaria* and grey mildew. Apart from this, about 150 accessions of *G. barbadense* and about 400 accessions of *G. hirsutum* being maintained in the station were also evaluated for yield and quality. Wide range of variability was recorded in all the species. About 93 accessions of *G. barbadense* received from National Bureau of Plant Genetic Resources, New Delhi were also multiplied.

P1-89/5-ICR-F30-0430 : **Development, maintenance and utilization of cytoplasmic and genetic male sterility for hybrid seed cotton and fertility restoration in cotton** (T. Gunaseelan).

Development of male sterile system

A total of 35 cytoplasmic male sterile (CMS) lines were maintained and promising genotypes identified were included for conversion. Promising varieties identified at the multi-location testing viz., HLS 329, HLS 72 and 29F were initiated for conversion. These are maintained by recurrent back cross methods.

In addition to the eleven genetic male sterile (GMS) lines developed, promising interracial cross derivatives viz., IRH 1-4, IRH 1-6 and the already released varieties were initiated for conversion. The developed GMS lines are maintained by sib mating.

Fertility 'R' gene transfer from Pima restorer *(barbadense)* and Deshaf 277 and Mex (*hirsutum*) to 13 promising *hirsutum* varieties was undertaken. They are in various stages of backcrosses. In addition to the successful development of Suvin restorer utilizing the 'R' gene from Pima restorer in *barbadense* background, transfer of 'R' gene from Pima restorer to four other varieties viz., SB 289F, SB 425 YF, C17 and P4 were taken up.

The *aridum* source of cytoplasm has been successfully developed from the synthetic hexaploid derivative involving *G.aridum* with a *hirsutum* variety. The plant is maintained by sib mating to avoid loss of source. The *aridum* CMS source is being crossed with many varieties viz., 19, J, 6, 29F, Sn, P39, LH 14, IRH 1-4 and HS3. They are in the first backcross stage. Several test crosses were done to study whether the fertile ones of the *G. aridum* source restore the fertility under *G. harknessi* background.

Development of male sterile hybrids

A trial with 31 male sterile based hybrids along with the control conventional hybrid Savita showed 29.7 per cent increase for boll number, 18.9% for lint index, 20.5% for ginning outturn and 64% for seed cotton yield. Cms Ali x D III (1) and Cms RK x M gave a seed cotton yield of 33.6 and 34.1 q/ha compared to Savita's 22.1 q/ha. The fibre characters viz., 2.5 span length, uniformity ratio, micronaire, bundle strength 1/8" g/tex are all comparable with the conventional extra long staple hybrid Savita.

In the case of GMS hybrids, Gms J 34 x 19, Gms 2 x 19, Gms 12 x 19 gave an yield of 23.8, 23.7 and 23.6 q/ha respectively compared to Savita (15 q/ha). In the case of fibre characters, 2.5% span length was comparable to Savita's 31.3 mm and 19.5 g/tex of bundle strength also.

P1-89/6-ICR-F30/0430: **Inter specific and inter racial hybridization and gene transfer in *Gossypium*** (T. Gunaseelan).

Seventeen cultures selected from six different combinations involving the non cultivated races *Palmeri* and *Morrilli* were tried along with control LRA 5166. The increase for boll number was 31 %, 39 % for boll weight, 77 % for lint index, 27 % for ginning outturn and 55 % for seed cotton yield over LRA 5166.

In the advanced culture trial involving the three way cross combinations when compared with LRA 5166 showed that the increase for boll number was 64%, 28.4 % for boll weight, 47% for lint Index and 76.4 % for seed cotton yield.

In the 29 other advanced culture trial, several promising cultures were obtained. The increase over LRA 5166 for boll number was 45.6%, 61% for boll weight, 73.9% for lint Index, 23.7% for ginning out turn and 63.4% for seed cotton yield.

In the trial involving the race *Palmeri* with a *hirsutum* variety, the per cent increase for boll number was 43.4, 58.7 for lint index, 22.8 for ginning outturn and 69.9 for seed cotton yield.

In order to induce earliness in the inter racial cross derivatives and in three way cross derivatives, several early to medium cultures like AC 122, IC 461, 4727 were crossed. Nineteen cultures were selected out of this and tried in a trial. The increase over LRA 5166 was 39.1% for boll weight, 54% for lint index, 22.8% for ginning out turn and, 49.1% for seed cotton yield .

Another trial, with 15 cultures showed that the per cent increase for boll number was 48.7, 75 for boll weight, 46.2 for lint index and 101.8 for seed cotton yield.

Based on the promising performances of these advanced cultures, two entries have been entered in the National trials.

Sirsa

Collection, conservation, evaluation and maintenance of genetic resources (S K Verma).

One thousand and one hundred accessions were evaluated and maintained. Data of top ten lines for a particular trials alongwith important characters are given in Table 6.

Table 6. A.G.*hirsutum*

S. No.	Name of accession	Seed cotton per plant (g)	Boll wt. (g)	Mean halo length (mm)	G.O.T. (%)
1	DP 45 A (y)	90.0	3.2	20.6	34.5
2	E 460 x *G.herbaceum*	70.0	3.2	22.1	34.0
3	C 38 (SN)	68.0	3.2	21.8	34.0
4	CP 1512	65.0	3.0	21.3	34.0
5	Delcot-B	57.0	2.9	22.7	33.5
6	K 3122 DC 491	55.0	2.8	19.7	35.0
7	LL-90	50.0	2.8	22.4	35.0
8	Culture 21	47.5	3.1	20.1	35.1
9	C 38 Fuzzy	46.3	3.5	19.3	36.0

- Twenty working collection of G.*hirsutum* were crossed with five best commercial varieties namely HS-6, F-846, H-1098, LRA 5166 and LRK 516 in a line x tester fashion. Next year these will be sown in line x tester design with three replications.

- 141 single test crosses were attempted using working collection of G.*hirsutum* with best commercial varieties namely HS-6, F-846, H-1098, LRA 5166, LRK 516, BN, RS-875 and RST-9.

- The crosses (F_1s) attempted during 1998-99 were raised and the F_2 seed harvested. Forty five single plant selections were made.

Colour cotton.

The accessions of colour cotton were grown during 1998-99 and during 1999-2000. The crosses attempted during 1998-99 were advanced to F_2 which will be sown for the further evaluation during the next season.

P1-85/2-ICR-F30/0430: **Evaluation of parents in G.*hirsutum* for heterotic potential and useful heterosis for replacement of existing cultivars under north Indian conditions** (O. P Tuteja).

Demonstration trial

The trial consisted of 12 hybrids and six cvs released for the North zone. Each entry was sown in an area of 48.6 sq. m. and the spacing was kept at 67.5 x 60 cm for hybrids and 67.5 x 30 cm for varieties. The hybrid CSHH 98 gave the highest seed cotton yield of 3095 Kg/ha. followed by CSHH 89 (2881 kg/ha) as compared to 2716 kg/ha and 2469 kg/ha of hybrids Om Shankar and Ankur 651, respectively (check hybrids).

The highest 2.5% span length of 28.4 mm was recorded by the hybrids CSHH 86. The ginning out turn ranged from 29.8 to 36.0 per cent.

Evaluation of F_1 Crosses

The F_1 hybrids were evaluated in different trials for assessing their performance and to carry them to F_2 generation.

(i) Local Conventional Hybrid Trial 1

The trial comprised 12 hybrids and was evaluated in comparison with F 846 and Om Shankar, the popular cultivars of North zone. Only CISHH 6 and CISHH 8 recorded significantly higher seed cotton yield over the local checks. The 2.5% span length ranged from 23.8 to 27.4 mm. The highest ginning out turn of 36 per cent was recorded by the four hybrids viz., CISHH 3, CISHH 6, CISHH 9 and CISHH 10.

(ii) Local Conventional Hybrids Trial 2

The trial comprised 18 hybrids and was evaluated against local checks F 846 and Om Shankar, in randomized block design with two replications of three rows each. CISHH 14, CISHH 19, CISHH 18, and CISHH 28 recorded significantly higher seed cotton yield (33.26 to 40.12 q/ha) over the highest yielding local check Om Shankar (25.37 q/ha). The 2.5% span length ranged from 23.4 to 27.1 mm. The highest ginning out turn of 37.0% was recorded by the hybrids CISHH 16, CISHH 18 and CISHH 22.

(iii) Local Conventional Hybrid Trial 3

In this trial, 28 hybrids were tested against the local checks F 846 and Om Shankar in randomized block design with two replications of one row each. CISHH 45, CISHH 43, CISHH 32 and CISHH 56 recorded significantly higher seed cotton yield (23.32 to 24.69 q/ha) as compared to highest yielding check hybrid Om Shankar (19.2 q/ha). CISHH 35, CISHH 40 and CISHH 49 recorded the highest ginning out turn of 38.0 per cent, whereas the 2.5% span length ranged from 22.8 to 27.4 mm.

(iv) Local Conventional Hybrid Trial 4

The trial comprised 44 hybrids and was evaluated in comparison with F 846 and Om Shankar. Hybrids CISHH 60, CISHH 68, CISHH 79, CISHH 95, CISHH 100, CISHH 101 and CISHH 103 gave more than 50% increase over both the checks. The higher yield of these hybrids were due to increase in boll number and boll weight. The 2.5% span length ranged from 21.5% to 28.2 mm, whereas the ginning out turn ranged from 32.0 to 38.0 per cent.

GMS based hybrid Trial

This trial comprised 19 GMS based hybrids, which were evaluated in comparison with F 846 and Om Shankar. The highest yield of seed cotton

was recorded by the hybrid CISHHG 2 (220 g/plant) followed by CISHHG 7 (190 g/plant), CISHHG 18 (172 g/plant) and CISHHG 5 (160 g/plant), as compared to 110 g/plant, 65 g/plant of Om Shankar and F 846 respectively. The ginning out turn of GMS based hybrids ranged from 32 to 38 per cent and the 2.5% span length from 24.1 to 29.1 mm.

Conversion of potential parents into cytoplasmic male sterility background

- The work on transferring of cytoplasmic male sterility to adapted genotypes of North zone background was initiated in 1990-91. Cytoplasmic male sterility has since been transferred to H777, F 414, LH 1134, P31, RB 281 and Jhurar.

- Programme of transferring cytoplsamic male sterility to the female parent of hybrid Om Shankar and a number of other lines has been undertaken and is in advanced stages of development.

- In order to identify new restorer lines, a large number of crosses were attempted between CMS lines and potential male parents/germplasm lines maintained at the station. Five crosses have shown fertility restoration that will be confirmed during 2000-2001.

- A number of fresh crosses have been attempted between male sterile lines and germplasm lines to identify the suitable restorer lines.

- One hundred and fifty fresh crosses were attempted between local adapted cultivars as female parent and the various germplasm lines as male parent. The crosses will be evaluated in different station trials.

- To develop the GMS based hybrid, 32 crosses have been attempted between K 34, J 34, MCU 5 and GMS 13 lines and eight germplasm accession as male parent identified as good combiners in the earlier studies.

Breeding for heterosis

Based on performance of different cross combinations in the Station trials, the seed of promising hybrids was produced in large quantity in order to test them in AICCIP trials and Station trials of large plot size. The hybrids CSHH 25, CISHH 85 were sponsored in the zonal trial and CISHH 130 in the National trial Br 05 (a) 1.

Selection from the segregating generations

- One hundred and twenty F_2 populations were grown and 208 single plant selections having desirable traits for yield, quality characters, and resistance to CLCuV were made. The single plant progenies, will be grown in the coming *Kharif* season.

- From F_3 progenies, 39 selections were advanced to F_4 generation.

- One hundred and sixty two plants selected from the F_5 generation were advanced to F_6 generation

P1-85/4-ICR-F30/0430: **Development of varieties and hybrids of medium staple length in *Gossypium arboreum*** (O P Tuteja).

(1) Demonstration of promising Strains

Eleven promising selections developed through interracial hybridization were evaluated against local checks DS 5, RG 8 and LD 327. The trial was conducted in randomized block design with three replications of six rows each.

The strain CISA 9-3 (2820 kg/ha), CISA 9-10 (2463 kg/ha) and CISA 9-8 (2184 kg/ha) significantly out yielded the check varieties RG 8 (1622 kg/ha) and LD 327 (1785 kg/ha). Three strains viz. CISA 40-5, CISA 17 and CISA 9-17 gave 39 per cent ginning out turn, at par with the check variety LD 327. The highest 2.5% span length of 19.7 mm was recorded by the strain CISA 9-10.

In the common institute trial comprising 13 entries (10 coded entries from Nagpur and three from Sirsa) were evaluated against local check HS 6 and H 1098. Entry CSHH 85 of CICR Regional Station, Sirsa and T14 of CICR, Nagpur recorded higher yield during this year. The higher yield in entry no. 14 is because of more no. of bolls and in CSHH 85 due to higher boll wt. Incidence of CLCuV was noticed in entry T2, T3, T13, T18 CSHH 28, CSHH 68 and CSHH 85.

2. Initial Evaluation Trial of *G.arboreum*

The station (IET) trial consisted of 26 entries selected from the segregating generation and were evaluated in comparison with check varieties RG 8 and LD 327. The trial was sown in unreplicated plot size of two rows for each entry.

The entries CISA 3, CISA 21, CISA 34 and CISA 46 recorded more than 40% increase over the highest yielding check variety LD 327. The higher yield of these strains was mainly due to more number of bolls per plant and boll weight. The 2.5% span length of 24.7 mm. The strains CISA 33 and CISA 66 recorded 42% ginning out turn as compared to 40% of LD 327.

3. Development of GMS based Hybrids

The large quantity of seed of DS-5 GMS line was multiplied and 16 GMS based hybrids involving medium staple genetic accession were evaluated. The performance of various GMS based hybrids of *G.arboreum* were tested.

The cross combinations CISAAG 11 (3697 kg/ha), CISAAG 3 (3497 kg/ha) and CISAAG 4 (2881 kg/ha) significantly out yielded the check varieties RS 8 (1622 kg/ha) and LD 327 (1785 kg/ha). The boll weight ranged from 1.9 to 2.6 g and the 2.5 span length ranged from 15.3 to 21.5 mm. The CISAAG 7 recorded the highest 2.5% span length of 21.5 mm. The cross combination CISAAG 1, CISAAG 3 and CISAAG 8 have given the ginning out turn of 40.0 per cent.

Seed Technology

Nagpur

P1-92/2-ICR-F25/0430 : **Effect of different environmental conditions on seed yield and quality of varieties and hybrids in cotton** (R.K. Deshmukh and P.R. Vijaya Kumari).

Studies in relation to hybrid seed production and quality

Studies on boll setting, seed yield and germination were made with one GMS based hybrid (CCHHG 1) and one conventional hybrid (CNHH 102). The crossing period of 60 days was divided into four phases (P1, P2, P3 and P4) each of 15 days interval. Boll setting was 32.6, 29.7, 29.0 and 27.0% during four phases respectively in conventional hybrid (CNHH 102). However, it was 55.8, 43.2, 37.1 and 36.3 per cent respectively in GMS based hybrid during different phases.

Yield in conventional hybrid (female parent i.e. hybrid seed per plant was 38.2, 29.8, 24.2, 20.5 in different phases (P1 to P4) and yield per plant of hybrid seed in GMS system was 44.9, 42.0, 21.6 and 14.0 in different phases. Germination percentage in conventional hybrid was 82.1, 83, 70.8 and 68.6 in different phases while in GMS hybrid it was 84.8, 78.8, 70.5 and 67.8 respectively.

Reciprocal crosses of three released hybrids viz. CICR HH1, NHH 44 and H6 were evaluated in terms of impact on seed production and quality. The yield and boll setting were higher in reciprocal crosses of CICR HH1 and H6, as compared to direct crosses. However, the germination percentage was not much affected.

Seed cotton yield per hectare was 16.10 and 13.44, 11.26 and 13.27, 10.96 and 10.88 in straight and reciprocal hybrids of NHH 44, CICR HH1 and H6, respectively.

A Common Hybrid Trial was conducted at, Nagpur and Coimbatore. CIHH 101 (8.30 q/ha) at

Nagpur and CCHy 10555 (13.44 q/ha) at Coimbatore recorded the highest seed cotton yield against the check NHH 44 with 7.48 q/ha and 10.76 q/ha at Nagpur and Coimbatore, respectively.

Three newly developed CMS hybrids were tested alongwith two leading hybrids NHH 44 and PKV Hy-2. Yield (q/ha) obtained was 9.06 from CMS 12, 6.06 from CMS 10 and 3.99 from CMS 11 compared to 13.00 from PKV Hy-2 and 13.72 from NHH 44 which shows that no CMS hybrid is at par with conventional hybrid.

Hybrid seed of PKV Hy-2 and PKV Hy-3 was produced by conventional and reconstituted way and these hybrids were tested for performance alongwith AK 32, DHY 286-1 and DHY 286-1-R. Seed cotton yield obtained was 11.30, 10.23, 5.31, 16.56 and 12.69 q/ha from AK 32, DHY 286-1, DHY 286-1-R, PKV Hy-2 and PKV Hy-3 respectively. This shows that conversion of hybrid parents has adverse effect on yield.

Sirsa - (R. A. Meena)

To study the effect of different environmental conditions on seed quality and seed yield, six common cultivars i.e. H777, LRA5166 and Suman of *G.hirsutum* and LD 327, AKH 4, and K10 of *G.arboreum* were sown at Nagpur, Coimbatore and Sirsa. Under Sirsa conditions the seed yield, seed index, germination, and vigour index were higher in the varieties recommended for this zone i.e. H 777 and LD 327 followed by central zone (varieties LRA 5166 and AKH 4). The seed yield and quality in South zone (varieties K10 and Suman) were poor when produced under North zone conditions.

Performance of new hybrids bred by private seed companies (R. K. Deshmukh).

Performance of twenty two new hybrids bred by private seed companies was evaluated in field with larger plot size. The highest yield of 15.74 q/ha was recorded by the hybrid T9. The yield of check hybrids i.e. NHH 44 and PKV Hy2 was 12.12 and 10.97 q/ha respectively.

Seed of three hybrids viz. H6, NHH 44 and CICR HH1 (direct and reciprocal crosses) and their parents were produced, processed and stored in cotton cloth bags under ambient conditions. Hybrid H6 and its parents (F x M) exhibited better storability then other two hybrids and their parents. This hybrid recorded higher initial germination as well as germination after one year.

Coimbatore

P1-97/1-ICR-F-25/0430: **Studies on viability, vigour and longevity of cotton seeds**
(K. Rathinavel, P. Chidambaram and K. Natarajan).

A field experiment was conducted with three different dates of sowing viz., 4th August, 16th August and 31st August, 1999, using the parents of hybrids Savitha, Surya, Sruthi, HB 224, Kirthi, LHH 144 and NHH 44. Sowing the parents on 4th August reduced the boll setting efficiency by 20% than on 16th August besides higher infestation of stem weevil and alternaria leaf spot. Delayed sowing (31st August) also reduced the boll setting efficiency by 5%. However, the seed quality and yield of parents were higher in case of sowing on 16th August and 31st August.

A field experiment was conducted using the seeds of CMS based cotton hybrid DMSHH-4 (DMSA-1 x DR-4) to study the synchronisation of flowering between parents and resultant hybrid seed quality. The results revealed that the flowers produced in the male parent were sufficient when sowing was taken up in either of the following methods.

Sowing I : 50% male along with female, remaining 50% after 10 days of 1st sowing.

Sowing II : 50% of male, 10 days after 1st sowing all female + 50% remaining male.

Another field study confirmed the results of previous year that delinted seeds of LRK 516 with less specific gravity (low seed index) produced poor and low

vigour seedling initially and there after attained reproduction potential equal to that of seeds with high specific gravity (high seed index) and the yield was near parallel.

The seed storage experiment conducted under ambient conditions with the CMS based cotton hybrid PKV Hy.3 and its parents (AK-32-A, AK 32 B, DHY 286-1-R) packed in cloth bag and stored in the laboratory revealed that loss of viability is more in maintainer and restorer lines than in CMS line and hybrid after 10 months of storage.

A storage experiment was conducted in the laboratory under ambient condition with LRA 5166 seeds treated with Carbendazim @ 2g Kg^{-1}, iodine formulation @ 3g Kg^{-1}, Imidacloprid @ 5g Kg^{-1}, Neem leaf powder @ 10g Kg^{-1} and Neem kernel powder @ 10g Kg^{-1} along with untreated seeds (Control) and packed in cloth bag, poly lined cloth bag and poly ethylene laminated paper aluminium foil pouch (PAF pouch). The initial mean seed viability of 83% was reduced to 57% in polylined cloth bag, 52% in cloth bag and 44% in PAF pouch after 15 months of storage period. Among the seed treatments, Neem leaf powder and neem kernel powder had little higher efficiency compared to other treatments in controlling the seed deterioration in all the containers.

Another storage experiment was conducted under ambient condition in the laboratory with cleaned untreated seeds of six genotypes viz., LRA 5166, Surabhi, Suman, H 777, AKH-4 and LD 327 packed in paper bag, cloth bag, polythene bag, PAF pouch and Polyvinyl bag. The trimonthly assessment of seed viability and vigour exhibited the better storability of Surabhi in paper bag; Suman and AKH-4 in cloth bag, AKH-4 and LD 327 in polythene bag; Suman, H 777 and AKH-4 in polyvinyl bag after 21 months of storage period.

An experiment with following pre sowing seed treatments was conducted in the laboratory and under field conditions. .

T0 Control

T1 Hydration (16-18 h) and drying at RT (below 25°C)

T2 Cold hydration 72 h at 10°C

T3 Hydration with 100 ppm GA3 (16-18 h)

T4 Osmo conditioning in PEG at 10 bar at 15°C

T5 T1 + dry dressing with Carbendazim @ 2g Kg^{-1}

LRA 5166 seed lots of following standards were used in the study.

A High level of germination

B Germination upto MSCS but low vigour

C 5-10% lower than MSCS

Improvement in seed quality due to seed treatments was found less or Nil in Lot A and B. However, in lot C, the initial germination of 57% could be increased to 73% by T3 and to 78% by T5.

Sirsa

Studies on seed technological aspect of hybrid and varietal seed production under north zone (R A Meena, O P Tuteja and D Monga).

- Suitable crossing period for higher hybrid seed yield and superior seed quality

To identify the suitable crossing period for higher boll setting, higher seed setting, superior, seed quality and less incidence of disease on seed, a study was undertaken on all the released hybrids of North zone i.e. Om Shankar, Maruviakas, Dhan Laxmi, Fateh and Kirti. The boll setting (%), seed setting (%), seed index, germination (%) and vigour index values were higher during second and third crossing stages i.e. 16th Aug. to 15th Sept.

- Picking wise seed quality of varieties

In the varieties, seed index, germination (%) and vigour index were higher in the seed from second picking followed by first picking. Lower values of these parameters were recorded in seeds of last picking.

Storage potential of seed of hybrids and varieties

To assess the storage potential of each hybrid and variety, 500 gm fresh delinted seed after recording data on germination (%) and vigour, was packed in cloth bags and stored under room conditions. From stored seed at trimonthly interval, data on germination (%) and vigour index were recorded. In hybrids no significant reduction in germination and vigour upto nine months was noticed during storage. Gradual decline in germination percentage and vigour was observed after this period. At 15th month of storage (last observation period) all the hybrids maintained germination above certification standard. In varieties also no much reduction in germination and vigour was observed upto nine months of storage. After that, gradual decline in germination and vigour was noticed and at 15 months of storage the germination (%) was below certification standard (65%) in variety LRA 5166. The germination (%) in several other varieties was also noticed to be near certification standard during this period.

Studies on seed development

Seed development behavior was studied in the five genotypes H 777, RST 9, F 505, H 1098 and F 846. In each variety about 600 flowers (200 per replication in three replications) were tagged on the day of anthesis. Ten random bolls at each five day intervals from tagged bolls were picked and data on seed index, moisture (%), germination (%) and vigour index were recorded. The seed index in all the cultivars was very low during early stage of seed development, thereafter it increased gradually and reached maximum level on 60th day in all the cultivars. The moisture content of seed was highest at the beginning, and declined gradually and reached lowest at 60th day. The rate of reduction in moisture content was higher after bursting of bolls (30th days). The developing seed started germination at around 30th day of seed development but at this time germination percent was very low. It increased gradually and at 60th day the germination (%) was highest. Similar trend was also observed for vigour index.

SPECIAL RESEARCH SCHEMES

Development of Hybrid Crops in the Mission Mode under the National Agricultural Technology Project (NATP)

Nagpur

Principal Investigator : M.S.Kairon,

Co-PI : Suman Bala Singh

Associated Scientists, : P.Singh, V.Gotmare, N.K.Taneja, S.Vennila and M.K.Meshram

A1. To develop high yielding, medium staple and short duration hybrids with required fibre quality having resistance/tolerance to major pests, diseases and drought using available male sterile sources.

Thirty six CMS, 11 GMS and seven R-lines were maintained. Thirty CMS lines were evaluated for yield, morphological and economical characters. Some local and promising genotypes including selected genotypes of working collection of germplasm are being converted into CMS, GMS and R-lines - 70 lines are under conversion for CMS, 32 for R-lines and 16 for GMS. Two lines viz. LRA 5166 and SRT 1 have been converted into GMS background.
They showed 1:1 segregation for fertility and sterility.

Evaluation of F_1 : In all, 142 GMS and 334 CMS based hybrids were evaluated during the season in six different trials. NGMSH 22 (1639 kg/ha), NGMSH 7 (1522 kg/ha), NGMSH 14 (1502 kg/ha), NGMSH 67 (1565 kg/ha) and NGMSH 75 (1496 kg/ha) were some of the good performing hybrids in different trials.

CMS hybrid, NCMSH 18 was at par with the check CAHH-8 which recorded 986 kg of seed cotton. Two hundred and seventy three CMS hybrids were evaluated for (i) fertility restoration, (ii) yield potential for the new R-lines under development; 149 hybrids were fertile and 124 were male sterile. NCMSH 321 recorded 1667 kg of seed cotton/ha. During the crop season, 190 GMS and 210 CMS crosses were affected.

A2 : Breeding for early maturing intra-interspecific 'desi' cotton hybrids for different agro-climatic zones and evaluation of fibre properties.

Two GMS lines were sown for maintenance (Akola and Hisar source). However, Hisar GMS lines could not survive due to wilt infection.

Four genotypes are under conversion. This year, the material was in F_1. BC_1 will be made next year with the male sterile plants.

Six GMS hybrids were evaluated in non-replicated trial using AKH 4 and DH 9 as checks. In these crosses, heterosis ranged from 15.06 to 57.64% over AKH 4 and from 7.55% to 47.34% over commercial diploid hybrid DH9. The highest useful heterosis was exhibited by the hybrid GAA 1 (47.34%) followed by GAA 2 (34.69%).

Three hybrids viz. GAA 2, GAA 5 and GAA 6 had long staple. The ginning percent was more than 38 in five hybrids.

Twenty two crosses were affected using Akola male sterile line and important varieties/germplasm lines.

A3 : To identify, develop and diversify the cytoplasmic and genic sources of male sterility and effective, stable restorer genes with fertility enhancing factors in *G. hirsutum* and *desi* cottons.

Sixteen crosses using 14 wild and two cultivated species were evaluated in non-replicated trials. No male sterile plant was observed in F_1.

Nine new crosses were effected involving seven wild species viz., *G. anomalum, G. barbosanum, G. klotschianum, G. aridum, G. harknessii, G. stocksii, G. bickii* and two cultivated species *arboreum* and *hirsutum*. Limited number of seeds were obtained.

Advanced breeding material of two interspecific crosses was evaluated for yield, fibre properties, disease and insect resistance, plant type. Based on these observations, ten single plant selections were made.

New male sterile source *G. aridum* was evaluated. CAK 32 A, AK 32 B and 89 R (*G. aridum* based) were procured during the season. Crosses were effected for maintenance, conversion and F_1 evaluation.

A4 : Screening of germplasm and identification of immune/resistant sources from the breeding material for CLCuV and other diseases and to utilise them in the development of resistant hybrids.

One hundred *arboreum* germplasm lines were screened for *Alternaria* leaf spot and grey mildew. Sixteen entries viz. 30847, 5974, 6187, 30797, 30805, 30807, 30816, 30841, 1011, 6040, 8251, 30814, 30815, 30817, 30843 and 30856 showed immune/resistant reaction. Tamcot CAMD-E, UKA-B1 (72) 049 and UKA BA (72) 54 were immune to bacterial blight and TAM 86-DD-11, TAM-86-E-14, BJA-81-Nect, TAM-2055 and PD-9232 were found resistant to bacterial blight.

Sixty one CMS and 64 GMS based hybrids were observed for *Alternaria* leaf spot, grey mildew and bacterial blight under field condition. None of the CMS and GMS hybrids were found to be immune to *Alternaria* leaf spot. However, 13 CMS and six GMS hybrids showed resistance to *Alternaria* and five CMS and 20 GMS hybrids did not show grey mildew incidence.

A5 : Screening of germplasm and identification of resistant sources from the breeding material for bollworms and sucking pests and their utilisation in the development of resistant hybrids.

Sixty one CMS and 64 GMS based hybrids were evaluated for reaction to sucking pest (jassids, whitefly) and bollworms (spotted, American and pink bollworms).

Host Plant Resistance to CMS hybrids : As the resistant and susceptible checks themselves did not differ for population of sucking pests and bollworm damage due to low level of insect pest occurrence in the field, CMS hybrids could not be categorised either for sucking pests and bollworms. Based on performance, grouping of hybrids was done for sucking pest and bollworm complex. Hybrid viz. NCMSH 2, 11, 25 and 40 hold promise for further utilisation.

Host Plant Resistance in GMS hybrids : Thirty three hybrids showed tolerance to jassids and whitefly

while, 26 showed tolerance to bollworm damage on open boll basis and 33 to bollworm damage on loculi basis. Hybrids NGMSH 3, 16, 20, 22 and 32 showed high level of resistance to all the insect pests considered in the study.

Breeder Seed Production

Breeder seed production targets were met in full. The following quantities of breeder seeds were produced during 1999-2000 through the Institute, Central and State seed farms and distributed (Table - 7).

Table 7: Details of Breeder Seed Production.

	Hybrid / Variety	Production Centre	Indent (in quintals)	Production (in quintals)
1	Savita	CICR, Coimbatore		
	T7		00.51	01.30
	M 12		00.30	00.53
2	Sruthi	CICR, Coimbatore		
	70 E		-	00.40
	RS P4		-	00.20
3.	LRA 5166	CICR, Sirsa		1.45
		CICR, Nagpur		06.90
		CICR, Coimbatore		01.64
		SSF, Sathy, TN		03.21
		SSF, Pongalur,TN.		03.70
		Total	**14.76**	**16.90**
4.	LRK 516	CICR, Sirsa		01.50
		CICR, Nagpur		3.60
		CICR, Coimbatore		01.78
		CSF, Chengam, TN		3.20
		Total	**09.12**	**10.08**
5.	MCU 5 VT	CICR, Coimbatore	**02.80**	02.12
6.	Surabhi	CICR, Coimbatore		01.08
		SFS, Pongalur, TN		02.10
		Total	**00.50**	**03.18**
7.	Suvin	CICR, Coimbatore		00.51
8.	Supriya	"		1.56

Biotechnology

Nagpur

Development of tissue culture protocol in cotton for use in breeding and genetic transformation (S. B. Nandeshwar and A. B. Dongre).

Establishment and performance of RD Plants

Plant derived from multiple shoot induction of cultivar PKV 081, LRA 5166, LRK 516, Khandwa-2 and Indore-2 were successfully hardened and established in the soil. Plant growth was straight with zero branching habit. Plants flowered normally, set bolls and seeds, however, their reproductive capacity was less compared to mother plants. The R_0 seeds collected will be sown this year as R_1 and yield and yield attributes characters will be recorded.

Somatic embryogenesis

Calli were induced from hypocotyl explants harvested from *in-vitro* germinated seedlings of cv. PKV 081 and Khandwa 2. The calli were asceptically isolated and periodically sub-cultured in callus induction medium. Calli have been transferred on embryo induction medium. Presence of globular pre-embryoids have been noticed in calli derived from some specific seedlings only.

Development of interspecific hybrids through embryo culture

Three hundred and twenty buds of cvs LRA 5166, PKV 081, MCU 5 were cross pollinated with diploid cv. AKH 4. Pollinated buds (15 DAP) were collected and their ovules were removed asceptically.

The ovules were cultured on embryo development medium containing NAA 1.5 mg/L and Kinetin 0.5 mg/L alongwith Caecin hydrolysate (250 mg/L). The cultures are being monitored for plant development.

Evaluation of cotton germplasm through molecular techniques (A.B. Dongre, S.B.Nandeshwar, G. Balasubramani, J. Amudha and V. V. Singh).

DNA Fingerprinting

Germplasm lines with different characters like fibre, jassid and bollworm resistance, and wild species were subjected for DNA isolation. High quality genomic DNA, checked by agarose gel electrophoresis and spectrophotometrically were used for further PCR amplification study.

Gene tagging

Gene introgression from the wild species to the cultivated species was studied by molecular marker technique. RAPD marker of 0.5 kb and 1.0 kb has been introgressed from the wild species *G. anomalum* into the cultivar MCU 5 (*G. hirsutum*).

Leaf curl virus resistant and susceptible lines were subjected for DNA isolation and characterized by RAPD analysis. Polymorphism exists between the susceptible and resistant lines. Generation of F_2 progenies for mapping the resistant gene is in progress.

One hundred and twenty germplasm lines were sown in the field and selfing has been done to maintain genetic purity. Electrophoresis and PCR analysis for molecular fingerprinting are in progress.

Development of Bt transgenic cotton (NATP - Mission Mode) (A.B.Dongre, S. B. Nandeshwar, G. Balasubramani and Keshav Kranthi).

Agrobacterium mediated transformation

Seedlings of Khandwa-2, Khandwa-3 and PKV 081, LRK 516, LRA 5166, H 777 and MCU 5 were raised in half strength MS medium without growth regulator. Shoot apex containing meristamatic tissue and embryo axis from mature seeds (4897 explants of above varieties) were infected with log phase culture of *Agrobacterium tumefaciens* LBA 4404 harbouring Bt Cry I A (b) and npt-II gene. The explants were co-cultivated for six to 48 hours and were subjected to selection in medium containing Kanamycin. Out of 4897 explants treated initially with *Agrobacterium*, 7-10 explants of cvs LRK 516, LRA 5166, H 777, MCU-5 and PKV 081 survived and are growing in shoot induction medium. Bioassay of three plants with three bollworms have been carried out. Results were not encouraging.

Dr. JNL Srivastava, Special Secretary, Department of Agriculture & Coop., Ministry of Agriculture, Govt. of India, addressing the delegates

Scientific Advisory Panel of the NATP Rainfed Ecosystem in session

Dr. C. R. Hazra, Commissioner of Agriculture, Govt. of India, delivering the inaugural address

Crop Production

Nagpur

Studies on the long term effect of nutrient management practices on the productivity, nutrient balance and sustainability of cotton based cropping systems (M. V. Venugopalan and Blaise).

G. hirsutum (LRK-516) grown in rotation after sorghum (C3), significantly out yielded *G. hirsutum* (C1 Cotton-Cotton) by 48.9% and had more number of bolls m^{-2}. Monocropped *G. arboreum* (C2 : Cotton-Cotton) gave 53.9% higher yield than monocropped *G. hirsutum* (C1) and recorded significantly higher number of bolls m^{-2}. Nutrient combination, N_{60} P_{13} and N_{90} P_{20} significantly improved seed cotton yields over N_{60} and N_{90} alone. Supplementing K with N had a significant effect only at higher K level (38 kg/ha). Treatment N_{90} P_{20} K_{88} + 15 t FYM/ha (substituting ½ N dose with FYM) increased the yield by 23.3% over N_{90} P_{20} K_{38} treatment. Response to higher NPK dose i.e. 90:20:38 over 60:13:15 was not significant for C1 monocropping system but it was significant in C2 and C3 cropping systems. This differential response was due to increased bacterial blight incidence with higher NPK dose in C1 cropping system.

Studies on nutrient balance in cotton based cropping system with special reference to secondary and micronutrients (Jagvir Singh).

Results of second year experiment on cotton based cropping system indicate that higher dry matter yield (30.1 q/ha) and seed cotton yield (11.2 q/ha) were obtained with recommended NPK + 10 t FYM/ha in sorghum-cotton rotation than cotton-cotton (8.6 q/ha) and cotton+soybean (8.3 q/ha) systems. Application of S @ 30 kg/ha with recommended NPK resulted in higher yield of soybean (7.8 q/ha) in soybean-soybean rotation system compared to cotton-soybean (5.7 q/ha) and cotton+soybean intercrop (5.1 q/ha) systems. N balance at the end of second year was positive in cotton-soybean plots and had higher soil-N than soybean-soybean and cotton+soybean plots. Build up of soil-N was also observed in NPK+FYM treatment. Soil available-S content (18 kg/ha) with NPK + S treatment in sorghum-cotton plots were higher than other cropping systems. Treatment NPK + FYM increased Zn content in seeds of cotton (18 ppm) and surface soil (0.28 ppm) over NPK alone in cotton-soybean system.

Effect of sulphur in cotton based cropping systems under irrigated conditions (Jagvir Singh).

The effect of sulphur on cotton based cropping systems viz. cotton-wheat and cotton-mustard with or without sulphur application was studied in field experiments under irrigated conditions at Sirsa. An increase in yield of seed cotton, mustard and wheat by 16%, 20% and 7% respectively, was noticed with continuous S application over no S. Maximum seed cotton (Omshankar) yield (15.6 q/ha), was obtained in cotton-mustard compared to cotton-wheat (12.5 q/ha) sequential cropping system. Similarly, higher N (40 kg/ha) and S (18 kg/ha) uptake by cotton and by mustard (35 kg N/ha and 21.5 kg S/ha) was recorded by applying S every year to both the crops. Sulphur content of surface soil (0-20 cm) has shown an increase from 10.5 to 15.8 kg S/ha in continuous S application in cotton-wheat cropping system.

Tillage and crop residue effects on soil, nutrient and cotton crop behaviour (Blaise, C. D. Ravindran and N. Gokte-Narkhedkar).

In the previous three years, with *hirsutum* cotton, minimum tillage plots yielded significantly better than the conventional tillage plots. In the fourth year of the study, *(G. arboreum) (*all the tillage treatments (conventional, reduced and minimum tillage) were found to be equally good with the yield level ranging from 8.86-8.94 q/ha. Similarly, no differences were found among the residue amendment (no residue, leaf, stem and leaf + stem) treatments. High rainfall and cloudy weather during the 36-40th meteorological weeks coincided with the boll formation period that resulted in 33% damaged bolls (unopened and boll rot). Minimum tillage with residue amendment is a moisture conservation practice and is found to improve yields in relatively dry years, as was observed in the first two years.

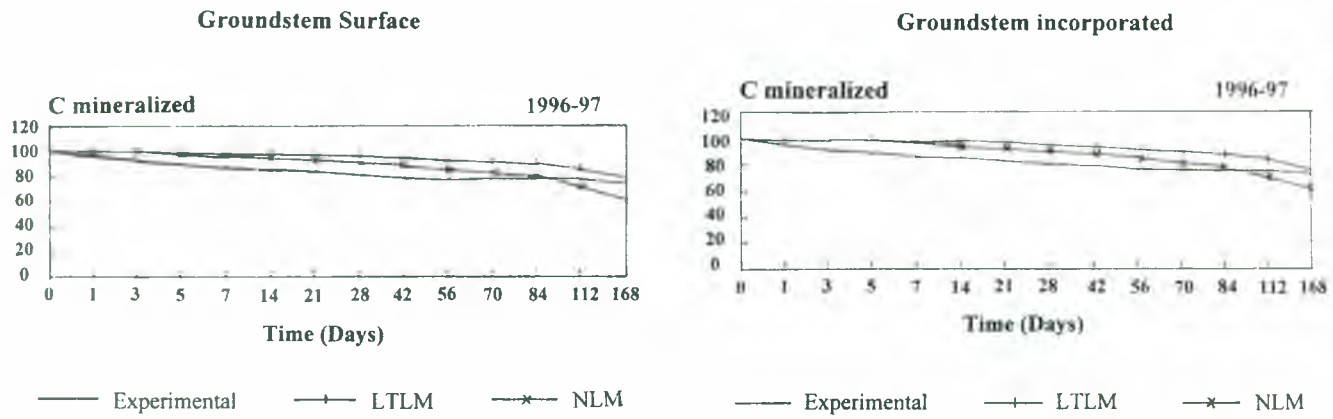
Although no improvement in yield was observed with the reduced and minimum tillage treatments, higher population of microfauna and microflora was observed. Pitfall traps were placed in the soil, flush with the soil surface and were removed after three days. The number of arthropoids in the conventional tillage treatment was 4.25 per trap per plot as compared to 7.5 arthropods plot^{-1} trap^{-1} in the minimum tillage treatment. Similarly higher number of arthropoids were observed in the leaf residue amended plots compared to the unamended plots. The ant nest density was also higher in the minimum tillage plots (0.14 m^{-2}), compared to 0.02 m^{-2} in the conventional tillage plots.

Plant parasitic nematode populations were highest in treatments with minimum tillage while lowest number of nematodes was recorded with conventional tillage indicating that disturbing the soil results in decline in nematode number. Different nematode species also responded differentially to different tillage treatments. Populations of *Rotylenchulus reniformis* were higher in disturbed soil i.e. in conventional tillage while lesion nematode *Pratylenchus* sp. population were higher under minimum tillage and thus indicating different ecological requirements of the two genera.

Soil microbial biomass-C (SMB-C) and SMB-N were estimated after fumigation. In the conventional tillage plots the microbial biomass was 0.19 mg C g^{-1} soil compared to 0.25 mg C g^{-1} soil in the reduced tillage plots and 0.24 mg C g^{-1} soil in the minimum tillage plots.

Cotton crop residue decomposition kinetics were studied in a laboratory experiment. Modelling of the decomposition data was attempted to estimate the decomposition rate constant by the log linear model ($\ln C_i = \ln Co\ kt_i$ $= C_i = C_o e^{k\,n}$) and direct estimation of k by non linear method. The decomposition rate constants for ground stem, leaf and stem was 0.00145, 0.00106 and 0.00094 day^{-1} by the log linear method. The corresponding values by using the non linear model was 0.00283, 0.00243 and 0.00205 day^{-1}. The values obtained by the non linear model are in reasonable agreement with the observed (Figure-1)

Fig. 1 : Carbon Decomposition Model



Adhoc Trial : **Evaluation of prometryne for phytoxicity and bio efficacy** (A.R.Raju).

Seed cotton yield, biomass and boll number / plant were significantly influenced by herbicide over control under rainfed condition. The three doses evaluated viz. 0.75, 1.00 and 1.25 kg a.i. ha^{-1} were not significantly different and was at par with farmers practice.

Under protective irrigations all doses were significantly better than control but only prometryne 1.25 kg a.i. ha^{-1} was found at par with farmers practice. Application of glyphosate as layby method, to control over grown weeds under heavy and continuous rains along with conventional intercultures was found to be superior to control and at par with chemical weed control.

Adhoc trial : **Evaluation of Glyphosate layby application** (A. R. Raju).

The layby application of glyphosate using a protective hood at 8-10 leaf stage was superior over 4-6 leaf stage due to efficient control of late emerging weeds. This treatment produced seed cotton yields similar to that of farmers practice and chemical control of weeds using trifluralin as pre plant (1.0 kg a.i. / ha) with two intercultures at 30 and 45 DAS and one hand weeding after first interculture.

Studies on improving the water use efficiency of harvested runoff through drip and fertigation (K.S.Bhaskar, A.R.Raju, J.V. Singh and G.Majumdar).

This was the second year of the study. The soil application of fertiliser at the rate of 120 : 60 : 60 and 150 : 75 : 75 did not show any significant difference but was superior to fertigation @ 150:75:75. The weedicide (Fluchloralin) @ 1 kg a.i./ha was superior to trifluralin at similar rate.

The water budget available in summer was worked out. With the available water and recharge after every 6-7 hrs, it is possible to irrigate half hectare of premonsoon cotton under drip irrigation 4 l/day/plant from a single well. During the crop growth period upto 3rd week of November, continuous heavy rains were received and soil moisture deficits were not observed. Therefore, no significant differences in yield were observed in the scheduling methods of irrigation (Table - 8). However, from 3rd week of Nov. to 3rd week of January, plants were irrigated with 1168 mm/plant to extend the crop growth period.

Table 8 : Scheduling methods of irrigation.

Treatment	Scheduling	1998	1999	Mean
I1	Gravimetric	11.26	11.58	11.42
I2	IW/CPE 0.75	13.13	11.50	12.31
CD		1.16	N.S.	

After 6 years of drip installation the uniformity of discharge from drippers along the lateral was found to vary from 75% more than the rated discharge at the beginning of the line to 15% less at the end of the line, due to pressure variations along the laterals. Coefficient of uniformity of drippers was found to be 69.88%.

Water spread from a single dripper after one hour of water delivery was also studied. The water front advanced uniformly in all directions with a radius of 30 cm from the emitter. The soil moisture percentages after 72 hours of irrigation are given in Table-9.

Table 9: Soil moisture percentage after 72 hours of irrigation.

Button No.	Soil Moisture Percentages		
	0-20 cm	20-40 cm	40-60 cm
A	31.57	30.71	22.69
B	29.87	28.20	27.38
C	27.38	28.20	25.00
D	28.20	26.58	29.03
Average	29.26	28.42	26.03

The water front advance in the initial stages of crop growth was found to be more than required by the plants.

Integrated nutrient management in rainfed cotton var. CNH-36 in soils of varying depths under supplemental irrigations (K.S.Bhaskar, A.R.Raju, J.V.Singh and G.Majumdar).

Similar to the previous years, under continuous

rains, shallow soils produced 27% more seed cotton yield over medium deep soils due to effective drainage. Scheduling of irrigation at peak boll development stage at 80% F.C. increased seed cotton yield by 17%, which was found to be non significant in both the years. The var. CNH-36 seems to be typical days fixed variety and does not respond significantly to irrigation. The INM packages involving *Azatobactor chrococum* strain HT-57 improved seed cotton yield by 8% over the farmers' practice. Seed treatment with phosphate solubilising bacteria *Bacillus megatherium* and VAM resulted in positive improvement in yield. These trends were also reflected in N, P uptake studies. The fertiliser responses in both the years were non significant probably due to heavy weed growth and the leaching losses under heavy and continuous rains.

Development and evaluation of a bullock drawn seed drill cum planter for cotton sowing (G.Majumdar).

The prototype of cotton seed drill cum planter designed and fabricated in 1998-99 was tested for its performance.

Drilling : Acid delinted seeds of LRA 5166 were drilled at a row to row spacing of 60 cm. With a pair of bullocks the field capacity of the machine was found to be 7.7 bullock pair man hrs/ha or 0.1296 ha/hr. Compared to the dibbling which took 50 woman-hr/ha or 0.02 ha/hr maintaining a row to row spacing of 60 cm and plant to plant spacing of 30 cm. Depth of seed placement could be maintained at five cm in friable soil but with increasing stickiness of wet soil, the soil stuck to guage (depth) wheels, increasing the diameter thus running the implement shallower. This was modified by providing scrappers of M.S. flats on the depth guage wheels. Seed rate was found to be at a higher side with 25 kg/ha against the recommended 13-18 kg/ha, due to larger openings at the hopper bottom. The hole sizes have been reduced to 1.5 cm dia. In terms of energy requirements the drill was found higher at 22.04 MJ/ha compared to 8.895 MJ/ha for manual dibbling. It could be drastically reduced by adding more number of rows (5) from the present two rows and making the machine cover more area in unit time.

Planter : The prototype was tested for maintaining seed to seed spacing of 30 cm within rows, by adding the seed metering plate. The design of the seed plate caused the cotton seeds to get caught between the seed plate and seed hopper bottom clearance. Due to constraints in fabrication, the waviness in the hopper bottom remained, causing non uniform clearance. The seed metering plate has been redesigned and the planter will be tested with this plate for its performance.

One of the problems of vertisols on planters, that of sticking soil on the drive wheel, causing change in its diameter, thus varying the seed dropping rate and causing variation in seed to seed spacing within row was addressed by providing a simple soil knocking device. This device was found to work satisfactorily.

A seed covering device was found lacking in the prototype. The prototype has now been provided with a long plate tied behind the tynes, to act as seed covering device.

Rainfall analysis for use in cotton agriculture and planning (C.D.Ravindran).

The analysis of historical daily rainfall data base of 72 years (1916-87) covered various rainfall characteristics of agronomic value like the distributions of start, end and length of rains, expected rainfall amounts during crop growth season, analysis of dry spells, etc. To relate the results of rainfall analysis to crop management problems, these results were put forth to crop scientists for a feed back and the following application to crop management decisions and planning by the rainfall analysis were broadly discerned :

decision on the sowing and harvesting dates,
interculture operations, fertilizer applications and plant protection scheduling
utilization of excess rainfall in July and August
dry sowing
crop improvement

Studies on the efficacy of bio inoculants in cotton wheat based production system - NATP (Irrigated Agro eco system) (A. R. Raju).

The N fixing bio inoculants as seed treatment in

wheat Cv. DWR 343 at CICR, regional station, Sirsa improved wheat grain yield by 25% (880 kg ha^{-1}) on an average over the corresponding fertiliser (65% of rec. N) applied. The best strain was *Azotobacter chrococcum* mutant Ht-57 (heat tolerant strain upto 42°C) which produced yield similar to that of fully recommended N by applying only 65% of recommended N. This was followed by *Azotobacter chrococcum* strain E-12 with an improvement of 1509 kg wheat grain (34%) over corresponding fertiliser applied. The *Azospirillum* strain FS increased wheat grain yield by only 16.5%, while *Azotobacter diazotrophicus* strain 35-47 improved the wheat grain yield by 36% or 1297 kg ha^{-1} over corresponding fertiliser applied.

Coimbatore

P1-85/1-ICR-F 25/0430**: Studies on the long term effect of nutrient management practices on the productivity, nutrient balance, soil physico-chemical properties and sustainability of cotton based cropping system** (K. Shanmugham).

The experiment contains two cropping sequences i.e. 1. Cotton - Cotton and 2. Cotton - Jowar - Cotton. Cotton was raised during winter (August to March) and jowar in the following summer. The cropping sequence formed the sub-plot treatment. Two separate experiments were conducted one for cotton variety Surabhi and another for hybrid cotton Savita. The jowar variety CO.26 was grown after the Surabhi and Savita cotton without any nutrient application.

In cotton-jowar-cotton system, the germination and growth of cotton seedlings was normal. But in cotton-cotton system, the germination of cotton seeds was poor, gradual and started showing signs of drying after a week. So there was reduction in plant population which reflected in lower yields.

An interesting observation was made in cotton-cotton system. The general growth rate of cotton in this system was very slow up to 60 days from germination, particularly in Surabhi variety. Hybrid Savita grew somewhat normally and matured in time and lot of physiological boll shedding was observed. The variety Surabhi could not pick up growth till 60 days and when Savita was in boll development phase this variety was in peak flowering phase. The late flowering and boll formation caught in monsoon rains resulting in heavy shedding of fruiting points. So no yield was obtained after 165 days. After late monsoon rains in December and January, a second flush of flowers was produced and this was allowed to form into bolls and yield recorded. The crop was delayed by 45 days more than normal 165 days.

The seed cotton yield ranged between 39.3-58.1 g/plant and 6.6-8.9 q/ha in Savita and 20.0-26.6 g/plant and 7.2-12.6 q/ha in Surabhi. Among the cropping sequences Savita in jowar-cotton produced significantly higher yields of 65.7 g/plant and 10.6 q/ha than in cotton - cotton system. But Surabhi produced similar yields in both systems. The maximum seed cotton yields of 11.9 and 5.4 q/ha in jowar-cotton and cotton-cotton systems in the case of Savita was recorded in P45-K45-FYM 15 t / ha, and the variety Surabhi recorded the highest yields of 11.7 q and 13.4 q/ha in the same treatment in cotton-cotton and jowar-cotton systems respectively in both genotypes and cropping sequences this treatment proved its superiority.

Ad hoc trial: **Testing new herbicides for their weed control efficiency in irrigated cotton** (K. Shanmugham and Smt. K. Nalayini).

Two commercial products viz., Prometryn 50 WP and Gesagard 50 WP (A-114U) were tested in a Randomised Complete Block Design replicated three times for their weed control efficiency in winter irrigated cotton and compared with popular herbicides already in use. The test variety was 'Surabhi' cotton (*G.hirsutum* Lin.).

In general, prometryn 1.5 kg and Gesagard 1.5 kg were found to be effective but not comparable to pendimethalin-hand weeding treatment, which recorded the least number of weeds from 26-65 days after sowing.

The dry matter weight of weeds ranged from 16.7 - 46.7 g, 61.7-205 g and 16.7-240 gm^{-2} on 25, 45 and 65 days after sowing in different treatments. On 65th day, weeds in control plots recorded the maximum of 240 g followed by 28.3 g in hand weeding treatment. In the rest of the treatments the dry weight remained on par (16.7-23.3). Prometryn recorded 16.7-21.7 g and Gesagard, 18.3-21.7 g. Minimum dose of 1.0 kg in either herbicide was found to be effective and comparable to Pendimethalin which recorded 23.3 g dry weight m^{-2}.

Due to severe weed competition in the control plots, the final cotton plant population remained at 71 plants/plot which was the least compared to all other treatments. Since the herbicides did not cause any phytotoxicity on cotton, no plant mortality was observed and so the population remained to be on par (92.7 105.7). Numerically, more population (103.4 105.7) was recorded in Gesagard and hand weeded treatments.

The seed cotton yield showed significant differences between treatments and ranged from 7.25 - 18.37 q/ha. The minimum yield was recorded in the control and the maximum in the hand weeded treatment. Prometryn treatment recorded 11.7 q/ha at 1.0 kg dose and 14.7 q/ha in 2.0 kg dose. Gesagard produced 12.0 q/ha at 0.75 kg dose and 14.1 q/ha at 1.5 kg dose. Prometryn and Gesagard treatments with17.35 q/ha of seed cotton yield out yielded Pendemethalin.

Ad hoc trial : Studies on the influence of micronutrients in the presence or absence of FYM/Compost under varying levels of NPK application on the yield and quality of cotton under irrigated conditions (K. Shanmugham and Smt. K. Nalayini).

During 1999-2000, 12 treatments were tried in hybrid cotton 'Savita' in a Randomised Block Design with three replications.

Treatments

1 Absolute Control
2 90 kg N + 45 K P_2O_5 + 45 kg K_2O/ha
3 T2 + 12.5 t FYM/ha
4 T3 + 12.5 kg micronutrient mixture/ha (soil)
5 45 kgN + 22.5 kg P_2O_5 + 22.5 kg K_2O/ha + 12.5 kg micronutrient mixture + 12.5 t FYM/ha (soil)
6 45 kg N + 22.5 Kg P_2O_5 + 22.5 kg K_2O/ha+12.5 kg micronutrient mixture + 6.25 t FYM/ha (soil)
7 T2 + 10 kg $MnSo_4$ / ha (soil)
8 T2 + 10 kg $ZnSo_4$ / ha (soil)
9 T2 + 10 kg $CuSo_4$ / ha (soil)
10 T2 + 1.5 kg B (soil)
11 T2 + 1.0 kg B (foliar)
12 FYM 12.5 t / ha

The DMP ranged between 33-45, 125-175 and 250-375 g/plant on 60, 90 and 120 days after germination in different treatments. The higher weights of 40-45 g/plant on 60th day were recorded in T1, T5, T8, T9, T10 and T11 and the minimum of 33.3 g was recorded in T2, T4, T5, T8 and T9 and the minimum of 125 g was recorded in T12. On the 120th day higher dry matter accumulation ranging from 360-391.7 g/plant were recorded in T2, T5, T7, T8, T9 and T10. Thus the recommended NPK dose alone produced more DM but when combined with micronutrient mixture N with Mn, Zn and Cu separately the dry matter production showed considerable improvement compared to other treatments. Recommended NPK with FYM did not show much increase in the DMP.

The seed cotton yield ranged between 42.7 - 70 g/plant and 10.6 - 13.65 q/ha in different treatments. The higher per plant and per hectare yields of 70 g and 13.7 q/ha were recorded in T2 followed by 69.7 g and 13.0 q/ha in T4, and 69.3 g and 13.12 q/ha in T9. The better features like higher rate of flower production, dry matter accumulation and boll weight observed in the micronutrient treatments failed to translate them in the seed cotton yield production. However, they have maintained the yield levels above average.

Crop Protection

Nagpur

P1-93/1-ICR-H.10/0430 : **Screening of cotton germplasm against key pests to find out morphological and bio-chemical basis of resistance** (T.V.Kathane and Sandhya Kranthi).

Out of 90 *G. hirsutum* lines, 16 were found to be tolerant to sucking pests and bollworm as the incidence was low ranging between 19.70 to 30.00 per cent under natural condition.

Lines 38, I-81-B, JBWR-34 and Ambassador showed tolerance consecutively for the fifth year. These lines and JK-57, L-11, ND 51, LRK 516, Kandaya 19 showed consistent tolerance / resistance to sucking pests and bollworms (Tabel 10) and crosses were made in different combinations and seeds of F_1 obtained.

Two hundred lines each of *arboreum* and *hirsutum* under Br 01 trials of AICCIP from the new and old collections were screened to find out their reactions to key pests under field condition. Nine from *arboreum* and ten of *hirsutum* were found to be tolerant to key pests.

P1-93/1-ICR-F60/0430 : **Biochemical basis of induction of defense related proteins in cotton** (Sandhya Kranthi and S.B.Nandeshwar).

Raising of antisera against the purified protease inhibitor

Protein isolated from bolls of PeeDee 0695, 48 hours after injury, showed protease inhibitory action against *H. armigera* gut enzymes. Column purified protein was characterised as having 12 major fractions of which fraction number 11 indicated the highest protease inhibitory activity. This fraction was used as antigen to elicit an immune response in rabbit. Fraction five was also used as an antigen. Rabbits were bled at regular intervals and immunoglobin proteins were precipitated out and will be used to initiate the screening of the cotton germplasm pool for the presence of protease inhibitors. The antibodies were used in Quchterlony immunodiffusion to check out affinity to the P1 of PD065.

Screening of wild germplasm lines for the presence of protease inhibitors

Wild germplasm lines were screened for the presence of inducible defense responses. Ten day old bolls of *G. bickii, G. mexicanum, G. somalense, G. australe, G. thurberi and G. davidsoni* and two belonging to cultivated species *Burmanicum and Indicum* were tested for the presence of protease inhibitor proteins. Protein from bolls of *G. bickii* showed protease inhibitory activity.

P1-94/1-ICR-H10/0430 **Interaction effects of cultivars, agrotechniques, insect pests and entomophages in cotton ecosystem** (S.Vennila and C.D.Ravindran).

Influence of cotton based cropping systems (CBCS) on insect pests and entomophages

Table 10 : Promising cotton germplasm and their reaction to sucking pest and bollworms during 1995-99

Germplasm	1995-96 Sucking pests			1996-97 Sucking pests			1997-98 Sucking pests			1998-99 Sucking pests			1999-00 Sucking pests		
	A	J	Th	A	J	Th	A	J	Th	A	J	Th	A	J	Th
38	R	R	-	T	T	-	T	T	T	R	R	T	R	R	-
I-81-B	NT		R	R	-	T	T	T	T	T	T	T	T	-	
Ambassador		NT		T	T	-	T	T	T	T	T	T	T	T	-
JBWR-34		NT		T	T	-	R	R	T	R	R	T	R	R	-
L-11		NT			NT		T	T	T	T	T	T	R	T	-
JK-54		NT			NT		T	T	T	R	R	T	R	R	-
NC-51		NT			NT			--		R	R	T	R	R	-
Kandaya-19		NT			NT		T	T	T	T	T	T	T	T	-

A=Aphid, J = Jassid, Th = Thrips, R = Resistant, T = Tolerant, NT = Not Tested

Germplasm	1995-96 % Bollworm infestation				1996-97 % Bollworm infestation				1997-98 % Bollworm infestation				1998-99 % Bollworm infestation				1999-00 % Bollworm infestation			
	Sq.	GB	BB	TFB	Sq.	GB	BB	TFB	Sq.	GB	BB	TFB	Sq.	GB	BB	TFB	Sq.	GB	BB	TFB
38	12.0	7.7	0.0	8.8	3.3	6.0	0.0	5.1	30.2	26.3	25.0	27.7	9.7	25.0	0.0	11.4	0.0	25.0	20.7	19.1
I-81-B		--			5.1	8.8	0.0	8.0	25.6	12.1	13.3	18.7	15.7	18.2	16.7	15.4	0.0	0.0	20.6	17.7
Ambassador		--			8.1	4.5	0.0	6.8	45.0	0.0	0.0	37.5	23.1	20.0	0.0	20.4	0.0	0.0	42.1	39.7
JBWR-34		--			6.3	2.7	0.0	5.1	20.4	19.2	0.0	20.0	28.1	14.3	0.0	21.4	0.0	0.0	19.7	19.7
L-11		--				--			33.3	11.7	10.5	10.7	20.5	12.5	0.0	16.7	0.0	0.0	24.3	24.3
JK-54		--				--			14.3	21.3	0.0	15.3	23.3	6.3	0.0	19.5	38.1	21.3	30.6	25.5
NC-51		--				--				--			42.9	12.5	16.7	25.0	0.0	0.0	27.1	27.1
Kandaya-19		--				--			37.5	8.7	0.0	22.2	16.7	6.2	25.0	13.4	0.0	0.0	23.8	23.8

A confirmatory trial on CBCS was carried out using early (ICPL 87) and late (C11) varieties of redgram under strip and border cropping system. Two cultivars of cotton *viz.*, variety CNH 36 and hybrid NHH 44 were tested. None of the cropping systems had any influence on the incidence of sucking pests and their predators or bollworms and their parasitoids. Red gram served as an alternate host for the population of *Helicoverpa armigera* emerging from cotton after second week of October. Early or late varieties of red gram grown as strip or border crops did not differ for *H. armigera* infestation. *H. armigera* larval parasitization during November by *Campoletis chlorideae* Uchida was 20% and 13% on early and late red gram varieties, respectively. Yield levels of cotton and red gram indicated risk responsive nature of CBCS to adverse weather conditions than being pest interactive.

Plant - bollworm interactions in relation to dates of sowing and control methods

For the second year, data base was generated on the interaction effects of cotton cultivars and dates of sowing under protected and unprotected conditions. One hybrid (NHH 44) and two varieties (CNH 36 and LRA 5166) were sown on two dates (early sowing : 22nd June and late sowing : 20th July) under protected and unprotected conditions.

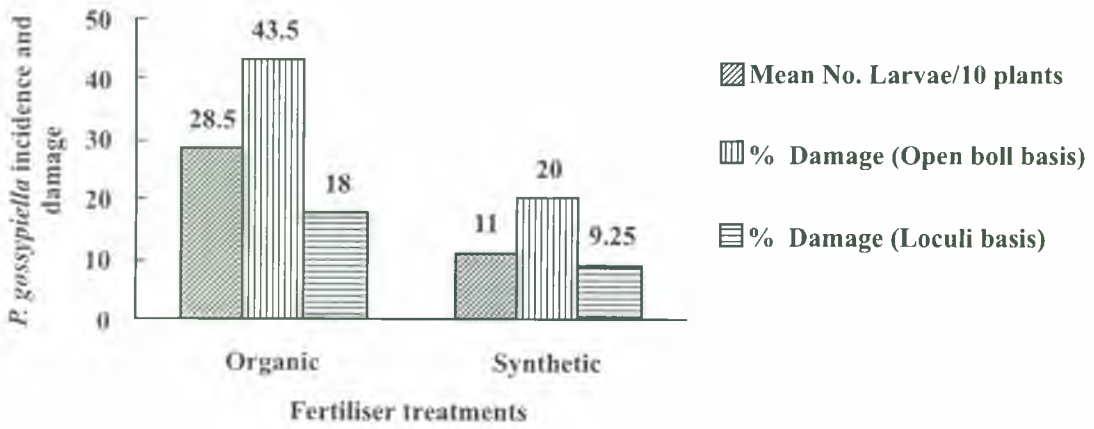
Yield levels signified a 45% loss in the late than early sown crop. All cultivars showed narrow differences for yields between protected and unprotected conditions under both sowing dates, representing the advantage and disadvantage of early and late sowings, respectively in-terms of pink bollworm incidence. Late sown crop suffered 27.7% higher pink bollworm damage (on loculi basis) than the early sown crop. The unprotected plots had 2.3 times higher damage due to pink bollworm than protected plots.

Interaction effects between dates of sowing and control methods were significant only for open boll damage. Early sown NHH 44 had significantly higher damage under unprotected situation that was not observed for varieties or in late sown condition. Analyses of age class of contributing fruiting structures, age distribution of harvestable bolls, dynamics of damaged bolls and the degree of physiological shedding revealed higher compensation and delayed maturity associated with NHH 44 under unprotected condition and its subsequent susceptibility to pink bollworm attack.

Cultivar - fertilizer interactions on *Pectinophora gossypiella*

Observations taken from 20 cotton cultivars grown under organic and synthetic fertilizer treatments revealed *P. gossypiella* infestation as well as damage to be more than double in the former than the latter (Fig.2.)

Fig. 2 : *P. gossypiella* incidence and damage in relation to fertiliser treatments



Population dynamics of insect pests and natural enemies

The year 1999-2000 experienced minimal incidence of jassids and aphids except for early season single peak above ETL by jassids (July last week) and, substantial natural control by coccinellids and chrysopids (predator-prey ratio : 0.5). *Coccinellids* out numbered chrysopids during the season. Late season secondary outbreak by aphids subsequent to pyrethroid spray (s) favoured by dry weather (Nov-Dec months) resulting in high-grade sooty mould and lint contamination was a notable feature. Thrips build up was noticed with its severity during second fortnight of August.

Activity of *Anomis flava* was recorded between September and October months, and experienced 0.8% larval parasitisation from *Apanteles* sp. and *Palexorista laxa* (very less natural control compared to past five years).

Peak incidence of *Earias vittella* was noticed during November first fortnight with a seasonal mean field parasitisation of 0.3% by *Rogas aligarhensis*. Dynamics of *H. armigera* analysed over a period of last five years denoted perpetuating population of *H. armigera* on cotton *per se* causing damage, with no expected immigration. Late sown cotton escaped from damage due to *H. armigera*

Perpetuation of *P. gossypiella* on cotton started from September first week with progressive increase in infestation causing green boll damage of 20% (in association with *E. vittella*) till December. Later months till harvest had greater than 70% boll damage. Dynamics of moth emergence as monitored through pheromone traps coincided with the process of boll opening during the season.

Species associations among lepidopteran pests of cotton

Among four species of lepidopteran pests *viz. A. flava, E. vittella, H. armigera* and *P. gossypiella* the only significant positive association (r = 0.53) was between *E. vittella* and *P. gossypiella* for occurrence as well as damage. The population levels of *A. flava* and *P. gossypiella* had a significant negative (r = -0.564) association.

Population monitoring of bollworms variation among sampling aids

While *in situ* plant observations proved effective for assessment of *E. vittella* and *H. armigera*, ,whole plant destructive sampling was representative for *P. gossypiella* and its infestation. Temporally, *in situ* plant observations were valid till mid September, while destructive sampling was ideal once in 10 days from September second fortnight.

Intra field inter trap variations were high for *P. gossypiella* moth catches using pheromone trap and did not validate for field infestation.

Role of weather on *H. armigera* incidence

Retrospective, yet preliminary analysis of the relations between weather factors and *H. armigera* revealed that a reduction in minimum temperature of more than 2-3 °C than normal, with a humidity of 70% coupled with high and well distributed rainfall during September - October months facilitate high population build up and damage on cotton.

P1-95/2-ICR-H 20/0430 : **Studies on the utilization of biological enemies for the suppression of cotton pests - predators and parasites** (T. P. Rajendran)

Late stage aphid damage gave an opportunity to study the sex apportionment of *Aphidius* sp. and *Aphilinus* sp. It was found that between *A. craccivora* on cowpea and *A. gossypii* on cotton, the parasites selected larger body size of late stage aphids for yielding more female progeny. They also had higher fecundity. Preponderance of males was in these two parasitic species that emerged from small bodied hosts. The parasites apportioned the progeny sex ratio through their egg-laying manipulations.

Cotton crop was sown in five acres using NHH-44 and Anjali, with 4 treatments, viz., judicious use of insecticides, biological control-based IPM, IRM based management and untreated control plots, with six replications in each cultivar. The bio-control based IPM plots had cowpea as intercrop till tendril stage, when it was ploughed back. A lot of *Aphis craccivora* attacked the cowpea and attracted a number of syrphid flies, *Chrysopids* and *Coccinellids* that finally shifted to cotton. Although the pest load in terms of incidence and

damage was low, observations on the pests and natural enemies, as well as fruiting pattern in the crop were recorded.

Evaluation of indigenous pheromones from BARC for the three bollworms

The field trial for testing the BARC septa/trap design at Rangri village of Sirsa was conduced at Sirsa, with the help of the scientists from Nuclear Agricultural and Biotechnology Division (NABD), BARC. The indication regarding the damage and moth catch of *Helicoverpa armigera* is being analysed.

The same experiment was also conducted at Nagpur. The pest incidence was very low during the season.

In the trial on performance of various promising cultivars, under organic and inorganic conditions, the damage and incidence of various pests was observed and recorded in the case of all the test cultivars.

P1-96/1-ICR-H 10/0430 : **Estimation of loss by major insect pests in rainfed cotton** (S.K.Banerjee).

Field experiment was carried out on the estimation of loss due to major pests of cotton with eleven treatments including untreated control. Hybrid used was NHH 44 and the treatments included insecticides, bio-control agents and mechanical methods of control. Data on the incidence of different pests and yield have been recorded. Avoidable loss due to all the major pests collectively was estimated to be 32.31 per cent whereas due to sucking pests the loss was 18.07 per cent. Bollworm complex caused the yield loss to the tune of 26.57 per cent. Green boll damage was 16.42 per cent in control which could be brought down to 12.86 per cent due to adoption of different control measure. By adopting IPM technology the avoidable loss could be brought down by 18.36 per cent.

Adhoc : **Testing of new molecules against major cotton pests** (S. K.Banerjee).

A. Testing of newer insecticides against sucking pests of cotton

Two new molecules with different doses and formulations were tested against jassid, aphid and whitefly. All the new chemicals in different formulations were found to be more effective in controlling the sucking pests compared to standard check and control. Imidachloprid (@ 5 g a.i/kg seed), thiomethoxam (2.8 g/kg seed) were found to be most effective against jassid, upto 70 days after sowing.

B. Efficacy of newer insecticide molecules against bollworms of cotton

+ Five new insecticides were evaluated at different doses and formulations against bollworm and were compared with synthetic pyrethroids and organophosphate. All the molecules were found to be significantly effective in reducing the bollworm incidence. Decis tablet at 12.5 g a.i./ha gave highest yield (11.02 q/ha) followed by Indoxicarb 60 g a.i/ha (10.04 q/ha) and Spinosad 50 g a.i./ha (9.95 q/ha).

C. Management of cotton bollworms using insect growth regulator (IGR)

Two insect growth regulators with different doses were evaluated for their effectiveness against bollworms of cotton and were compared with chlorpyriphos. Both the chemicals were found to be significantly effective in reducing the bollworm incidence. RH 2485 @ 300 g a.i/ha and Rimon @ 100 g a.i/ha were found to be most effective.

D. Evaluation of combination products of pesticides against cotton pests

Several combination products along with their single components were tested against bollworm. Endophos (2500 ml/ha) and Spinosad + Chlorpyriphos (1000 ml/ha) were found to be good combination products in reducing the bollworm incidence and increasing the seed cotton yield and were also found better than their single components.

P1-96/2-ICR-H10/0430 : **Studies on plant parasitic nematodes asssociated with cotton** (Nandini Gokte-Narkhedkar and S.K.Banerjee).

Dynamics of plant parasitic nematodes associated with cotton in Nagpur region

Intensive survey in cotton growing areas of Nagpur recorded association of plant parasitic nematodes belonging to eight genera with cotton and cotton based cropping systems. Frequency of occurrence of *Rotylenchulus reniformis,* reniform nematode was recorded at 100%. *R.reniformis* showed two peaks, a low during summer and high in autumn / winter. Populations of plant parasitic nematodes were higher in 15-30 cm soil layer than at upper 0-15 cm or lower 30-45 cms layers. In rotations involving soybean and cowpea, four-fold increase in *R. reniformis* population was recorded. Rotations involving jowar resulted in reduction in population of *R. reniformis.*

Influence of Marigold was evaluated for possible deterrent action against plant parasitic nematodes. Samples were taken in concentric circles around rhizosphere of marigold plants growing on periphery of cotton fields. There was a marked gradient in population of plant parasitic nematodes with minimum population near rhizosphere of marigold plants. The deterring influence of Marigold for phytonematodes was found to extend up to 14 cm from base of plants.

Damage potential of plant parasitic nematodes against cotton

Damage potential of *Rotylenchulus reniformis* was evaluated on cotton under pot conditions. *R. reniformis* infective females were inoculated at different inoculum levels and at different age of seedlings. Shoot and root weights were taken and data were analyzed using Seinhorst' equations. Cotton was most susceptible at 15 DAS. Damage to shoot was recorded at 2 j/g soil while root damage was evident at 1 j/g soil.

P1-89/1-ICR-H20/0430 : **Studies on multiple disease resistance in upland cotton** (Sheo Raj, N.K. Taneja and V.V. Singh).

One culture namely, CNH 911 performed well in Br02 (b) trial during 1999-2000 and has been promoted to Br03 (b) for testing in Central Zone AICCIP during 2000-2001. Out of 14 advanced lines tested, two performed better than CNH 7-94. One hundred and sixteen single plant selections were made from progenies of a three way cross based on desirable plant characteristics. Five new crosses have been made possessing resistance to multiple diseases and sucking pests.

Out of 234 germplasm lines belonging to *G. hirsutum* screened against grey midew under pot culture, B 59-14-14, BSP 170 BCT, Bobdel, BT 955, Coker 100 AWR 64-65, Combed seed and DP 16 showed immunity while B 59-1519-2, B 61-2033 cy, B 61-2050, BC 68 G-5 (1035), BC 68 x Mococc, BC 177 cy, BC 176 and Bobdel 3-5-4 LYC showed resistant reaction to the disease.

P1-89/2-ICR-H20/0430 : **Evaluation of *Gossypium arboreum* germplasm against grey mildew disease of cotton and the utilization of resistant sources in breeding programme** (P.M.Mukewar and V.V.Singh).

The immunity of *G. arboreum* lines namely, Bangladesh, G. 135-49, 30805, 30814, 30826, 30838 and 30856 to grey mildew disease was confirmed for the 10th consecutive crop season by artificial inoculation.

The AKH 4 - GMT (Grey mildew tolerant) lines established from single plant selections of cultivar AKH 4 were evaluated under artificial conditions of infection in the field. Of the total number of six lines evaluated viz. AKH4 - GMT 1, AKH 4 - GMT 2, AKH4 - GMT 5, AKH4 - GMT 6, AKH4 - GMT 7 and AKH4 - GMT 15, GMT 1, GMT 5 and GMT 6 were found superior in resistance to grey midew disease with desired economic characters.

P1-89/3-ICR-H20/0430 : **Studies on seed transmitted pathogenic infections and other seed microflora of cotton** (P.M.Mukewar).

Infection due to various fungi viz. *Alternaria macrospora, Cercospora* sp. *Colletotrichum capsici, Drechslera tetramera, Macrophomina phaseolina, Myrothecium roridum, Pestalotia* sp., *Phoma exigua,*

Phoma tropica and the bacterial blight pathogen were observed on cotyledonary leaves. In the month of October, a visible infection of anthracnose disease (*C. capsici*) was noticed in *G. arboreum* cultivar AKH 4.

Bad seed-cotton lots of *Gossypium arboreum, G. herbaceum, G. hirsutum, G. barbadense* varieties and their hybrids from 1998-99 crop season were analysed for the presence of seed microflora wherein a total of 18 fungus genera and the presence of bacterial blight pathogen *X. a.* pv. *malvacearum* was observed. Incidence of economically important pathogens such as *A. macrospora, C. capsici, M. phaseolina (= Rhizoctonia bataticola)*, *Phoma biguttulata* and *X. a.* pv. *malvacearum* was noticed.

P1-92/1-ICR-H20/0430 : **Studies on evolution of races of *Xanthomonas axonopodis* pv. *malvacearum* (*Xam*) and utilization of HVS in identification of resistant sources** (M.K.Meshram and Sheo Raj).

Pathotypes

Six races viz. 3,5,8,10,15 and 18 were identified from the 150 isolates of *Xam* made from the bacterial blight infected leaf samples of five susceptible cultivars viz. Ganganagar Ageti, LRA 5166, LRK 516, PKV 081 and SRT 1 having varying degree of susceptibility. Races 10 and 18 dominated accounting for 70.00 86.67 per cent isolates.

Testing of 57 isolates made from the normal sown extended crop of LRA 5166 and LRK 516 during the unfavourable weather of March-April, 1999 revealed the predominance of race 18.

Fifty seven isolates were made from the infected leaves collected from Punjab. Testing of these isolates indicated the presence of five races viz. 5,7,10,15 and 18. Races 10 and 18 were most predominant and 89.48 per cent isolates belonged to these races.

Identification of Resistant Sources

Two hundred and fifty seven germplasm lines of *G. hirsutum* were artificially inoculated with race 18 of bacterial blight pathogen under pot culture test. Out of these, seven lines viz. Coker 4 in 1, Delfor 719, Extreme Okra leaf, Heldom 4, Mc Namara Wine Sap, Original Wine Sap and Rugose Indore exhibited the resistant reaction. Remaining 15 lines were observed to be moderately resistant, 126 lines moderately susceptible and 109 lines susceptible.

Of the seven hundred and sixty seven lines of upland cotton evaluated under field conditions, 67 lines were free from disease, while 21 exhibited the resistance, moderately resistant, 329 moderately susceptible and 296 susceptible.

Out of 195 lines of *G. hirsutum* of Br 01 trial evaluated under field conditions, five lines viz. Tamcot CAMD-E, UKA B1(72) 049, UKA B1 (72) 54, Membesa and lockeff 4789 A were free from bacterial blight, whereas 12 lines exhibited resistant reaction. Remaining 24 lines were moderately resistant, 71 lines moderately susceptible and 84 lines susceptible.

Thirty two selected lines involving wild species were evaluated under field conditions for bacterial blight resistance. Out of these, seven lines were free from bacterial blight, whereas five lines exhibited resistant reaction. Remaining six lines each were moderately resistant and moderately susceptible and eight lines susceptible.

Out of 124 upland cotton hybrids evaluated under field conditions, 16 were free from bacterial blight incidence and seven exhibited resistant reaction. Of the rest, 18 were moderately resistant, 48 moderately susceptible and 85 susceptible.

Utilization of Resistant Sources

One hundred and sixty seven single plant selections were made for further evaluation based on their resistance and plant characters from the progenies involving four immune lines Tamcot SP 21, Tamcot SP 23, Tx ORHD 1-78 and Tx Bonham as resistant donors with susceptible cultivars Ganganagar Ageti, LRA 5166, LRK 516, PKV 081 and SRT 1. The yield of these

selected plants varied from 47.8 - 84.2 gm/plant, 15.6 - 27.5 bolls/plant and boll weight of 2.74 - 3.85 gm.

Fourteen resistant selections have been identified for their plant characters and fibres quality. The boll number of these selections varied from 19.1 24.6 plant and boll weight of 2.91 - 3.73 gm. The seed cotton yield varied from 57.5 - 74.9 gm/plant with plant height of 94.2 - 117.6 cm. The monopodia and sympodia varied from 0.8 - 3.2 and 15.2 - 24.6 per plant, resepectively.

P1-92/3-ICR-H20/0430 : **Studies on Fusarium wilt resistance in diploid cotton and development of resistant breeding material** (S.T.Tembhurnikar and P.Singh).

Crosses were made between susceptible and resistant varieties of desi-cotton and their F_2, F_3, F_4 and onward generations were studied in the sick plot and in the field. Thus 225 progenies (individual plants) of F_2, 60 progenies of F_3, 60 progenies of F_6 were tested in the field and selection was made with desirable characters.

Five resistant cultures were developed and tested for their yield potential in the field. Culture FWR-5 gave highest seed cotton yield of 25.5 q/ha followed by cultures FWR 2, (20.69 q/ha), FWR 4 (17.88 q/ha), FWR-1 (16.625 q/ha) and FWR-3 (14.14 q/ha). The fibre test showed that span length was between 22.3-22.5 mm, uniformity 45% to 48%, micronaire value 5.0 to 6.0, maturity 0.80 and bundle strength 17.3 to 19.0.

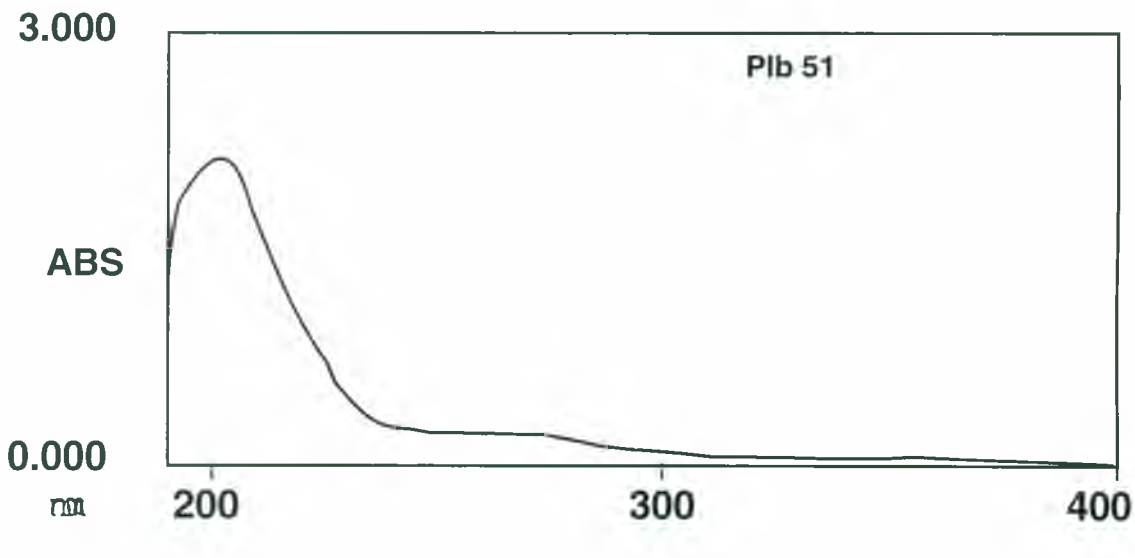
Evaluation of germplasm lines against Fusarium wilt

Seventy four germplasm lines of *G. arboreum* were tested in the Fusarium sick plot, of which nine viz. 6557, 6574, 6575, 6576, 6580, Bll 6581, 6584 Bll, 6587 and 6589 found resistant.

P1-93/1-ICR-H20/0430: **Molecular basis of pathogenicity and race specificity in *Xanthomonas axonopodis* pv. *malvacearum* (*Xam*) and molecular characterization of antagonists of *Xam*** (P. K. Chakrabarty, Sheo Raj & M. K. Meshram).

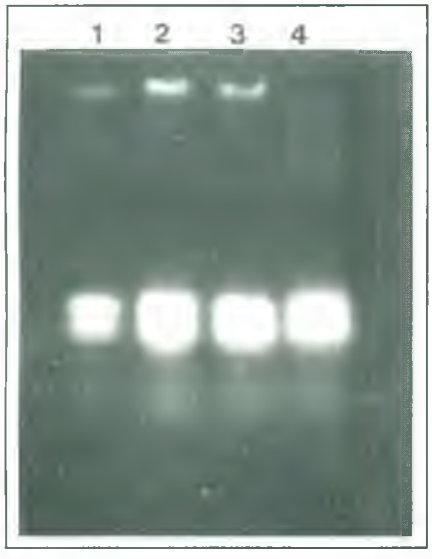
Biocontrol of *Xam*: Out of 20 bacterial strains screened against *Xam* strains *in vitro*, two strains designated PLB 51 and 53 gave highest inhibition of the pathogen. PLB 51 revealed the presence of two plasmids of 5 and 6 kb in size (Fig 3). SDS-PAGE of cell

Fig.3. Plasmids of PLB 5.



free culture filtrate as well as lysed cells showed the presence of many bands with one prominent band in case of PLB 51. Spectroscopic analysis of PLB 51 and 53 showed 1 and 2 prominent peaks respectively at $A_{200-360}$ (Fig.4).

Fig. 4. Spectroscopic analysis of cell-free cultural filtrate of antagonists effective against *Xanthomonas axonopodis pv. malvacearum.*



P1-93/2-ICR-H20/0430: **Evaluation of cotton germplasm against *Alternaria* and *Myrothecium* leaf spot diseases** (N.K.Taneja).

Out of 234 germplasm lines belonging to *G. hirsutum* screened against the diseases under pot culture, two lines, namely Bold Rowden and C-33 were found to be resistant to *Myrothecium* leaf spot. All the lines were susceptible to *Alternaria* leaf spot. Observations were recorded on 681 lines of *G. hirsutum* under natural incidence of diseases. Fourteen lines showed field immunity, 64 resistant, 330 moderately resistant, 177 moderately susceptible and 96 showed susceptible reactions against Alternaria leaf spot.

Adhoc trial : **Testing of new molecules** (N.K.Taneja and Sheo Raj).

Three molecules (Octave, Folicur, Kitazin) were tested against *Alternaria* leaf spot and grey mildew. All of them were effective against grey mildew whereas kitazin was not effective against *Alternaria* leaf spot.

P1-95/1-ICR-H20/0430: **Isolation, identification and characterization of pathogens of cotton insect pests and development of mass production protocols of effective pathogens** (N.K.Taneja and S. Vennila).

Dust formulation of HNPV was prepared and kept in the laboratory for assessing the quality during storage. Twenty kg Bt powder was prepared. HNPV and Bt samples were sent to CCA Indore for trial on chickpea result. A field trial was laid for assessing the efficacy of HNPV, using UV protectants but the results could not be obtained due to low incidence of *Helicoverpa*.

Coimbatore

P1-72/1-ICR-H10/0430: **Studies on the population dynamics of cotton pests and their natural enemies in the cotton ecosystem** (K. Natarajan).

Population of aphid was high in September and January and that of Jassid in December - January. Among the bollworms, *H.armigera* was predominant and maximum damage of fruiting bodies (65.7%) was recorded during the middle of December and a larval density of three per plant was observed during this period. The moth catch of *H.armigera,* as high as 203 per week, was collected in the pheromone trap during the same period. Coccinellid predator was high during September and the parasitism on aphid was upto 50% during January.

A survey was made on the pest and disease problems and pesticide use pattern in the prime cotton growing region of Salem and Perambalur areas. Jassid and *H.armigera* were the major problem in most of the tracts. In Suvin grown areas of Rasipuram, stem weevil incidence was up to 90% with the plant mortality of 50-60%. Pesticide use pattern revealed that on an average of 9-10 sprays were given up to 90 days old crop and a maximum of 13 sprays were recorded in some tracts. Among the pesticides used, 90% of the farmers preferred combination products (Cypermethrin + Quinalphos).

P1-89/6-ICR-H10-0430 : **Studies on host plant relationship and development of resistant varieties to insect pests of cotton** (T. Surulivelu, K. Natarajan and S. Manickam).

1. Screening of advance cultures and Germplasm accessions for resistance to bollworms

(i) Gossypium hirsutum

Twenty one cultures of *Gossypium hirsutum* were screened for bollworm resistance (*Helicoverpa* and *Pectinophora*). Five cultures viz., RR 1007-123-4, RR 1007-124-3, RCH 5266-1-2, CWROK-165 and BRS 23 were found tolerant to bollworm damage and gave higher seed cotton yield over LRA 5166. The boll and locule damage were less by 34.4 to 43.2% and 16.2 to 44%, respectively while the retained bolls and seed cotton yield were higher by 12.4 to 88.8% and 48.6 to 90.1% over LRA 5166.

(ii) Gossypium barbadense

Out of 13 germplasm accessions of *G. barbadense* screened for bollworm resistance (*Helicoverpa* and *Pectinophora*), two cultures viz., G.B. 106 and G.B. 100 were found tolerant (Boll damage less by 11.7% in GB 106) and gave highest seed cotton yield by 19.9 to 29.4% over the existing variety 'Suvin'.

(iii) Reaction to stem weevil damage

Among the thirty four entries screened, one entry of *G.hirsutum* viz., RCH (LRK x D1) 34-2-2) and three entries of *G.barbadense* (G.B.38, 69,92) were found tolerant and had less than 10% infestation, while rest of the entries were found susceptible and had 10 to 30% infestation.

2. Breeding for bollworm resistance

(i) Screening of parental genotypes for resistance to bollworms

Eighteen parental lines (cultivars) were assessed for bollworm resistance and *Helicoverpa* infestation. The retained, healthy and damaged bolls were also assessed from eight randomly selected plants. The study revealed that BRS 23 (a selection for bollworm resistance) was significantly superior in offering resistance to bollworms. It had only 2.5% damage in bolls and there was no larval incidence of *H.armigera*. Cultivar Abhadita (a variety released for bollworm resistance) was the second best and had 10.4% damage while IRH-2 was third in order and had 16.3% damage. The rest of the cultivars had significantly higher damage ranging from 16.5 to 38.3% and were found susceptible.

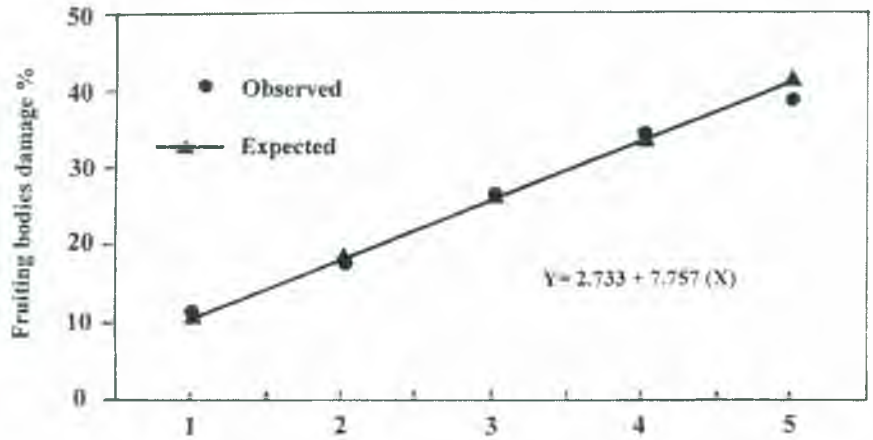
(ii) Larval incidence and damage relationship of *H.armigera*

Detailed investigations were carried out to correlate the larval incidence and damage relationship of *H.armigera* during 1999-2000 cropping season (Table 11, Fig.5). From this study, it was noted that one larva per plant caused nearly 10% damage to the fruiting bodies. The regression equation worked out was Y = 2.733 + 7.757(X) where X represents larvae and Y represented fruiting bodies damage in percentage. It is therefore proposed to lower the existing larval threshold of one larvae per plant to one larva for two plants, which corresponds to the existing damage threshold of 5% fruiting bodies damage (Table 11, Fig.5).

Table-11 : *Helicoverpa armigera* : Larval incidence and damage relationship

Larvae / Plant	77-78 DAS FBD Observed No.	Mean	%	Expected FBD %	87-90 DAS FBD Observed No.	Mean	%	Expected FBD %
1	2-5	3.4	11.47	11.41	2-7	5.1	11.43	10.49
2	3-10	6.7	20.15	23.26	4-8	6.3	17.50	18.25
3	9-14	11.5	40.35	35.11	8-12	11.0	26.83	26.00
4	13	13	50.00	46.96	14-15	14.5	34.28	33.76
5	-	-	-	58.82	18	18	39.13	41.52

Fig. 5: Helicoverpa armigera: Larval incidence and damage relationship



FBD Fruiting Bodies Damage; DAS Days After Sowing; Mean of 10,10,6,3 and 1 plant for 1,2,3,4 and 5 larvae/plant respectively

3. Screening of advance cultures and germplasm accessions for resistance to sucking pests

About 646 germplasm lines were screened against jassid during 1999-2000. Among these, 101 lines were observed to be resistant to jassids.

P1-89/4-ICR-H10/0430 : **Studies on the role of insecticides in cotton ecosystem** (T.Surulivelu and K. Natarajan).

1. Toxicity studies on *H.armigera*

The mortality of *H.armigera* larvae (3-4th instars) assessed 48 hours after exposure under laboratory conditions revealed that the treatments Cypermethrin, Lufenuron, Sherlone and Phosalone brought out 11.1, 22.2, 33.0 and 44.0 mortality, while Lufenuron + Profenophos, Profenophos, Triazophos, Endosulfan, Endophos and Viratsuper brought out 56, 78, 78, 89, 89 and 89% mortality, respectively. The treatments Spinosad, Chlorpyriphos, Quinalphos, Nurelle D and Spinosad + Chlorpyriphos effected cent per cent mortality.

2. Evaluation of new molecules and combination products for the management of key pests of cotton

(i) Two new insecticides viz., Indoxacarb and Spinosad, one new formulation of pyrethroid, Alpha cypermethrin and one new pyrethroid, Beta-Cyfluthrin were evaluated against bollworms control for the second year. The study revealed that the larval incidence of H.*armigera* per 10 plants ranged from 1.0 to 3.3 in Spinosad (60 and 75 g ai/ha), 3.0 to 4.7 in Indoxacarb 75 g ai/ha, 22.7 to 44 in Beta-*Cyfluthrin*, 26.7 to 43.3 in Alpha-*Cypermethrin* 5% EC, 14.3 to 22.3 in Endosulfan and 9.3 to 12.3 in control. Larval incidence and boll damage were significantly less in Spinosad treatments followed by Indoxacarb. Seed cotton yield was significantly higher in Spinosad (18.8 to 23.6 q/ha) followed by Indoxacarb (18 to 18.5 q/ha). Beta-*Cyfluthrin* and Alpha *Cypermethrin* gave poor yield (6.4 to 9.5 q/ha) and were on par with control (7.1 q/ha).

(ii) Six combination insecticides were evaluated along with their individual insecticides for assessing their effectiveness against bollworm control. Observations made on incidence of *Helicoverpa*, boll and locule damage, retained and good opened bolls and seed cotton yield revealed that Spinosad + Chlorpyriphos and Lufenuron + Profenophos were effective against bollworms. However, the individual compounds of Spinosad and Lufenuron registered 13.8 and 17.5% higher seed cotton yield respectively. The combination products Endophos, Viratsuper, Sherlone and Nurelle-D were not effective as compared to their individual compounds and control.

3. Evaluation of Spinosad 48 SC (alone and in combination with Chlorpyriphos) against bollworms in cotton

Spinosad 48 SC was evaluated against bollworms alone and in combination with Chlorpyriphos at three dosage levels each, along with Chlorpyriphos, Spark and Polytrin C 44 as comparison standards. Boll damage was significantly less in Polytrin C 44 treated plots while, locule damage was significantly less in Spinosad higher dosage (156 ml/ha) treatment and also in Polytrin C 44 treatment (25.6 to 25.9%) as compared to control (38.6%). The individual treatment of Spinosad 48 SC at all the three dosage levels (52, 104 and 150 ml/ha) registered significantly higher number of good opened bolls (13.1 to 15.4 per plant) and also higher seed cotton yield (15.87 to 19.96 q/ha) as compared to 7.2 bolls per plant and 9.92 q/ha in control respectively. The rest of the treatments were on par with control in this regard. The treatment Polytrin C 44, eventhough registered significantly less boll and locule damage, the good opened bolls and seed cotton yield were on par with control, because of heavy shedding of fruiting bodies due to *Helicoverpa* bollworm infestation during the fruit maturation period. The Spinosad treatments had comparatively more retention and more good opened bolls which contributed to the significant increase of yield in those plots.

4. Evaluation of new molecules and combination products for the management of sucking pests of cotton

The seed dressing chemical Imidacloprid 600 FS and Thiomethoxam remained effective against sucking pests upto 45 days. There was a phytotonic effect and the plants had luxuriant growth. The sprayable formulation of Acetamiprid and Thiomethoxam were effective against aphid and jassid. But they are not effective against whitefly. Triazophos was observed to be ineffective against jassid.

P1-89/3-ICR-H20/0430 **: Studies on the epidemiology and management of fungal foliar diseases** (P Chidambaram, A. Kannan, K.N. Gururajan and N. Gopalakrishnan).

A. Survey

Alternaria leaf spot was observed throughout the winter cotton season causing severe defoliation. Moderate incidence of grey mildew was seen starting from November.

B. Evaluation of germplasm

The *Gossypium hirsutum* lines (200 new accessions received from CICR, Nagpur during 1998 and 1999 and nearly 550 old accessions available at CICR, Coimbatore) were evaluated in the field for reaction to grey mildew and Alternaria leaf spot. Similarly, 200 *G. arboreum* accessions were assessed in pots for reaction to grey mildew and Alternaria leaf spot, following inoculation with *Ramularia areola* and *Alternaria macrospora,* respectively.

C. Studies on variation of isolates of *Ramularia areola*

i. Host pathogen interaction

Two hundred *G.arboreum* lines along with several grey mildew resistant *G.hirsutum* lines and the susceptible cultivars LRA 5166 and Anjali

were evaluated in pots for reaction to *arboreum and hirsutum* isolates of *R.areola.* The investigation clearly indicated the presence of variation among the isolates and also host reaction (Table 12).

Table 12: Reaction of *G.arboreum* lines to *arboreum* (A) *hirsutum* (H) isclates of *R.areola*

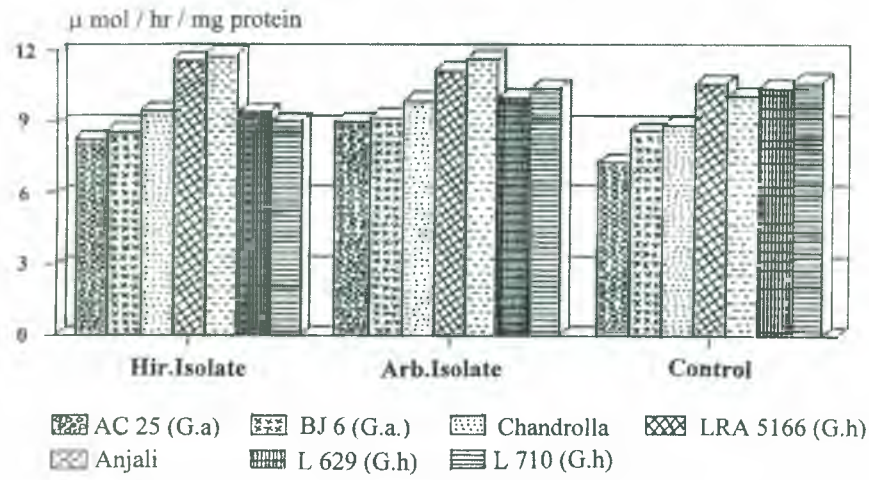
G. arboreum lines	*1997-98*		*1998-99*		*1999-2000*	
	A	H	A	H	A	H
BDN 5628	++*	+	++	+	+	-
CC-1-1-37	++	+	++++	++	-	-
BL Naked	++	-	+++	+	-	-
BJ 6	++	-	+++	+	-	-
B 188 NLL	++	-	+++	-	+	-
B 8	++	-	++++	+	++	-
B 15-23 W	++	-	++++	+	+	-
CERNUM	++	++	++++	++	+	-
B 15 W	+++	-	++++	++	++	+
AC 25	+++	-	+++	+	+	+
BISNOOR	+++	-	+++	-	+	-
CHANDROLLA	+++	++	+++	+++	+	-

*-:No reaction; +:Resistant; ++:Moderately resistant, +++: Moderately susceptible; ++++: Susceptible

ii. Biochemistry of interaction :

Moderate changes in the activity of peroxidase was observed in the resistant *hirsutum* and *arboreum* lines, following inoculation with *arboreum* and *hirsutum* isolates of *R.areola*, while there was noticeable decrease in activity in the susceptible lines following disease development. The moderate rise in acid phosphatase activity observed in the compatible interaction of *arboreum/hirsutum* isolates with susceptible lines points to the development of disease following rise in membrane permeability due to enhanced hydrolytic activity. Similar trend was also observed in the case of alkaline phosphatase activity (Fig. 6).

Fig. 6: Acid P ase Activity in Compatible and Hypersensitive Reaction between Cotton Genotypes and R. areola.



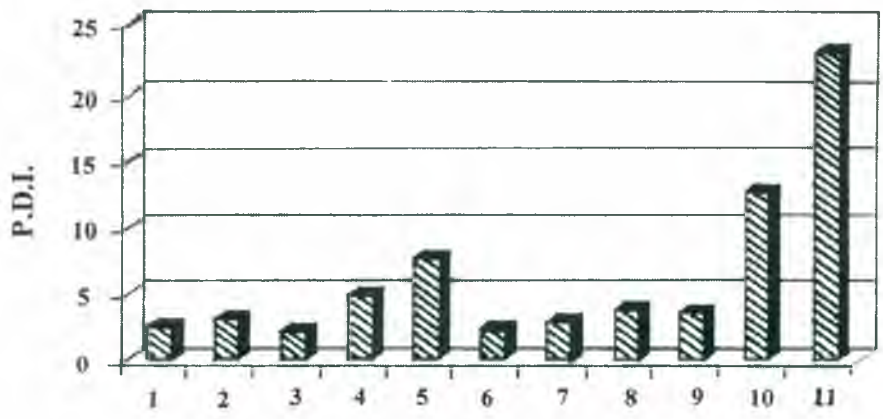
D. Disease Management

i. Management through fungicides and bioagents :

Three new fungicides viz., Tebuconazole (Folicur 250 W), Benzothiodiazole (Bion 50 WG) and Prochloraz (Octave 50 WP) were tested for their efficacy against Alternaria leaf spot and grey mildew in separate field trials. In addition, four bioagents viz., *Trichoderma viride*, *T.harzianum* and *Pseudomonas fluorescens* Pf1 and CHAO strains were also evaluated.

Benzothiodiazole was most effective against Alternaria leaf spot, followed by *T.viride*, Prochloraz and the CHAO strain of *P.fluorescens*. Tebuconazole, Prochloraz, Carbendazim, *T.viride* and Propiconazole were the most effective fungicides/bioagent against grey mildew (Fig.7)

Fig.7 : Performance of fungicides and Bioagents against Grey Mildew.



Fungicides/Bioagents

1 Carbendazim (250 g/ha)
2 Propinconazole (500 ml/ha)
3 Tebuconazole (500 ml/ha)
4 Benzothiodiazole (20 g a.i./ha)
5 Benzothiodiazole (30 g a.i./ha)
6 Prochloraz (500 a.i./ha)
7 Trichoderma viride (2 g/l)
8 T.harzianum (2g/l)
9 Pseudomonas flurescens **Pf1** (2g/l)
10 Pseudomonas flurescens CHAO (2 g/l)
11 Check

Biochemistry of interaction:

The metabolic interaction between the biochemical profile of cotton and the chemical / biological agents used in the control of *R.areola* was investigated. The characteristic enhancement in the synthesis of phenolics and terpenoid aldehyde 'Gossypol' due to application of *Pseudomonas* and *Trichoderma* sp. was seen to the tune of 18-25%, while about 10-15% higher accumulation of gossypol and phenols was evident due to fungicidal applications (Table 13). On the other hand, marked reduction in Nitrate Reductase activity, soluble protein and reducing sugar content was observed due to compatible host - pathogen interaction.

Table 13 : Effect of chemical/biological agents for control of grey mildew on biochemical metabolites in cotton leaves

Treatments	Gossypol (mg/g)	Total Phenols (mg/g)
Carbendazim 50 W.P. (250 g/ha)	8.3	13.7
Propiconazole 25 E.C.(500 ml/ha)	7.6	12.9
Benzothiodiazole 50 W.G.(20 g a.i./ha)	8.3	12.6
Bensothiodiazole 50 W.G.(30 g a.i./ha)	8.2	13.8
Prochloraz 50 W.P.(500 g a.i./ha)	8.0	13.7
Trichoderma viride	8.9	14.4
Trichoderma harzianum	8.7	13.9
Pseudomonas fluorescens Pf1	9.2	14.1
Pseudomonas fluorescens CHAO	9.0	14.2
Water spray (Control)	7.4	12.9
C.D. 5%	0.5	0.7

ii. Development of resistant lines

a. Grey mildew

Eleven lines of F_{10} and BC_1 F_7 progenies involving the four resistant germplasm lines (IC 629, 710, 755 and 1017) and LRA 5166 and RHR 4145 were tested in the field under heavy disease pressure for their resistance to grey mildew and yielding ability. Based on their performance, 40 single plant progenies were selected and advanced.

In addition, the F_1 progenies of the crosses involving RR 1017 and L 629 (grey mildew resistant lines) were tested in the field and advanced.

The eight resistant selections involving the backcross progenies of RKR 4145 and IC 1017 and one selection involving LRA 5166 and IC 629 were again tested for their yield potential in comparison with LRA 5166. Five selections of RR 1017 (GMR 1,2,3,5 and 7) out performed LRA 5166 in yield ranging from 23 to 42%.

The selection RR 1017/3133 (CCH 18) has been retained in the Preliminary Varietal Trial of AICCIP for one more year to evaluate its performance.

b. Alternaria Leaf Spot

The F_{10} and BC_1 F_8 progenies of ten resistant selections generated from the crosses between LRA 5166, RKR 4145, Abhadita and Anjali and five germplasm lines (IC 727, IC 762, IC 851, IC 1007 and IC 1017) were evaluated in the field under severe disease stress. Out of these, 55 single plants having resistance and better quality were selected and advanced for further test.

Twelve resistant selections (ALR 1 to 12) were once again tested in the field for their yield potential in comparison to LRA 5166 and Anjali. Five lines viz., ALR 4 (RR 1007/124-3), ALR 9 (AA 727/112), ALR 8 (LR 1007/833-1), ALR 3 (RR 1007/123-4) and ALR 10 (AA 1007/54-1) have once again out performed both LRA 5166 and Anjali.

The resistant line AA 727/112 (ALR 9) which was entered in the Irrigated National Initial Evaluation Trial as CCH 727 has performed well both in the Central and South zones and hence been advanced to the Preliminary Varietal Trial. It has also shown resistance

to Cotton Leaf Curl Virus disease in three centers and moderate resistance in one center of North zone.

c. Development of MAR lines

Several F_4 and BC_1F_3 progenies of multiple crosses evolved for resistance to bacterial blight, grey mildew and Alternaria leaf spot have been selected from the field trials and advanced for further test.

P1- 89/1- ICR- H20/ 0430 : **Studies on soil borne diseases of cotton** (A Kannan , K. N. Gururajan and N. Gopalakrishnan).

In the station trial, select V*erticillium* resistant cultures viz., VRS 16, VRS 19, VLV 3, VLV 6, VTV6 were tested along with Surabhi and MCU5 VT as checks. Culture VLV 3 recorded the highest seed cotton yield of 14.82 q/ha and registered an increased seed cotton yield of 36 and 11 per cent over MCU 5 VT (8.77q/ha) and Surabhi (10.87 q/ha), respectively. Cultures VLV 3 has been entered in the institute's common trial.

Eleven progenies involving Surabhi, LRA 5166 were found to be resistant to *Verticillium* wilt. Single plant selections combining resistance and requisite fibre standards will be advanced.

Verticillium wilt tolerant selections viz., VLV 1, VLV 2, VLV 3, VLV 6, AVTH, VRS 16, Surabhi and MCU 5 VT possessed better metabolic profile with higher Peroxidase activity and IAA Oxidase during post-inoculation stages compared to susceptible checks. Similarly, the constitutive levels and inducible levels of secondary metabolites like condensed tannin, phenols and gossypol were more in tolerant selections following stem inoculation with the pathogen resulting in incompatible interaction.

P1-89-2/ICR-H20/0430 : **Studies on bacterial blight of cotton** (A. Kannan P. Chidambaram and K. N. Gururajan).

Thirty three progenies involving RKR 4145, Badnawar 1, CBR 3, 101-102 B, MCU.10, culture 1412, Aleppo 40, BJA 592 and LRA 5166 were screened for resistance to Bacterial blight. Thirty progenies registered 'O' grade. Single plants possessing requisite fibre standards and economic characters will be advanced.

Sirsa

Studies on the management of cotton leaf curl virus disease (D. Monga, O P Tuteja, R A Meena and S K Verma).

Screening of germplasm lines

Twelve hundred and sixty seven, 1220 and 1531 gemrplasm lines were screened under natural field conditions during 1997,1998 and 1999 crop season respectively against, CLCuV disease and whitefly population (Table 14). During last year, there were 1205 lines showing CLCuV incidence range from 5.88-100%, whereas whitefly population ranged between 0.07-1.13 leaf. Based on three years data 65 lines showing no leaf curl incidence were selected.

Table 14 : Screening of germplasm lines

Year	Germplasm lines tested	Lines showing CLCuV incidence	Range of disease incidence (%)	Range of whitelfly population/leaf
1997	1267	523	3.85-93.75	0.07-1.80
1998	1220	494	3.85-80.00	0.07-1.27
1999	1531	1205	5.88-100.00	0.07-1.13

Resistance breeding

One hundred and fifteen crosses involving local cultivars as female and CLCuV resistant lines as males were attempted. The F_2 of 41 crosses were selected, and eighty-eight promising disease free single plant selections were made from it. Back crosses (BC_2) with recurrent parents were made in 32 (BC_2) lines.

Epidemiology of CLCuV

One hundred and ten lines in 1998 and sixty-six lines in 1999 were screened against CLCuV and whitefly incidence at four stages during the crop season. Incidence of leaf curl disease was higher during 1999 season as compared to 1998 season. No correlation was observed between leaf curl incidence and whitefly population. It was observed that higher maximum temperature, lower maximum and minimum relative humidity, more bright sunshine hours and less rainfall prevailing during May and June in 1998 led to lower disease incidence as these factors might have proved unfavorable to cotton leaf curl virus primary inoculum development and disease incidence.

Significant increase of leaf curl disease was observed during the crop season upto 22nd August when the leaf curl incidence touched 38.36 per cent starting from 4.15 per cent on 3rd July in variety HS 6. The progress of disease slowed down from August end and almost stopped after middle of September. No correlation appeared between leaf curl incidence and whitefly population. There was 50.0, 50.0 and 94.0 mm rainfall in May, June and July. The maximum and minimum temperature ranged between 29.7 to 39.2°C and 26.3 to 29.9°C during July and August when the progress of leaf curl disease was fast. Similarly, maximum and minimum relative humidity ranged between 58-81 and 47-62 per cent respectively during that period. These factors appear to be favorable for the development and progress of cotton leaf curl virus disease.

Cross loss estimation

Losses due to CLCuV on three varieties i.e. HS 6, F 846 and RST 9 was studied at two planting dates i.e. 3rd and 28th May, 1999. At first planting date, maximum and significantly higher seed cotton yield reduction was observed in variety HS 6 (68.31%) followed by varieties F 846 (47.31%) and RST 9 (32.58%). However, in the second sowing date, variety F 846 showed maximum and significantly higher reduction in seed cotton yield (70.90%) as compared to varieties HS 6 (47.73%) and RST 9 (15.09%).

Effect of date of sowing on CLCuV

Highest leaf curl incidence was noticed in variety HS 6 in second sowing date (14.68%). In F 846 and RST 9, the incidence of leaf curl virus was more in first date of sowing. The whitefly incidence was higher in varieties at first sowing date as compared to second date of sowing. Seed cotton yield was more in first date of sowing, with variety HS 6 showing highest yield followed by varieties F 846 and RST 9. (Table 15).

Management of cotton (Leaf Curl Virus)

Spraying of attenuated virus preparation at different temperatures and some pseudomonas preparations tested against CLCuV under field conditions. There were six treatments and two controls i.e. water spray and spray of unheated virus solution in this trial (Table 16). Incidence of leaf curl ranged from 24.87% to 48.55%. Maximum leaf curl incidence was noticed in a plot where unheated virus solution was sprayed. There was significant reduction in leaf curl incidence in all the treatments except T1. The minimum incidence was noted where water extract of leaf curl virus solution attenuated at 50°C was sprayed followed by water spray and leaf curl virus water extract attenuated at 70°C. The population of whitefly was low in general and no significant differences among treatments in case of whitefly and seed cotton yield were recorded. Highest seed cotton yield however was observed in CHAO strain spray followed by spray of leaf curl virus extract attenuated at 70°C.

Table 15 : Effect of varieties and sowing dates on the incidence of cotton leaf curl virus disease

Sr. No	Varieties	Date of Sowing					
		3-5-99			28-5-99		
		% leaf curl	Whitefly/ leaf	Yield q/ha	% leaf curl	White-fly/leaf	Yield (q/ha)
1	HS 6	8.98	1.2	21.64	14.68	1.0	15.87
2	F 846	11.53	1.4	20.15	9.47	1.0	19.10
3	RST 9	12.14	1.47	19.33	6.25	0.73	11.35

		CLCuV	Whitefly	Yield
SEm ±	Var.	.26	.022	.45
	P.D.	.21	.018	.37
	Var. x P.D.	.37	.031	.64
CD (0.05)	Var.	.78	.07	1.36
	P.D.	.63	.06	1.11
	Var. x P.D.	1.1	.10	1.92

Table 16 : Management of cotton leaf curl virus.

Sr. No.	Treatment	Leaf Curl (%)	White fly/ Leaf	Seed Cotton Yield (Q/ha)
1	Seed soaking in virus extract	42.57	0.38	16.44
2	Strain CHAO	38.55	0.33	19.61
3	Strain PF 1	31.73	0.33	17.54
4	Attenuated Strain (50°C)	24.87	0.31	17.54
5	Attenuated strain (70°C)	30.21	0.27	19.35
6	Attenuated strain (90°C)	35.53	0.29	16.08
7	Water spray	26.39	0.27	19.24
8	Unheated virus solution	48.55	0.31	15.87
	SEm ±	2.34	.026	1.16
	CD(0.05)	7.21	NS	NS

Studies on the management of root rot of cotton

(D. Monga).

Screening of germplasm lines against root rot of cotton

Sixteen germplasm lines were tested for 2nd year in root rot sick field. The root rot incidence varied from 26.7% to 71.4% with 50.0% incidence in check variety H-1098. The maximum seed cotton yield of 19.4 q/ha was recorded in line, Plains followed by 11.9 q/ha in MESR-17 and 8.9 q/ha each, Acala 5625 and Dunn S6-3885. An yield of only 1.4 q/ha was observed in check variety H-1098.

In another experiment, a set of 46 germplasm lines with H 1098 and DS 5 as check varieties were screened against root rot disease. Minimum root rot incidence was noted in line VV 770 (11.8%) followed by lines PH 36A (14.3%) and 1143EC (16.7%). The root rot incidence varied from 11.7% to 84.6%. The maximum seed cotton yield was recorded in line 2225/92 and 770/102 (13.4 q/ha each) followed by line Deltapine-19 (11.9 q/ha) and lines BAR 7-82,Texas 34 and IH 144-3-62 (10.5 q/ha each).

Management of root rot incidence

Different chemicals and bioagents were tested in root rot sick field. The differences in root rot incidence among different treatments were non-significant. However, carbendazim seed treatment @2g/kg seed, showed minimum root rot incidence followed by Thifluzamide seed treatment and carbendazim seed treatment in combination with soil application of $ZnSo_4$. The seed cotton yield differences in various treatments were non-significant.

Breeding for resistance to bacterial blight of cotton with reference to north zone (D Monga and O P Tuteja).

Thirteen selections were made from F_4 population and ten from single plants of F_3 during the crop season. Ten plants from each plot were bulked for F_5 generation and F_4 generation respectively.

Sixteen BC_4 populations were further back crossed with their recurrent parents. Similarly thirteen BC_3 populations were further back crossed with their recurrent parents. The promising material was further advanced.

Screening of breeding lines under AICCIP Trials for disease incidence under natural conditions

There were three trials i.e. Br 05 (a)1, IET and NEVT allotted to CICR, Regional Station, Sirsa. In Br 05 (a) 1 trial, out of 24 entries, the hybrid NZHH 53 was completely free from bacterial blight and Alternaria leaf spot, where as fourteen entries were free from Myrothecium leaf spots and no leaf curl appeared in twelve lines. The incidence of leaf curl ranged from 0.83 to 34.17%.

Fifteen entries were screened under NEVT trial. Entry PKV Rajat showed resistant reaction to bacterial blight, whereas RS 810 and Khandwa showed resistance against Alternaria leaf spot. The incidence of Myrothecium was low in general and hence most of the lines showed resistant reaction. Seven entries were free from leaf curl virus disease. The incidence of leaf curl virus on other varieties ranged between 0.44 to 26.32 per cent.

In IET, 25 entries were tested. Entry IET 165 showed resistant reaction to bacterial blight, where as there were five and twelve entries showing resistance to *Alternaria* and *Myrothecium* leaf spots respectively. In case of leaf curl, seven entries were completely free and the disease in other entries ranged from 0.88 to 14.3 per cent.

Entomology

Testing of new molecules (P Jeyakumar).

Effect of seed treatment and other new molecules for the control of sucking pests.

Three new seed treatment chemicals (Imdacloprid 600 FS and 70 WS and Thiomethoxan 70 WS) were tested against jassids and whitelfy in the cotton variety HS 6. Imidacloprid 600 FS at the rate of 9 ml/kg of seed was found effective against jassid as the nymphal population was less in this treatment (0.89/3 leaves), where as the same chemical was effective against whitefly at lower dose (5 ml/kg of seed). The spray of Acetamiprid 20 SP (10 g a.i./ha) and Thiomethoxam 25 WG (50 g a.i./ha) were effective in the management of jassid as well as whitefly.

Bioefficacy of insect growth regulators (IGR) against bollworms

The IGR RH 2485 at the rate of 250 g a.i./ha was found effective against bollworms, which recorded 5.2% damage on loculi basis. The bollworm incidence in all other treatments viz. RH 2485 (300 g a.i./ha) and Match 5 EC (30 g and 60 g a.i./ha) was more than the standard check (Dursban 20 EC, 500 g a.i/ha), whereas the seed cotton yield was more in plots treated with match 5 EC i.e. 15.27 q/ha in 30 g a.i./ha and 11.77 q/ha in 60 g a.i./ha treatments.

Resource Generation :

HNPV was produced at the Institute and 70,000 LEs were supplied to TAOs on demand and generated Rs.1,22,000/-. Another 75000 LEs were produced during the winter months. The Institute earned Rs.1,48,500/- by way of service charges and consultancy fees from consultantees (J.R.Biocontrol and NBL) as also Rs.2100/- towards royalty on multicell plastic trays.

Externally Funded Projects

DBT Project

Development of sensitive molecular diagnostic tool for rapid detection of *Xanthomonas axonopodis* pv. *malvacearum (Xam)* strains and differentiation of its races (P.K.Chakrabarty and Sheo Raj).

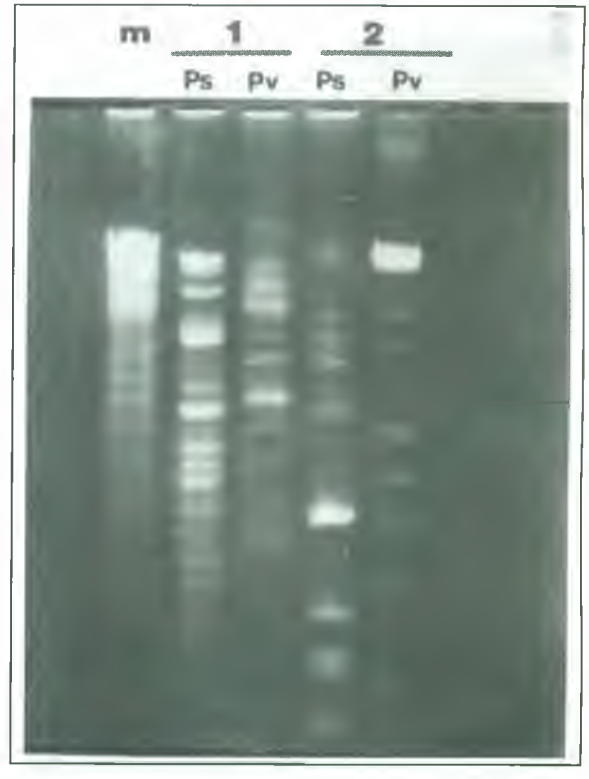
Survey and Collection of isolates and development of antibiotic resistant mutants

One hundred and fifty isolates of *Xam* were collected from different cotton-growing states of India . Single colony purified cultures were stored in 15 per cent glycerol at 0° C. Majority of the isolates belonged to the highly virulent race 18 of *Xam* as 30 out of 50 isolates assayed on differential cotton lines cleary showed the reaction for race 18. Fifty five Rifampicin resistant mutants of *Xam* were developed. Antibiotic resistant markers are useful for all molecular and pathological manipulations.

Isolation of Plasmid DNA and their restriction fragmentation

Seventy bacterial strains were screened for their plasmid profiles. All of them contained 1-3 plasmids ranging between 7.4 55 kb. Although no correlation could be observed between the number of plasmids and virulence of the races, the highly virulent races invariably harboured a plasmid of 31.2 kb . This particular plasmid can be used as a marker for higher virulence. Restriction digestion of plasmid DNA showed polymorphism in DNA fragmentation pattern when isolates belonging to different races were digested with same enzyme. Isolates 111 and 135 belonging to races 18 and 13 respectively, when digested with enzymes *Pst*I and *Pvu*II showed a variable restriction digestion pattern (Fig 8). Thus it is clear that isolates belonging to different races of *Xam* posses polymorphic DNA fragmentation pattern and holds a promise for use as tool for race differentiation

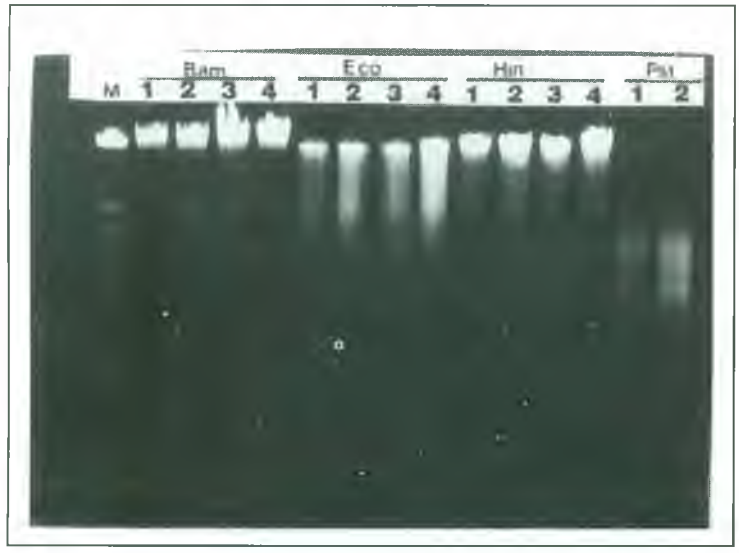
Fig.8.Restriction fragmentation pattern of plasmid DNA of *Xanthomonas axonopodis* pv. *malvacearum* isolates; 1, isolate 111 (race 18); 2, isolate 135 (race 13)



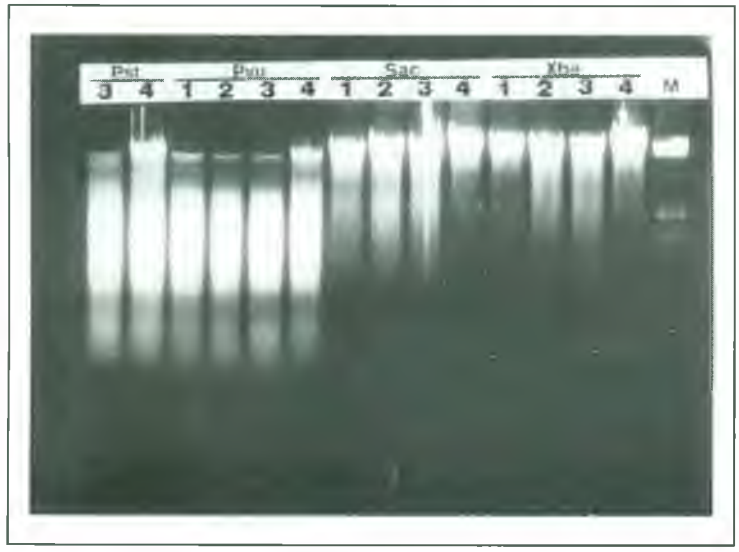
Genomic DNA digestion pattern

A miniprep protocol yielding high concentration of genomic DNA was standardised. Genomic DNA isolated from four different isolates of *Xam* viz., 79, 109, 124 and 135 DNA was subjected to restriction digestion with seven restriction enzymes viz., *Bam* HI, *Eco* RI, *Hin*d III, *Pst* I, *Pvu* II, *Sac* I, *Xba* I. First three isolates exhibited similar digestion pattern (Fig 9 a and b). Bio-assays of isolates 79 and 109 showed that they belonged to race 18. Isolate 124 collected from Kanpur showed similar digestion pattern of its DNA but the race is yet to ascertained. From its digestion pattern it appeared to belong to race 18 which however, need confirmation. Isolate 135 belong to race 13 and its digestion pattern is also different from the other three isolates. The race to which each of these isolates belong, is being identified by commercial method.

Fig.9 (a&b). Restriction fragmentation pattern of genomic DNA of *Xanthomonas axonopodis pv. malvacearum* isolates; 1, isolate 79 (race 18): 2, isolate 109 (race 18) 3, isolate 124 (race ?) 4, isolate 135 (race 13)



9 a



9 b

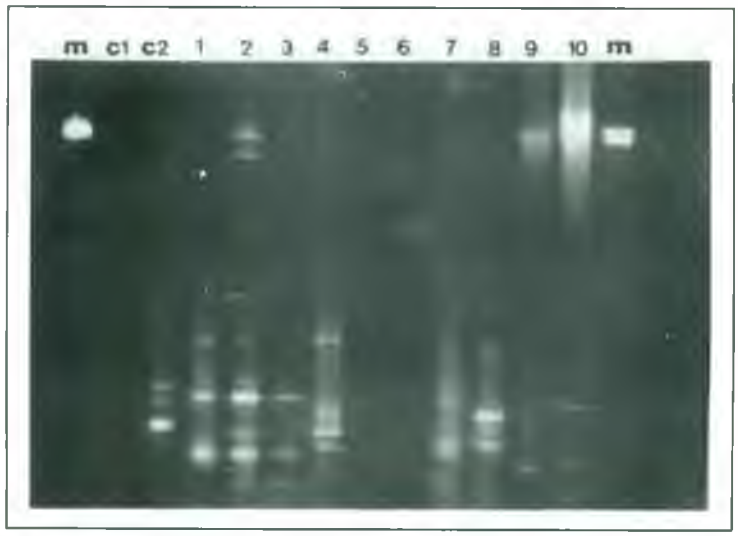
PCR amplification

PCR amplification pattern for isolates belonging to different races was attempted. A 17-mer nucleotide primer based on inverted nucleotide repeat sequence flanking the cloned pathogenicity gene *pthN,* was custom synthesized having the following sequence.

5' CAC TTT GGC TGT TTT TT 3'

Since the repeats are nearly perfect, a single primer is expected to serve the purpose of both forward as well as the reverse primers. Plasmid DNA isolated from 10 different isolates was subjected to PCR using the above primer. Amplification was obtained in case of all the isolates (Fig 10). However, a variable pattern of amplification was observed for different isolates. Two of the isolates viz 21 and 24 (lanes marked 1 and 2 respectively) belong to races 16 and three respectively, showed a distinct amplification pattern. However, the isolates 111 belonging to race 18 (Lane marked 7) showed an amplification pattern similar to that of the isolates 21 belonging to race 16 . We have to ascertain whether the scoring of reaction by conventional method has been done erroneously. On the basis of PCR analysis later two isolates showed that they belonged to the same race. Nevertheless, many of them (see Fig 10, lanes 1,2,3,7,8) shared common amplified fragments yet exhibiting polymorphism. It is thus expected that the PCR amplification pattern resulting out of these studies will be providing vital information regarding feasibility of using amplified fragments as a tool for race-differentiation.

Fig.10.Amplification pattern of DNA fragments delineated from the plasmid DNA of *Xanthomonas axonopodis* pv. *malvacearum* isolates subjected to PCR using a 17-mer custom synthesized primer: lanes marked c1 and c2 (control); lane 1, isolate 21 (race 16); 2, isolate 24 (race 3); lane 3, isolate 28 (race ?); lane 4, isolate 75 (race ?); lane 5 and 6, isolate 107 (race ?); lane 7, isolate 111 (race 18); lane 8, isolate 137 (race ?); lanes 9 and 10, isolate 34 (race 6);



Amplification using a 20-mer custom synthesized primer pair delineated a DNA fragment of 0.6 kb when genomic DNA of 3 different isolates of *Xam*, irrespective of their geographic origin, was subjected to PCR. This primer pair, thus can be employed as a *Xam* pathovar-specific diagnostic tool.

AP CESS FUND SCHEME

Nagpur

Use of entomopathogenic nematodes for biological control of insect pests of cotton (Nandini Gokte-Narkhedkar and S.K.Banerjee).

Isolation and identification of Entomopathogenic nematodes (EPN) from different geographical areas

Soil samples from cotton fields of CICR, Nagpur, areas adjoining to Nagpur (Ramtek) and Regional Station Sirsa, Hisar were screened for detection and isolation of entomopathogenic nematodes using *Galleria mellonella* and *Corcyra cephalonica* as bait. Eight isolates of EPN detected and isolated were maintained and multiplied on larvae of *G. mellonella* and *C. cephalonica.*

Three EPN isolates from Nagpur were identified as *Heterorhabditis bacteriophora*. Salient characters of *H. bacteriophora* were : av. juvenile length- 600 um; av. width- 25 um; av. distance to excretory pore: 82 um; av. distance to pharynx base- 130 um; head truncate, slightly round; tail pointed with anal swelling; bursa present.

One isolate from Ramtek was identified as *Steinernema glaseri*. Salient character of *S. glaseri* were: av. juvenile length- 1080 um, av. width- 60 um; av. distance to excretory pore- 40 um; av. distance to pharynx base- 118 um; head rounded, not offset, vulva with lips, bursa absent

Third isolate from Nagpur and one from Coimbatore were identified as *Steinernema sp*. While two isolates from Ramtek were identified as *Heterorhabditis sp.*. Further identification of these isolates is under process.

Evaluation of efficacy of EPN isolates against *Helicoverpa armigera*, American bollworm

Efficacy of eight EPN isolates was evaluated against all the instars of *H.armigera* by sand bioassay and petridish bioassay. All insect stages were found susceptible though isolates differed in efficacy. *H. bacteriophora* isolates from Nagpur were very effective against all stages of *H.armigera* with 15 EPN juveniles per *H.armigera* causing 88-100% mortality of different stages. *Steinernema sp.* from Nagpur was comparatively less effective with 15 EPN juveniles causing 59% and 49% mortality respectively in IV and V stage of *H armigera. S. glaseri* recorded 85%-98% mortality in different insect life stages with 15 EPN juveniles. Variation in susceptibility to EPN was recorded with different life stages of *H.armigera*. Second stage juveniles were susceptible to all the EPN isolates tested while older stages (IV and V) recorded variation in susceptibility to EPN isolates.

Evaluation of efficacy of EPN isolates against other insect pests of cotton

One isolate each of *H. bacteriophora, S. glaseri* and *Steinernema sp.* were tested against pink bollworm, spodoptera, armyworm, semilooper and leaf folder larvae. Significant insect mortality was recorded with all the isolates tested. However, Spodoptera larvae did not record population build up for any of the isolate.

Studies on biology of EPN isolates

Biology of three isolates, one each of *H. bacteriophora, S. glaseri* and *Steinernema sp.* was studied on *G. mellonella* and *H. armigera*. The aspects studied were: time taken for penetration, site of penetration, influence of inoculum level on per cent penetration and reproduction factor. Penetration by *Heterorhabditis* juveniles was through head, anus and spiracles with some direct penetration through cuticle. *Steinernema* juveniles penetrated through body openings only. In *Steinernema* isolates, males and females in 1:1 ratio were recorded 44 h after inoculation. Reproduction in first generation was amphimictic in *Steinernema sp.,* while it was parthenogenetic in *Heterorhabditis sp.*

Penetration at different inoculum levels ranged between 22-50%, whereas reproduction factor ranged between 68-20% at lowest and highest inoculum levels. Pupae once formed resist nematode invasion, EPN build up in pupa was recorded with all the isolates tested due to infection at prepupal stage.

Studies on storage of EPN isolates

The above three isolates were taken up for studies on survival at three temperature regimes of : 25-15°C, 6°C and 13°C. All the three isolates survived and were infective for three weeks at room temperature while at 6°C and 13°C, per cent survival and infectivity plunged steeply just after four days of storage. Addition of 0.01% hydrogen peroxide improved survival in storage and needs to be confirmed.

Standardization of protocol for mass culturing of EPN isolates

Mass culturing of three isolates was tried and found to be successful on animal kidney peptone medium system. Population build up was recorded with all the isolates after two weeks. Further studies on infectivity of juveniles thus reared is going on. To facilitate mass culturing of EPN isolates on synthetic media, primary colonies of associated symbiont bacteria, *Xenorhabdus sp.* were isolated. The work on standardisation of protocols for mass culturing of EPN will be continued using other sources of animal protein.

Areawide implementation of IRM/IPM strategies through farmers participation (S. K. Banerjee & K. R. Kranthi).

The programme was carried out in about 1500 hectares of 700 farmers in nine villages of Wardha District. The participating farmers gave 0-2 applications of insecticides and realised an average yield, of 8.22 q/ha compared to about 5 q/ha in non-participating villages. Insecticide application in the participating villages was reduced by 90%.

Coimbatore (T.Surulivelu)

The major components of IRM particularly "Cow-pea as bund crop", manuring based on soil testing, monitoring of pests and predators, pest scouting for assessment of economic threshold level, topping (removal of terminals), proper application technology, cultural control of grown up larvae, setting up of bird perches and alternation of various chemical groups etc. were demonstrated periodically. Observations were made on pests (jassid, aphid), predators (Coccinellids, Chrysopa, Syrphid and Spiders) and damage by bollworms.

Sucking Pests and Predators

In the project farms, dominant sucking pest was jassid, which was at moderate level from 65 to 117 days of growth (11 to 23.8/10 leaves), however, it crossed ETL twice during the first fortnight of October, 1999. In non participating farmers' field it ranged from 11 to 40/10 leaves and crossed ETL five times during the season. The population of aphid/10 leaves ranged from 0 to 90 and 0 to 124 in IRM and non-IRM fields respectively. Against aphid, sprays were not given/recommended as predators particularly coccinellids were found in abundance (3 to 11.5/10 plants) in IRM fields.

Bollworm Damage

The square damage was relatively higher as compared to boll damage. It ranged from 3.1 to 12.9% and 4.0 to 21.4% respectively in IRM and non-IRM fields. Average square and boll damages for the whole season were 7.9 and 5.5% in IRM fields as against 12.7 and 6.6% in non-IRM fields.

Impact of IRM in Cotton

The adoption of IRM strategies in cotton resulted in significant reduction in usage of insecticides from 4701 to 2665 g a.i/ha (-43.4%) and plant protection cost from Rs 7040 to Rs 3401 per/ha (-51.7%). In addition, it recorded an increased seed cotton yield from 9.17 to 14.72 q/ha (+60%) and net returns from Rs 7482 to Rs 19,652 per ha (+163%). Besides, the sucking pests (jassid and aphid) and bollworms damage were less by 10 to 24% and 17 to 38% while predators, were higher by 68% in IRM participating farmers' fields as compared to non participatory farmers' fields.

3. Pesticide Application Technology (T.V.Kathane).

In a trial conducted to evaluate the performance of spraying technique, lowest sucking pests population was recorded in the treatment with three ml Endosulfan /ltr. of water, however, the differences between the treatments were non-significant due to low incidence. Cost of pesticide application as

per the PAT happens to be significantly less over the thorough application and power spraying. Spray should be recommended as per the PAT.

4. Insecticide resistance management of *Helicoverpa armigera* (K. R. Kranthi).

Resistance monitoring in cotton pests from different geographical regions of India

Monitoring for resistance to seven insecticides was carried out on five major insect pests of cotton from various geographical strains collected in 21 cotton-growing districts in India. Resistance was monitored in *Helicoverpa armigera* (Hubner), *Pectinophora gossypiella* (Saund.), *Spodoptera litura* (Fab.), *Earias vitella* (Fab.) and *Bemisia tabaci* (Genn.). Significant resistance to pyrethroids was recorded in insect populations collected from some parts of Andhra Pradesh and Central India in *H armigera, P. gossypiella* and *S. litura.*

Selection for resistance and genetics

Laboratory selection studies were carried out continuously for 8-9 generations using pyrethroids, pyrethroid + synergists, endosulfan, quinalphos, spinosad, spinosad + chlorpyriphos, Cry1Ac and Cry1Ab. Resistance to endosulfan, pyrethroids, pyrethroid + synergists rapidly rose to several folds only after the first four episodes of selection. Crosses of the resistant and susceptible strains were made to elucidate the nature of resistance. Resistance to Cry1Ac was detected after seven generations. Pyrethroid resistance appeared to be governed by co-dominant alleles.

Development of a novel kdr resistance detection kits

Based on the specific isozymes and mutant Kdr sodium channel peptides, a novel colorimetric test was devised. It is being validated for field reference.

Sensitivity of ladybird-beetles to insecticides

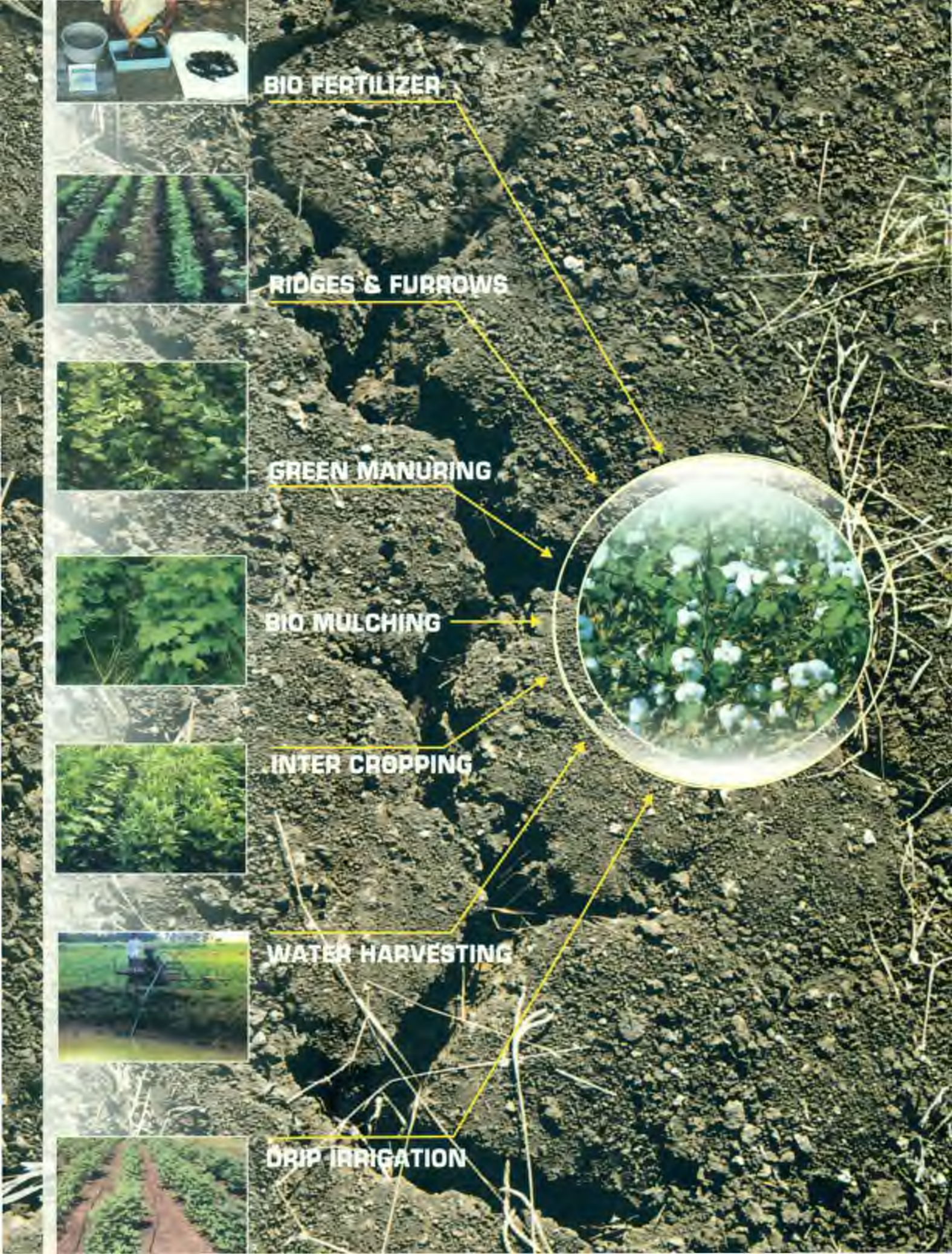
The sensitivity of ladybird beetles to 21 insecticides was determined. Fenvalerate, Profenophos and Deltamethrin were found to be the most toxic, while endosulfan, ethion, chlorfenapyr and spinosad were found to be the least toxic.

Determination of baseline toxicity for Cry1A toxins

The baseline toxicity of Cry1A toxins on field populations of the cotton bollworm, *Helicoverpa armigera* (Hub.) was determined through log dose probit analysis. All the three Cry 1A proteins were found to be toxic to the bollworm larvae. Cry1Ac was found to be the most toxic followed by Cry1Aa and Cry1Ab. LC_{5} s ranged from 0.07 0.99 g/mL (14-fold) for Cry1Aa, 0.69 9.94 g/mL (14-fold) for Cry1Ab and 0.01 0.67 g /mL of diet (67-fold) for Cry1Ac. The LC_{5} s deduced from the cumulative log dose probit response of the data pooled from all assays, were 0.62 g/mL for Cry1Aa, 4.43 g/mL for Cry1Ab and 0.100 g/mL of diet for Cry1Ac. The respective LC_{5} s represent the baseline susceptibility indices for resistance monitoring through the conventional log dose probit assays. The LC_{99} values derived from the cumulative data were 515 g/mL for Cry1Aa, 13,385 g/mL for Cry1Ab and 75 g/mL of diet for Cry1Ac. These values represent the diagnostic doses for routine monitoring of resistance to the respective toxins through discriminating dose assays after the introduction of Bt transgenic crops.

Development of a sensitive bioassay for the detection of Cry1A toxin expression in transgenic cotton

An assay based on the high levels of sensitivity of a leaf feeding insect, the semilooper, *Anomis flava* (Fabricius) to Cry toxins (Cry1Aa, Cry1Ab and Cry1Ac) was developed to detect Cry1A toxin expression in transgenic cotton. The assay is sensitive, quick and reproducible. Cry1Ac with LC_{50} and LC_{90} values at 1.12 and 2.68 ng/cm^2 was the most toxic followed by Cry1Ab and Cry1Aa. A severe growth inhibitory effect was noticed in all the surviving larvae of Cry1Ac even at the lowest dose of 0.9 ng/cm^2. Apart from being used to detect expression in putative Bt cotton transgenic plants, the assay can also be used to follow the activity of Cry toxins in transgenic cotton plants in the field during the growing season.


BIO FERTILIZER
RIDGES & FURROWS
GREEN MANURING
BIO MULCHING
INTER CROPPING
WATER HARVESTING
DRIP IRRIGATION