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केन्द्रीय कपास अनुसंधान संस्थान, नागपुर

CENTRAL INSTITUTE FOR COTTON RESEARCH, NAGPUR

वार्षिक रिपोर्ट

Annual Report

2002-03

Central Institute for Cotton Research, Nagpur

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

CICR

Central Institute for Cotton Research

Post Bag No.2, Shankar Nagar PO.,
Nagpur 440010 (Maharashtra, India)
Tel. No. (07103) 275536/275549
Fax : (07103) 275529
Email: cicrngp@rediffmail.com
cicrngp2003@yahoo.com
Website: http://www.cicr.nic.in

Published by
Dr. Phundan Singh
Director (Acting)

Editorial Committee
Dr. Phundan Singh
Dr. Sheo Raj
Dr. MRK Rao
Dr. T P Rajendran
Dr. P Ramasundaram

Compilation, Collation and Production
Dr. Mahendra Singh Yadav

Hindi Version
Dr. Kumudini Nautiyal

Computer Assistance
Shri Samir Chalkhure

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Shri P G Ghangare

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Preface

Cotton has always been an index of prosperity and economic well being of our country. Reaching pinnacle of glory as 'Dhacca Muslin' and its subsequent decline, cotton has regained its place in Indian economy. India is third largest producer of cotton. However, in India, cotton productivity hovers at about 310 kg/ha as compared to world average of 600 kg/ha. With Indian economy expected to surge forward and rapid increase in purchasing power of ever expanding Indian middle class, demand for cotton is expected to touch at about 220 lakh bales in the next ten years.

Last year in 2001-02, India witnessed reduction in production (136 lakh bales as compared to 158 lakh bales in 2000-01) as large areas of cotton growing states received scanty rainfall. There was also significant reduction in area under cotton (75.72 lakh ha) as compared to 2001-02 (88.51 lakh ha). However, despite this, there was slight increase in productivity.

Central Institute for Cotton Research has played a pivotal role in increasing quality and productivity of cotton. Several promising hybrids, with desirable quality parameters are in pipeline and will soon be entering trials. Diagnostic tool kits for detection of Bt cotton and latent infection of bacterial blight and cotton leaf curl virus have been developed. Innumerable 'On Farm Participatory Trials' under NATP, TMC and large scale demonstrations of IPM and IRM have validated technologies developed by CICR and taken them to doorstep of farmers. Cotton frontline demonstration, IVLP and Seed Village have brought enhancement of adoption of technologies and increased awareness in farmers about them. For mechanization of cotton farming, CICR has successfully developed bullock drawn cotton planter. For better implementation of IPM, CICR has developed an computer based expert system COT-IPM which could be used by extension officials for accurate and rapid diagnosis of insect pests and selection of appropriate insect management measures. As the nodal agency for the implementation of TMC-MM-I, more than 25 projects were executed in many centres all over the country. This has been made possible due to untiring efforts of my colleagues.

Despite all these achievements, CICR is making endeavour to reorient its research projects so as to meet projected needs of quality and productivity in the next two decades. Much emphasis is being placed on breeding for quality parameters. There is also need to modify system of grading at purchase centres from manual to instrument based grading so that cotton can be priced based on quality. CICR is intensifying R&D efforts so that pressures of globalisation will be effectively met.

I place on record my sense of gratitude for the guidance and leadership provided by Hon. Dr. Mangala Rai, Secretary, DARE and Director General, ICAR and Hon. Dr. Gautam Kalloo, Deputy Director General (Crop Science), ICAR, New Delhi in developing infrastructural facilities and manpower capabilities of the Institute. My thanks are also due to Dr. C D Mayee, Agriculture Commissioner, Minister of Agriculture, Govt. of India for his excellent stewardship during this period.

I am presenting the Annual Report (2002-03) with pride and sense of fulfilment of public scrutiny.

(Phundan Singh)
Director

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Introduction

Brief history with summary of past achievements

Indian Central Cotton Committee used to sponsor cotton research schemes on an adhoc basis till the work of the committee was taken over by the ICAR in 1966. All India Coordinated Cotton Improvement Project (AICCIP) initiated by the Council in the year 1967 with headquarters at Coimbatore gave new fillip and direction in terms of multidisciplinary and multi-centre approaches with the active involvement of State Agricultural Universities. The project has contributed significantly in tackling location-specific problems in terms of varietal improvement and development of appropriate production and protection technologies. However, looking to the low level of productivity which is primarily due to the fact that the major cotton growing area is under rainfed conditions and the need for expanding the research efforts in the spheres of basic and fundamental research the **Central Institute for Cotton Research** was established at Nagpur in the year 1976 by the ICAR. The erstwhile Regional Station of IARI at Coimbatore (Tamil Nadu) became a part of CICR simultaneously to cater to the needs of southern cotton zone. In the year 1985, the IARI Regional Station at Sirsa (Haryana) was transferred to CICR as a regional centre for the northern irrigated cotton zone.

Summarized Past Achievements

The main mission of CICR is to improve the production, productivity and profitability of cotton cultivation in different agro-ecological cotton growing zones through the development of relevant, feasible and economically viable and ecologically friendly production and protection technologies including the development of improved varieties and hybrids and promoting fundamental research.

The past achievements of the Institute are summarized below :

- Three kits viz., Bt-Express, Cry 1 Ac, Bt-Quant and Bt-detect were developed to identify Bt toxin in cotton seed/plant.
- Seed treatment with Imidacloprid and Iodine formulations maintained the seed viability and vigour with minimum loss, irrespective of the type of storage container.
- Skip row (2:1) irrigation and alternate furrow irrigation proved most profitable in saving irrigation water without affecting seed cotton yield.
- Drip irrigation with 70% of water used in flood method was found better with higher yields. Drip irrigation even with 50% of the nutrients supplied through drip irrigation was as good as supplying full dose of nutrients (100%) through the soil under flood irrigation.
- Performance of cotton under Cotton-Jowar-Cotton system was consistently better than under Cotton-Fallow-Cotton systems.
- The greater difference of palisade minus spongy parenchyma in *G.hirsutum* is a better indicator of drought tolerance than palisade thickness alone or total thickness of the leaf.
- A critical concentration of 1.5% nitrogen in leaf has been arrived at for identifying leaf reddening malady.
- Under simulated conditions of elevated CO_2 levels upto 660 ± 50 ppm in open top chambers, plant height, node number, sympodia, leaf number, dry matter production and seed cotton yield significantly increased throughout the crop growth.

- Physiological adaptation of cotton plants to water logging stress was seen in the form of development of lenticels with preparatory cell division at various planes beneath the parenchyma cells.
- A good relationship existed between the differential reducing sugar accumulation in fibre and seed than the absolute quantity with the fibre elongation process. Reducing sugars has a vital role to play in the fibre elongation process.
- Bollworm tolerant genotypes were characterised with higher levels of condensed tannin, terpenoid aldehyde gossypol, total and orthodihydroxy phenolics in squares.
- The project farmers of the "Farmer Participatory Research Programme on Insecticide Resistance Management" used less quantity of insecticides and recorded higher yield than the non-project farmers. The benefit cost ratio was also higher at 2.90 as compared to 1.66 to non-project farmers.
- The cross inoculation studies showed that there was enough variation among the isolates of *R.areola* and indicated the possible existence of races or differential strains in the pathogen population.
- The newer generation fungicides viz., Prochloraz 50 WP, Propiconazole 25 EC, Cyproconazole 60 SL and Hexaconazole 5 EC have been found effective in controlling both alternaria leaf spot and grey mildew diseases.
- The bioagents *T.harzianum, T. viride* and *P.fluorescens* (CHAO strain) have been found as effective as the fungicides in the management of grey mildew and alternaria leaf spot diseases.
- Varietal proliferation, intensive pesticide application, resort to natural farming are mainly risk aversion strategies.

Promising Technology Generated

Bt-Cotton Testing Kits

Testing for seed purity and for expression of Bt-toxin in plants have assumed importance for seed producers and farmers. Monitoring the expression through Cry toxin quantification is of paramount importance both in the initial and final steps of development of transgenic plants. CICR has developed three kits for testing the expression of Bt-toxin in plants at the users' level.

The **Cry 1 Ac Bt- Quant** is an ELISA Kit, which facilitates a precise quantification of Cry 1 Ab or Cry 1 Ac, expressed in transgenic plants. It takes about four hours for completion of one set of ELISA assay. Each ELISA plate can be used for 96 samples.

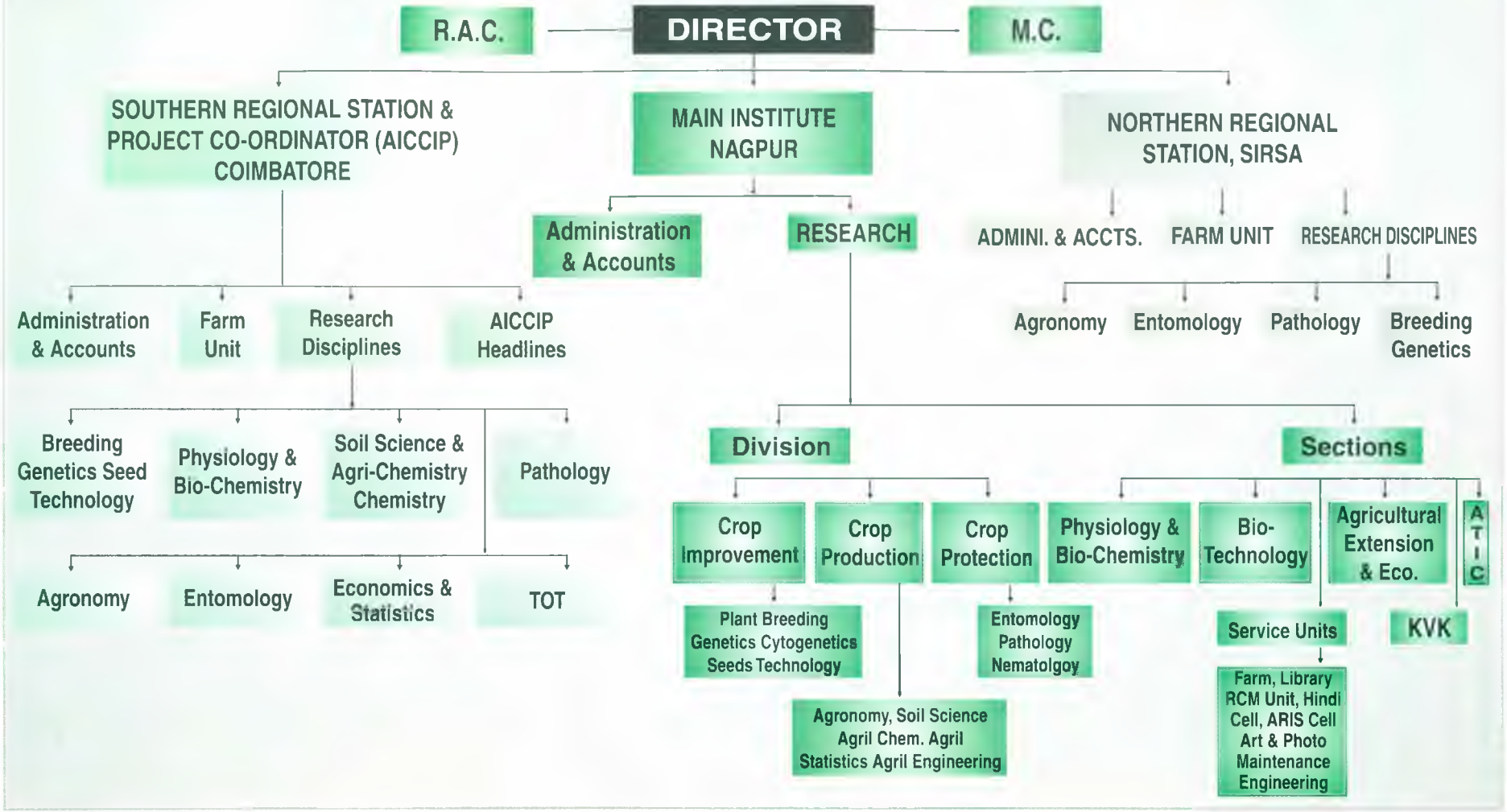
Cry 1Ac Bt-detect : This is a dot-blot assay and enables the user to detect the presence of Bt. toxin in seeds or plant tissue. Each kit can be used to test 100 samples. It takes about 2-3 hours for completion of one set of test assay.

Cry 1 Ac Bt express : This is a dip-stick format and can be used by even a layman, for instantaneous detection of Bt toxin in either seeds or plant tissue. The test can be used in fields and does not require any additional facilities for use.

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.

ORGANIZATIONAL SETUP



Financial Statement

The budget grant and actual expenditure for the year 2002-2003 are furnished below:

Budget Sanctioned and Expenditure		(Rs. in Lakhs)
Scheme	**Sanctioned**	**Expenditure**
Plan	120.000	120.000
Non Plan	823.000	810.480
PLAN SCHEME		
NSP Crop	-	0.392
AICCIP	410.000	410.000
KVK scheme	23.176	21.508
NATP	155.351	179.197
AP CESS FUND		
IQRC&P	3.179	0.326
IICBP	2.216	5.883
ENBCHABC	-	2.490
R DEPOSIT SCHEME		
NRI (ICAC/CFC/14)	24.000	16.444
EPSLC (De Nocil)	-	0.328
Development of molecular tools (DBT)	-	3.614
FLD in Cotton	3.500	2.124
TMC MM-I (ICAR)	112.550	112.536
TMC MM-I (DAC)	-	39.754
FLD KVK	0.467	0.827
DUS Scheme	10.000	9.579
Breeder Seed Scheme	2.471	1.278
TMC MM-II	34.480	23.814
Aventis	2.000	0.947
Toxicity of Bt (CRY)	7.770	2.362
Bt. Resistance Monitoring (Mahyco)	4.000	0.421

Staff Position

Name of Post	Sanctioned Cadre Strength				Post Filled Up			
	NGP	**CBE**	**Sirsa**	**Total**	**NGP**	**CBE**	**Sirsa**	**Total**
Director	1	-	-	**1**	1	-	-	**1**
P.C. & Head	-	1	-	**1**	-	1	-	**1**
Scientific	54	26	5	**85**	39	17	6	**62**
Technical	48	32	10	**90**	45	32	10	**87**
Administrative	33	11	8	**52**	31	11	8	**50**
Supporting	77	48	14	**139**	71	45	13	**129**
KRISHI VIGYAN KENDRA								
Training Organizer	1	-	-	**1**	1	-	-	**1**
Technical	9	-	-	**9**	8	-	-	**8**
Administrative	2	-	-	**2**	2	-	-	**2**
Supporting	2	-	-	**2**	1	-	-	**1**

Research Achievements

Crop Improvement

Nagpur

P1-86/1-ICR-F30/0430:

Collection, conservation, evaluation, documentation and utilization of genetic resources of cultivated species of *Gossypium* (V. V. Singh and Punit Mohan).

G. *hirsutum*

About 625 germplasm accessions of core collections, 400 working collections, 1540 base collections, 580 exotics, 130 new collections and 1200 accessions for registration (NBPGR) were grown and evaluated. Characterization/evaluation of core, working and new collections revealed wide range of variability for most of the economic attributes, fibre characters and reaction to major insect pests and diseases. The range was 3 to 160 g per plant for seed cotton yield, 1.6 to 5.2 g for boll weight, 18 to 35 mm for mean halo length and 31 to 45 % in ginning outturn. Elite germplasm lines identified were PSBCT8 and UPLC2 for seed cotton yield, MHR 11 and Nazilli 84 for boll weight, PCBCT 10 and NM 970513 for mean halo length and PSBCT 8 and CT 10 for GOT.

Multilocation evaluation of 100 germplasm accessions under Br 01 trial of AICCIP at Nagpur (rainfed), Sirsa and Coimbatore (irrigated) resulted in identification of ten best genotypes for major economic characters.

In all, 930 accessions of G. *hirsutum* were stored in medium term cold storage (4^0 C, 35 RH) at the Institute while 32 accessions of G. *hirsutum* and 530 of G. *herbaceum* were deposited in the long term cold storage conservation (-20 ^{0} C).

Forty three accessions were identified as salinity tolerant under field condition. The important ones are 79-4304-P-1, AR 27, Khandwa-2, DHY 286, DS 61, G-21-17-619-3, Pusa-31, Deviraj, BN Red etc.

More than 1400 accessions belonging to various groups were documented including passport data of 268 new collections.

The CNH 123, a CLCuV resistant genotype of G. *hirsutum* race *latifolium* was developed and registered with NBPGR, New Delhi as INGR No. 02021 (IC 325211).

G. *arboreum*

In G. *arboreum* , 119 germplasm accessions were collected from Mizoram, Andhra Pradesh and Orissa. About 75 germplasm lines were evaluated for salt tolerance at CSSRI, Regional Station, Anand. The differences for seed cotton yield were highly significant and varied from 10.5 g to 60.3 g per plant. The highest seed cotton yield per plant was recorded in AC 3127 B followed by AC 3655, AC 3206, AC 3209 and AC 3581 (MLL).

A set of 100 germplasm accessions was evaluated at three locations viz. Sirsa, Nagpur and Coimbatore. Ten best accessions for seed cotton yield, boll weight, GOT and mean halo length were identified. A wide range of variation was observed for seed cotton yield per plant (40.05 87.22 g), boll weight (2.9 3.1 g), ginning percentage (36.0 40.0 %) and mean halo length (22.3 25.0 mm). At Nagpur the ten best germplasm lines for seed yield included GDH 149 (SEL), Rasi-1, GDH 22 (SEL), YMLL, AC 3234, NA 78, AC 3361, JLH 2, 78/1 A BLL, AC 3644 and AC 3268.

One unique germplasm accession (30838) immune to grey mildew *(Ramularia areola Atlc)* has been registered with NBPGR, New Delhi as INGR No. 02020. More than 260 germplasm accessions were supplied to

various research centres of SAUs.

G. *herbaceum*

After characterization, the seed of 530 germplasm accessions was deposited with NBPGR, New Delhi. Another set of 530 germplasm accessions of G. *herbaceum* has been conserved at CICR, Nagpur. A set of 530 germplasm lines was evaluated for fibre properties at CIRCOT, Mumbai and at quality evaluation unit of CIRCOT, Surat. A wide range of variability for fibre length (18.9 to 27.9 mm), strength (13.5 23.5 g/tex), uniformity (45 54 %), and fineness (3.0 7.2) was observed. A set of newly collected 27 germplasm lines of G. *herbaceum* was evaluated for yield and fibre properties. The highest yield was recorded by IKAPO-01/33 (139 g/plant).

P1-86/2-ICR-F50/0430:

Conservation of wild species of *Gossypium* and introgressive hybridization for the improvement of cultivated species of Cotton (Vinita Gotmare, M.K.Meshram, S.Vennila, G. Balasubramani and K.B.Hebbar).

Twenty four wild species, races and perennials as well as sterile interspecific hybrids and synthetic polyploids are maintained. Eight sterile interspecific F_1 hybrids were established during the year.

In 156 single plant selections made from introgressed material, the seed cotton yield ranged from 7.1 to 151 g per plant.

An ideal plant type (MSH-sp-91) with zero monopodia was isolated in the population of multi species hybrids (*G. hirsutum, G. raimondii, G. barbadense* and *G. thurberi*).

The seed cotton yield of 16 entries was at par with the best check (PA 183), only 5 entries, Ponduru × *arboreum* (F2-6), Ponduru × *arboreum* (F2-8), Ponduru × *arboreum* (F2-1), GISV 2511699 × G. Cot 10, GISV 201 excelled in performance.

Best performing F_1's on the basis of yield/plant were DSFH1 x G. Cot. 16, IS-376-4/2-line 13 x LH886, GISV-213 x NHH 44 and MSH x Kh-3.

P1-2000/1-ICR-F-30/0430:

Breeding for high yielding, long staple genotypes of G. *arboreum* cotton with high fibre strength (Punit Mohan and P. Singh).

A set of 29 advanced cultures was tested at Central Soil Salinity Research Institute, Regional Station, Anand. Yield differences were found statistically significant. The salt tolerant cultures identified included CINA 324, CINA 305, CINA 323-A and CINA 316. In these four cultures, the seed cotton yield per plant varied from 65.7 to 68.5 g/plant against 34.2 g/plant of check AKA 8401.

Based on high boll weight, yield per plant, fibre strength and length, 10 new cultures viz. CINA 303, CINA 305, CINA 317, CINA 322, CINA 325, CINA 326, CINA 327A, CINA 327B, CINA 330 and CINA 331 were identified for further seed multiplication and evaluation.

Based on seed cotton yield, earliness and medium and superior fibre length coupled with high fibre strength, 157 single plant selections were made from segregating populations (F_3 and F_6). These cultures have high boll weight, high fibre strength, medium fibre length, earliness and locule holding capacity. Involving new elite genotypes of G. *arboreum* and G. *herbaceum*, 97 new crosses were effected for further evaluation. One culture viz. CINA 316 has been promoted from Br 22 to Br 24 in Central zone. A new culture (CINA 318) has been sponsored for evaluation in the National Elite Varietal trial (Br 22 a and b) .

The superior crosses included GAK 42340 x AKH 4 (2.7 g), GAK 8615 x K 6 (2.8), GAK 8615 x K-9 (2.8 g) and Sujay x AKA 8401 (2.8 g) for high boll weight; Sujay x K-6 (68.7 g), GAK 4234 x K 10 (58.9) , GAK 423 x AKH 4

(77 g) and 35 N x K 10 (56.9) gave high seed cotton yield per plant and GAK-4234 x AKH 4 (41.7 %), GAK 4234 x AKA 8401 (41.4 %) for high ginning out turn.

Crosses GAK 4234 x K-9 and Sujay x K 10 gave seed index of above 6 g. The crosses GAK 4234 x K 10, GAK 4234 x AKA 8401 and GAK 4234 x K 9 recorded higher seed lint index (3.9 g). In single plant selections, done in F_2 generation - selections from a cross GAK 4234 x CINA 326 (3.2 g) gave high boll weight of 3 gm. Crosses GAK 4234 x CINA 330, GAK 4234 x CINA 313 and GAK 4234 x 327 recorded more than 70 bolls per plant. The cross GAK 4234 x CINA 316 (28 mm) recorded high staple length of 28 mm.

P1-88/1-ICR-F 30/0430:

Genetical and anatomical studies for drought tolerance in cotton G. *hirsutum* (Suman Bala Singh and N.K.Perumal).

Segregating populations (25 F_4 and 18 F_6) and 23 advance cultures were tested under rainfed and irrigated conditions to assess drought susceptibility index. Out of the F_4 crosses evaluated, P3 x SP 3892 (c), LL 56 x SP 3892 C, S 4626 x SP 3892 cy and Badnawar x SP 3892 cc were identified as drought tolerant. The seed cotton yield ranged from 305 to 978 kg/ha under rainfed and 731 to 1560 kg/ha under irrigated condition. Among the 18 crosses of F_6 generation, P8 x AV 3469 was the best performing cross under both rainfed and irrigated conditions but its DSI was 117.6 % indicating that it is susceptible to drought. Crosses P3 x AV 3469, P6 x AV 3469 and P3 x A 72-62 recorded low DSI and were identified as drought tolerant cultures. Culture P6 x AV 3469 recorded a fibre strength of 24.7 g/tex, fibre length of 30.5 mm and 3.5 micronaire value. Its strength to length ratio was 0.80. Among the 23 advance cultures tested, Mysore Vijay x P3, B 58 1290 x P3 and LL 56 x P3 were found superior under rainfed condition. Cross LL 56 x P3 recorded DSI of 55.3 %

Thirty three single plant selections were tested in replicated trial and 136 SPS under unreplicated trial. The SPS 29 recorded the highest seed cotton yield of 1285 kg/ha with 124.0 and 126.5 % increase over the check PKV 081 and LRA 5166 respectively. The SPS 52, SPS 32 and SPS 36 were other good performing selections. Among the 138 SPS tested, SPS 105, 104, 117, 101, 111, 120, 128, 114, 119 and 113 were found promising.

Of the five cultures evaluated for salt tolerance at CSSRI Regional Centre, Anand DTS 25 and DTS 28 were found tolerant. They recorded seed cotton yield of the best cultures identified and recorded were 59.2 and 55.8 g/plant. The yield of LRA 5166 check was 34.7 g/plant.

P1-2000/2-ICR/F30/0430 :

Breeding cotton genotypes suitable for cultivation in shallow soils (Vinita Gotmare, Punit Mohan, K.S.Bhaskar and N.K.Perumal).

Sixty G. *hirsutum* genotypes were evaluated along with LRK 516 and PKV 081 as local *hirsutum* checks in a twice replicated trial with two replications. Similarly, seventy two G. *arboreum* genotypes were tested with AKA 8401 and AKH 4 as local checks. G. *hirsutum* genotypes namely JBWR-36 (879 kg/ha), Macha (601 kg/ha) and Tx ORS-80 (583 kg/ha). recroded high yield against local check LRK 516 (412 kg/ha). G. *arboreum* genotypes namely 30807 (1342 kg/ha), 7169 (1296 kg/ha) and B-11 (1203 kg/ha) recorded high seed cotton yield against check variety AKA 8401 (833 kg/ha).

Breeding trial on Bt cotton (Punit Mohan and P. Singh).

A breeding trial on Bt Cotton was conducted under rainfed conditions using recommended agronomic practices. Six Bt cotton hybrids viz., RCH 2, RCH 20, RCH 134, RCH 138, RCH 144, and MECH 162 and their non Bt

counter parts along with check NHH 44 and G.Cot.Hy 10 were evaluated.

Seed Cotton yield was significantly higher in Bt cotton hybrids as compared to non Bt hybrids and checks. The highest seed cotton yield was recorded by RCH 2 Bt (2015 kg/ha) followed by RCH 138 Bt (1953 kg/ha), RCH 20 Bt (1794 kg/ha) and RCH 144 Bt (1751 kg/ha) against non Bt hybrids and the Check NHH 44 (1251 kg/ha) and G. Cot. Hy 10 (1539 kg/ha).

P1-2002/1-ICR-F30/0430:

Studies on genetic enhancement of upland cotton (T. R. Loknathan, P. Singh, D. K. Agrawal, Vinita Gotmare, S. Vennila and M. K. Meshram).

Selection of parental lines

Seven lines were selected based on evaluation data presented in the catalogue of cotton genetic resources. Selective elite released varieties viz. LRK 516, G. Cot 10, PKV-081, MCU-5, Arogya, LH 134, CNH 36, H-777, Rajat and LRA 5166 were used as female parents. Germplasm lines viz., Reba Pvt 9 cc, Reba Pvt 9 lyy, Deltapine 66, G 21-17-619-3, A 72-62, DC 534-3, Galama and Suvin were used as male parents. A number of cross combinations using these parents was effected. Reciprocal crosses were effected between three germplasm lines viz. Reba Pvt 9 lyy, Reba Pvt 9 cc and Deltapine 66 with Rajat and MCU 5. Suvin as a donor was crossed with the above mentioned germplasm lines. LRA 5166 was also crossed with two elite cultures viz. CNH PT 6 and CIHS 97-9.

Inter specific crosses attempted

Introgressive hybridization between wild diploid species G. *stocksii* G. *barbosanum* G. *trilobum*, G. *thurberi*, G. *bickii*, G. *davidsonii*, G. *somalense* and G. *anomalum* and cultivated tetraploid (LRA 5166), species was attempted. Three races of G. *arboreum* viz. *indicum*, *sinense and bengalense* were also crossed with LRA 5166. In all, 70 cross combinations were effected and crossed seeds were obtained.

Coimbatore

P1-75/2-ICR-F-30/0430:

Development of high yielding intra *hirsutum* hybrids (K.N. Gururajan and S. Manickam).

In the station trials, three hybrids viz., K 8 x TK 30, LK 16 x TK 33, LK 6 x TK 31 were superior to Savita both in yield and quality (Table 1).

Table 1. Performance of intra *hirsutum* hybrids

Hybrid	Mean seed cotton yield (q/ha)	Ginning Per cent	2.5 % SL (mm)	Micronaire	Strength (g/tex)
LK 8 x TK 30	33.9	37.5	27.7	5.0	26.2
LK 16 x TK 33	32.5	39.0	31.1	4.7	26.3
Savita (c)	23.9	32.0	34.1	4.9	26.3
CD 5%	8.0				
LK 6 x TK 31	32.6	40.0	30.0	5.2	28.1
Savita (c)	22.7	33.5	33.0	4.3	25.9
CD 5%	15.1				

CCHH 10555 recorded a mean seed cotton yield of 23.9 q/ha and ranked second as compared to the check LHH 144 with 22.0q/ha ranking sixth.

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).

Medium staple culture CJ 1007 and C 1301 with a mean seed cotton yield of 21.0 q/ha was superior to all the three check varieties (Sumangala - 20.5 q/ha; Anjali -15.5 q/ha; LRA 5166- 11.6 q/ha). Quality-wise, they were on par with LRA 5166 and superior to Sumangala. Culture CCH 4 recorded the highest yield in both central and south zone trials (Table 2). The culture was also resistant to Alternaria leaf spot disease.

Table 2 . Mean performance of CCH 4 in coordinated varietal trial (South Zone and Central zone - irrigated)

Culture	Mean seed cotton yield (q/ha)		2.5 % SL (mm)		Micronaire (g/tex)		Strength	
	South Zone (4 Locations)	Central Zone (5 Locations)	SZ	CZ	SZ	CZ	SZ	CZ
CCH 4	25.7	13.2	29.2	25.8	4.8	3.7	20.3	22.3
Zonal Check	24.4	10.8	27.2	26.2	3.7	3.0	19.6	24.9
Local check	22.8	-						

Zonal Check: Sumangala (SZ); LRA 5166 (CZ)

P1-89/3-ICR-F30/0430:

Development of high yielding and high spinning extra long staple cotton (S. Manickam and K.N. Gururajan).

Of the twenty cultures tested, L 510-3 (RCH x T 13) recorded the highest yield of 25.5 q/ha as against 11.6 q/ha of Surabhi. However, quality wise VTV 6 (17.2 q/ha) was the best culture with fibre properties on par with Surabhi and MCU 5 VT.

In the Coordinated varietal trial, culture CCH 526612 recorded a mean seed cotton yield of 24.6 q/ha and was superior to both MCU 12 and Sumangala (Table 3).

Table 3 . Mean performance of CCH 526612 in coordinated varietal trial (South Zone-irrigated)

Culture	Mean seed cotton yield (q/ha)	Ginning Per cent	2.5 % SL (mm)	Micronaire	Strength (g/tex)
CCH 526612	24.6	37.2	31.3	4.8	21.4
MCU 12 (LC)	22.1	36.8	33.0	4.5	22.6
Sumangala (cc)	22.9	39.9	29.5	5.1	21.0

P1-89/1-ICR. F30/0430:

Development of extra long staple high spinning hybrids of interspecific origin with wider adaptability (S. Manickam and K.N. Gururajan).

Of the seventy six interspecific hybrids (HXB) tested, six recorded significantly higher yield over the best check (TCHB 213). The conventional hybrid LK 8 X P 27 recorded the highest yield of 28.7 q/ha followed by LK 12 X P 27 with 27.3 q/ha as against 21.9 q/ha recorded in TCHB 213. Among the GMS based hybrids, G 10 X P 30 was the best, recording a yield of 21.6 q/ha. For 2.5% span length, the GMS based hybrid G 8 X P 28 was the best with 41.3 mm, whereas for fibre strength the hybrid G 10 X P 28 was the best with 29.2 g/tex bundle strength.

CCHB 1054 recorded a mean seed cotton yield of 15.9 q/ha in the coordinated trial and was superior to both the checks DHB 105 (14.3 q/ha) and TCHB 213 (12.8q/ha).

Maintenance and Evaluation of Cotton Germplasm (S. Manickam).

Of the two hundred accessions in each of *G. hirsutum* and *G. arboreum* species evaluated. A wide variability was noticed in both morphological and agronomical characters (Table 4).

Table 4. Variability in Germplasm accessions

Character	*G. hirsutum*						*G. arboreum*					
	Old Set			New Set			Old Set			New Set		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
Plant Height (cm)	76.3	105.3	90.0	76.5	106.3	44.7	114.8	162.7	110.0	114.8	167.7	57.7
No. of Monopodia / Plant	0.4	2.0	0.0	0.4	2.0	0.0	21.3	28.3	11.0	22.3	34.3	13.3
No. of Sympodia / Plant	15.9	21.0	7.3	15.3	20.3	9.0	1.0	13.3	0.0	1.3	3.3	0.0
No. of bolls/plant	8.3	18.3	2.3	9.0	17.3	2.7	17.0	33.3	2.7	15.5	30.7	4.0
Boll Weight (g)	4.2	6.8	2.9	4.4	7.8	2.7	2.6	3.5	1.6	2.9	4.4	2.0
GOT (%)	37.8	44.9	30.6	37.7	44.9	28.9	6.2	8.0	4.6	6.6	8.7	4.5
Seed Index (g)	8.7	13.6	6.7	9.0	14.2	6.3	3.8	5.1	2.4	3.8	5.1	2.7
Lint Index (g)	5.3	8.1	3.5	5.4	8.0	3.1	37.9	45.1	30.1	36.4	45.8	29.3
Seed Cotton Yield (g/plant)	18.8	48.4	3.2	19.5	38.5	5.3	31.4	55.1	6.2	30.0	56.5	6.3

Three hundred and twenty six accessions of *G. barbadense* and 390 working collection of *G hirsutum* accessions were maintained. Yield evaluation of elite *G. hirsutum* germplasm lines indicated that accession IC GH 561-2 recorded a mean yield of 29.3 q/ha (75 % increase over LRA 5166).

P1-89/5-ICR-F30-0430:

Development and utilization of cytoplasmic and genetic male sterility for hybrid seed production and fertility restoration in cotton (S. Manickam).

Genetic male sterile based hybrids GMSH 17, 26 and 27 were significantly superior to the male sterile based check PKV Hy 4 (Table 5). Quality wise also, they were superior to the male sterile based check PKV Hy 4. However, all the male sterile based hybrids were lower yielding than the conventional check Bunny or DHH 11.

Table 5 . Performance of GMS based hybrids

Hybrid	Seed Cotton Yield (q/ha)			2.5% SL (mm)		Micronaire		Strength(g/tex)	
	Test Hybrid	PKV Hy.4 (c)	% inc. over Check	Test Hybrid	PKV Hy.4 (c)	Test Hybrid	PKV Hy.4 (c)	Test Hybrid	PKV Hy.4
GMSH 17	16.6	12.8	30	28.0	30.3	4.9	4.6	23.6	23.1
CD 5%		7.4							
GMSH 26	22.3	15.6	43	26.9	28.8	5.0	4.8	23.3	23.0
GMSH 27	21.3	15.6	28	29.6	28.8	4.7	4.8	24.7	23.0
CD 5%		6.4							

Among the cms based hybrids MS S x M recorded the highest yield of 28.3 q/ha as against 25.9 q/ha of Bunny. A perusal of two years data indicated that J 34 x Suman (17.9 q/ha) and G 67 x Suman (17.2) were superior to the check hybrid (17.0 q/ha).

Eleven genetic male sterile lines and 35 cms lines are being maintained apart from other lines received through other sources. The *G. aridum* species has been successfully utilised to diversify the cms base and new R lines are being developed.

P1-89/6-ICR-F30-0430:

Interspecific and inter-racial hybridization and gene transfer in *Gossypium* (S. Manickam).

Inter racial derivatives (9 x 1)x(14b x 4)-3 with a seed cotton yield of 28.5 q/ha (check variety Sumangala -18.9 q/ha), IRH 1-9-[3] with 29.0 q/ha (check variety LRA 5166 - 15.8 q/ha), 12-32 HS-[3] with 28.4 q/ha (check variety LRA 5166 - 15.8 q/ha), IRH 1-10-[3] with 37.9 q/ha (check variety LRA 5166 - 21.3 q/ha), recorded significantly higher yield. Some of the inter racial derivatives were also characterized by high ginning out turn (> 40 %) and big bolls (>5.5 g).

Sirsa

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 demonstration trial consists of 12 hybrids developed at the station. Each entry was sown in an area of 48.6 sq. meter with 100x 45 cm spacing. CSHH 198 gave the highest yield of 2453 kg/ha followed by CSHH 4311 and CSHH 238y. The ginning outturn ranged from 30 to 33 per cent. CSHH 825 has shown the highest bundle strength of 24.1g/tex and has been sponsored for multilocation testing under AICCIP National trial Br 05(a-1).

CSHH 198 ranked 1st and CSHH 238 ranked 5th in the AICCIP trial of North zone. CSHH 243 ranked 3rd in the preliminary National trial during 2002-03. CSHH 243 recorded the seed cotton yield i.e. 2283 kg/ha with 2.5% span length of 26.5 mm.

Local conventional hybrid trial 1:

The trial comprised 42 hybrids with local check, Om Shankar. Three hybrids recorded significantly higher seed cotton yield over the local check. The highest yield of 3542 kg/ha was recorded in F 505 x PIL 8 followed by LRA 5166 x HS 6 and H 1098 x PIL 8. The highest ginning out turn of 36% was recorded by hybrid LRA 5166 x HS 6. The hybrid LH 1556 x RST 9 has shown the highest bundle strength of 24.1g/tex and followed by the

hybrid LRA 5166 x HS 6.

Local conventional hybrhid trial 2 :

The trial comprised 60 hybrids evaluated in unreplicated trial. Only one cross i.e HS 6 x 7 recorded higher seed cotton yield. Highest seed cotton yield of 403 kg/plot was recorded in cross combination HS 6 x 7 followed by 307 kg/plot in LRA 5166 x 10 . Maximum ginning out turn was recorded to be 36% in HS 6 x 4.

Performance of *G.hirsutum* cultures in different AICCIP trials

Performance of CSH 7106 in Br-02 National trial 2002-2003

In the AICCIP North zone trials, the culture CSH 7106 recorded the seed cotton yield i.e.1637 kg/ha with 35% ginning outturn and ranked 5th in this trail and promoted to Br 0 3(a) of north and central zone.

Performance of CSH 33 in Br 03(a) Zonal trial- 2002-2003

In the AICCIP North zone trials, CSH 33 recorded the seed cotton yield i.e.1658 kg/ha with 35 % ginning outturn and ranked 4th in this trial and promoted to Br 0 4(a) of north zone.

Development of male sterility based hybrids of *G. hirsutum* for North India

(O.P.Tuteja, D.Monga and P.Jeyakumar).

Fifteen CMS, five GMS and 20 restorer lines are being maintained through selfing in addition to five GMS and 10 CMS lines being converted to male sterility. The CMS based hybrids attempted between CMS lines and restorer lines were evaluated to Local CMS based hybrid trial.

Local CMS based hybrid Trial 1: Sixteen CMS based hybrids were evaluated against two conventional check hybrids i.e Om Shankar and LHH 144 in randomized block design with three replications. SPC 17 x CIR 15 and SPC 17 x CIR 23 were found to give more seed cotton yield in comparison LHH 144 (1667 kg/ha) and Om Shankar (1780 kg/ha). Maximum ginning out turn of 39% was recorded in the cross combination SPC11x CIR16. SPC 15 x CIR 4 and SPC 1 x CIR 38 recorded the highest 2.5% span length of 31.1 and 30.7 mm, respectively.

Local CMS based hybrid Trial 2 : Of the hundred and seventy four crosses attempted between CMS lines and restorer lines, 128 could set seed and rest were sterile. The 129 CMS based hybrids were evaluated in comparison Om Shankar and LHH 144. CMS 3 x CIR 8, CMS 4 x CIR 32 and CMS 2 x CIR 32 were found to give more seed cotton yield in comparison to LHH 144 and Om Shankar . Maximum ginning out turn of 36% was recorded in cross CMS 3 x CIR 48 and CMS 4 x CIR 23.

Agronomy requirements for new/pre-release *hirsutum* hybrids

Among the four hybrids evaluated, CSHH198 recorded significantly higher seed cotton yield over the Omshankar and LHH 144. Planting of *G.hirsutum* at a spacing of 67.5 x 75 cm proved significantly superior to closer as well as wider spacing. Medium level of nitrogen i.e.125 kg/ha was found to be optimum under the existing condition. The increase in seed cotton yield of CSHH 198 was mainly due to increase in boll weight and boll number per plant.

Development of varieties and hybrids (MS based) of medium staple length in *Gossypium arboreum* L.

(Surender Kumar).

Development of varieties: Under this four advanced station trials were conducted for testing of the promising entries.

AVT-1:

Under this trial five entries were tested against the RG 8 in three replications. CISA-7 gave (3230.89 kg/ha) significantly higher seed cotton yield than check RG 8 (2103.32 kg/ha). The maximum GOT % was recorded by CISA-6 (33.0 %). The highest boll number (32.0) and

boll weight (2.3 gm) was recorded by CISA-4 and CISA-7 respectively.

AVT-2:

One entry namely CISA 25 (2255.13 kg./ha) recorded significantly higher seed cotton yield than check RG 8 (1797.88 kg/ha). The maximum GOT % was recorded by CISA 26 (33.8). The highest boll number (31.2) and boll weight (2.5 gm) was recorded by RG 8 and CISA 26 respectively.

AVT-3:

The entry CISA-52 (3817.55 kg/ha) gave significantly higher seed cotton yield than RG 8 (2846.36 kg/ha). The maximum GOT % was exhibited by CISA 56 (33.9). The highest boll number (41.2) and boll weight (2.8 gm) were recorded by CISA 36.

AVT-4:

This trial consisted of 15 entries which were tested against the PA 255 as check in three replications. Twelve entries gave significantly higher seed cotton yield than check PA 255. The maximum GOT % was recorded by CISA 65 (33.6). The highest boll number (32.4) and boll weight (3.5 gm) were recorded by CISA 11 and CISA 24 respectively. Six entries have exhibited span length more than 24 mm and three entries had strength more than 20 g/tex.

Generation of segregating material: A number of crosses were attempted between long linted strains received from Parbhani and Dharwad and the local cultivars. The F_1s obtained were evaluated two replicated trials and one unreplicated trial for staple length as well as for seed cotton yield.

Local hybrid trial 1:

Ten hybrids were tested against local checks RG 8 and HD 123 in three replications. None of the hybrid could significantly yield higher seed cotton over best local check RG 8.

The highest 2.5 % span length was recorded by RG 8 x CINA 316 (25.5 mm). LD 327 X PA 255 (24.1 mm), LD 327 X CINA 316 (25.2 mm) and SDH-8 (25.5 mm) gave 2.5 span length more than 24.0 mm. RG 8 x CINA 316 showed highest heterosis (34.21%) over check HD 123. The maximum GOT % was recorded by RG 8 X DLSA 8 (34.92). The highest boll number (39.6) and boll weight (3.2 gm) was recorded by RG 8 X DLSA 8 and LD 327 X PA304.

Local hybrid trial 2:

Among seventeen hybrids tested against local check HD-123 in three replications, none could give significantly higher seed cotton yield over check. The highest 2.5 % span length and heterosis for 2.5 % span length was recorded by HD 123 X DLSA 9 (25.6 mm). The maximum GOT % was recorded by RG 8 X DLSA 24 and RG 8 X PA 304 (36.0). The highest boll number (71.0) and boll weight (3.3 gm) was recorded by RG 8 x PA 255 and HD 123 X PA 255 respectively.

Development of Hybrids (MS based)

CISAH 3 having fibre length more than 24 mm performed well in AICCIP trial.

Collection, conservation and maintenance of genetic resources (R.A. Meena).

Under the Br 01 trial, 100 lines each of *G. hirsutum* and *G. arboreum* were evaluated for yield per plant, boll weight, boll number per plant, plant hight, mean hallo length, GOT, seed index, lint index, number of sympodia, number of monopdia, reaction to Jassid and CLCuV. The range and five superior lines for each parameter from Br 01 trial were identified. In addition to that 1145 germplasm lines of *G. hirsutum* and 535 lines of *G. arboreum* were maintained and evaluated for above parameters.

Seed Technology

Nagpur

P1-2000/ICR-F-25/0430:

Improvement of seed yield and its quality in hybrids and varieties (R. K. Deshmukh, M.R.K.Rao and Phundan Singh).

Effect of foliar application of potassium

nitrate on yield and quality

Potassium nitrate @ 2 % foliar spray (once) improved the yield by 63 kg/ha over control but not significantly. Quality in terms of seed index was increased by one gram but was non significant.

Impact of delinting method on seed quality

Three varieties namely AKA 7 (G. *arboreum*), PKV 081 and DHY 286 (G. *hirsutum*) were delinted by either gas or acid and stored alongwith fuzzy seeds of the same lot. Fuzzy seeds of PKV 081 and DHY 286 significantly showed lower germination compared to both the types of delinting. Further AKA 7 (diploid) had significantly lower germination as compared to other two varieties (tetraploid) in both the delinting methods.

Evaluation of varieties/hybrids for storage performance

Seeds of 13 varieties and hybrids were stored to study germination and vigour. Initially, all had 80 per cent germination and more than 2000 vigour index values. After 18 months of storage AKA 5 and LHH 144 had more than 80 per cent germination. DCH 32, AKA 5 and LHH-144 expressed a vigour index value of more than 2000.

Impact of boll damage on seed quality

In two varieties of upland cotton viz. Anjali and LRA 5166, seed cotton from fully open undamaged bolls (T_4) and from bolls with one (T_1), two (T_2) and three (T_3) good and undamaged locules were collected and observations were recorded on number of seeds per boll. In Anjali good seed number was 9.27, 10.46, 12.70 and 19.62 per boll in T_1, T_2 T_3 and T_4 respectively, while in LRA 5166 though the trend was the same, the seed number differed with 4.66 (T_1), 10.38 (T_2), 13.50 (T_3) and 18.41 (T_4).

Coimbatore

P1-97/1-ICR-F-25/0430:

Studies on viability, vigour and longevity of cotton seeds (K. Rathinavel, P. Chidambaram and K. Natarajan).

Improvement of cotton seed quality through halogen based formulations

Treatment of seeds with halogen based formulations exhibited significant differences in germination due to genotypes, ageing, seed treatments and the interactions. The viability improvement due to chlorine and iodine treatment was 11% and 9%, respectively over all the genotypes. In the artificially aged seeds also, the viability improvement due to chlorine and iodine was maintained in most of the genotypes tested.

Effect of polymer coating on the viability and vigour of cotton seeds

Coating of delinted cotton seeds with polykote, a starch based water soluble seed coating polymer, at 5 ml per kg of seed significantly enhanced germination up to 5% over uncoated seeds. However, a marginal decrease in root and shoot growth and dry matter of seedling was noticed when compared to uncoated seeds. Using of polymer higher than 10 ml kg^{-1} of seed reduced/ altered germination, seedling growth and vigour significantly.

Sirsa

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

Identification of suitable crossing period for higher yield and superior seed quality

The seed setting percentage was observed higher (above 85 %) up to 25 Sept. After that it also gradually declined. During this year the highest cross boll setting percentage was observed 32 per cent in Om Shankar and 38 in LHH 144. The cross boll setting percentage noticed higher during initial stage. After 18th of September it gradually declined and noticed below 12 per cent after first week of 1st

Oct. The germination and vigour index was also higher in seed received from crossing period up to 25th September.

Effective pollination from one male flower

At initial stage, by pollinating with one male flower, up to eight pollinated female flowers in both the hybrids (LHH 144 and Om Shankar) could set but the seed number in crossed boll declined if more than three female flowers pollinated. The boll setting after September 15th declined gradually and during late phase (September, 25) only up to three pollinated flowers in LHH 144 and four in Om Shankar could set and the seed number per boll declined if two female flower pollinated with one male flower in both the hybrids.

Picking wise seed quality: In case of varieties HS 6, RST 9, F 846, H 777, Suman, Anjali, LRA 5166, CNHH 3892, H 1098 and F 1050 the seed setting percentage, seed index, germination percentage and vigour index was noticed highest in second picking.

Standardization of delinting process and assessment of seed quality in floated seed

Among the various quanties of acid tested, 140 ml acid for *G. hirsutum* varieties and 125 ml for *G. arboreum* varieties was found optimum for one kg seed to remove all fuzz in 3-3.5 minutes. While washing, above 45 % seed in *G. hirsutum* and 28% in *G. arboreum* observed floated on water surface in which 35-40 % in *G. hirsutum* and 30-34 % in *G. arboreum* seed noticed germinable.

National Agricultural Technology Project

MM1: **Development of Hybrid Crops Cotton.**

Nagpur - (C.D.Mayee, Suman Bala Singh, P. Singh, Vinita Gotmare, S. Vennila, N.K.Taneja and M.K.Meshram).

Developing 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

During the year, 36 CMS, seven 'R' and 13 GMS lines were maintained in addition to 40 CMS, 10 GMS and 28 R lines received from cooperating centres. PH 93 B (583 kg/ha), LCMS 509 B (536 kg/ha) and Suman (416 kg/ha) were found superior lines under sprayed condition while AKH 8B (779 kg/ha), Badnawar and PH 93 B performed well under unsprayed conditions. Among the 'R' lines, AKH 5119 was ranking top both under sprayed and unsprayed condition followed by GSRH 24 and AKH 01-143 R. Out of the five GMS lines tested, GAK 32 A, DGMS 1 and DGMS 2 showed 1:1 segregation for male sterility and fertility. One newly converted GMS line i.e. LRA 5166 has been registered by Plant Germplasm Registration Committee of ICAR.

Among 41 GMS hybrids tested in two trials, four viz. NGMSH 11-03, NGMSH 13-03, NGMSH 1-03 and NGMSH 7-03 were found promising in first trial and recorded 10 % more heterosis than NHH 44. In second trial, three hybrids, viz. NGMSH 25-03, 26-03 and 31-03 were found superior. They recorded 14 % more heterosis than NHH 44 (local check).

Among the CMS hybrids tested in two trials, NCMSH 52-03 recorded the highest seed cotton yield (1141 kg/ha) and 15 % more heterosis than checks NHH 44, H8 and PKV Hy 4, while NCMSH 59-03 in the fourth trial recorded 836 kg/ha seed cotton yield with 72.06 % heterosis over H8 and 9.49 % over PKV Hy 4.

Under NATP common trial, 18 hybrids were tested alongwith check NHH 44. The hybrid CAHH 301 recorded highest seed cotton yield (1365 kg/ha) followed by GCMSH 46 (990 kg/ha) and NGMSH 110 (847 kg/ha) under unsprayed condition. CAHH 301 recorded

69.93 % and 179.93 % heterosis over NHH 44 and CAHH 99 respectively. However, under sprayed condition GCMSH 46 recorded the highest yield of 1177 kg/ha followed by FP3 x NH 380 (1082 kg/ha) and CAHH 301 (1003 kg/ha).

Breeding for early maturing intra and inter specific *desi* cotton hybrids for different agro-climatic zones

Five GMS lines of G. arboreum were evaluated and GAK 26 A and GMS 4-1 recorded 595 and 586 kg/ha of seed cotton yield out yielding other entries. Nine GMS based hybrids were evaluated in randomized block design. All the hybrids were superior to the check AAH 1. Hybrid GSGDH 62 recorded the highest seed cotton yield of 1484 kg/ha followed by AKDH 5 (1425 kg/ha).

Identifying, developing and diversifying the cytoplasmic and genetic sources of male sterility and effective stable restorer genes with fertility enhancing factors in *G. hirsutum* and *desi* cotton

Forty crosses involving 28 cultivars and eleven wild species were attempted with per cent success ranging from 12.5 to 100%. Among the ten reciprocal crosses attempted between eight wild and three cultivars, the success was low ranging from 7.1 to 50.0 %.

Five sterile F_1 hybrids were also obtained viz., Sahana x G. *harknessii,* NISD 3 x G. *harknessii,* LH 1134 x G. *harknessii,* AK 8401 x G. *stocksii,* and L 846 x G. *aridum.*

Screening of germplasm and identification of immune/resistant sources from the breeding material for important pests and to utilize them in the development of resistant hybrids

All the GMS, CMS, 'R' and 'B' lines were evaluated for important diseases. All except Badnawar showed no incidence of *Myrothecium* leaf spot. Both, A and B lines of genotypes viz. Badnawar, AK 8, LRK 516 and PH 93 showed moderately resistant reaction to *Alternaria* leaf spot. Among *desi* GMS lines, GAK 26A was resistant to *Alternaria* leaf spot. No incidence of *Myrothecium* leaf spot was recorded on these lines. Three lines, viz. PH 93, HGMS 2 (GMS lines) and LH 104 (R line) were immune to bacterial blight.

Among the hybrids CAHH 99 and CAHH 301 (A) in national trial and NCMSH 53, 57, 65, 45, 56, 61, NGMSH 10, 15, 22, 27, 28, 6, 18, 19, 31 and 33 in station trial were found immune/resistant to bacterial blight. Four hybrids, viz. CAHH 99, CAHH 301, NGMSH 28 and NGMSH 19 were found resistant to all the three major diseases.

All the entries viz. CMS, GMS, 'R' and B lines were found to be susceptible to Jassids, barring Badnawar and LRK 516 which were moderately tolerant to jassids. RCMS 3, PH 93, GSCMSB and RCMS 4 were moderately tolerant to bollworm under unprotected condition. Among the hybrids, LAMSH 3, RAJHHG 2 and CCHH 2 were found moderately tolerant to bollworm under unprotected condition.

Out of 153 hybrids evaluated under natural incidence of diseases in the field, 2 showed resistant, 63 moderately resistant while, 45 moderately susceptible and 43 susceptible for Alternaria leaf spot 128 lines, six were resistant and 19 moderately resistant against Myrothecium leaf spot.

Eighty five cotton hybrids were evaluated for bacterial blight reactions under field conditions. Out of these, seven were free from the bacterial blight incidence and nine exhibited the resistant reaction. Out of the remaining 14 were moderately resistant, 32 moderately susceptible and 23 susceptible.

Coimbatore - (S. Manickam)

Evaluation of CMS 'A' and 'B' lines

A common trial was conducted to evaluate 15 CMS 'A' and their corresponding 'B' lines along with MCU 5 VT, Sumangala and LRA

5166 as check varieties. The highest seed cotton yield was recorded in DMSA-15B (with 15.7 q/ha as against 14.9 q/ha recorded in Sumangala, the best check variety). The 2.5% span length ranged between 24.3 mm and 34.7 mm with a mean of 27.6 mm. The highest bundle strength at 1/8" was noted in Badnawar 'B' line with 23.9 g/tex.

Evaluation of restorer lines

When seven restorer lines developed from different cooperating centres were evaluated, few sterile plants were observed in some. The highest seed cotton yield was recorded in the check variety viz., Sumangala with 16.3 q/ha followed by LRA 5166 (12.5 q/ha) and DR 4 (10.6 q/ha). For 2.5% staple length, DR 4 was the best with 31.0 mm.

Evaluation of GMS lines of *G. hirsutum*

Six GMS lines viz., HGMS 2, Raj GMS 2, GAK 32, SH GMS 9, DGMS 1 and 2 were evaluated in an unreplicated trial for their stability. Of these six lines, Raj GMS 2 was found to segregate for normal, okra and super okra leaf types and it was found that all the plants in this line were sterile.

Evaluation of medium staple hybrids

In a common trial, 13 intra-*hirsutum* hybrids including NHH 44 and Bunny (Conventional hybrid checks) and PKV Hy-4 (MS based hybrid check) were evaluated. The hybrid CCHH 2 recorded the maximum seed cotton yield of 23.3 q/ha with 7 per cent increase over Bunny (21.7 q/ha). This hybrid also had highest lint index (6.7 g) and ginning outturn (39.1 %). For 2.5% span length, the hybrids CAHH 25 and the check hybrid, were the best, whereas, the highest fibre strength was recorded in the hybrid LMSH 104 with 23.6 g/tex.

Evaluation of extra long staple interspecific hybrids (H X B)

Five interspecific hybrids were evaluated in a common trial including DCH-32, DHB-105 and TCHB-213 as checks. The highest seed cotton yield was recorded in DHB-105 (21.9 q/ha) and among the entries, the hybrid CCHB 126 was the best with 17.1 q/ha of seed cotton yield. The hybrid CCHB 1026 recorded 2.5% span length of 38.3 mm, whereas the checks had a length of 33.9 to 37.2 mm. The maximum bundle strength was recorded in the check hybrid 27.0 g/tex followed by the test hybrid CCHB 426 with 26.8 g/tex.

Evaluation of existing and new promising *desi* GMS lines

Two sets of *desi* GMS lines were evaluated during the current season for their stability. It has been observed that, in none of the *desi* GMS lines, the segregation for fertile and sterile was found to be in 1:1 ratio. Most of the plants were found to be sterile and in some cases, semi-sterility was observed, wherein, few anthers burst pollen grains.

Evaluation of *desi* hybrids

Eight *desi* hybrids were evaluated in a replicated trial along with a hybrid check (AAH.1) and a varietal check (K 11) in a common trial. Two hybrids viz., RAJDH 80 (23.6 q/ha) and GSGDH 62 (23.1 q/ha) recorded significantly superior yield than the best check i.e., K 11 (with 15.0 q/ha). The hybrid DDAH 16 recorded the maximum 2.5% span length of 28.6 mm, whereas, the mean of the above was 23.1 mm.

MM3: **Sustainable Management of Plant Biodiversity Cotton** (V.V.Singh).

During the year, three explorations were conducted in Mizoram, Orissa and Andhra Pradesh and 268 samples were collected belonging to *G. hirsutum* (80), G. *arboreum* (119), *G. herbaceum* (41), *G. barbadense* (25) and unidentified (03). Some of these collections were made from hitherto unexplored area and high altitude (1200 m). In Mizoram, smooth stapled diploids and a few with striking marker characters were collected. Characterization and documentation of these samples were done and these were conserved.

PSR 27 : **Evaluation and Identification of Suitable Pest tolerant Compact Cotton Amenable to Mechanical Harvesting** (V.V.Singh).

Of the 18 new genotypes evaluated under National Common Trial, under closer spacing (90 x 10 cm) three superior genotypes were identified viz. ARB 8908 (1941 kg/ha), GSH 7 (1752 kg) and LH 1960 (1727 kg) against the check LRA 5166 (1019 kg). Under zonal trial, three best genotypes were CNH 152, GSH 2 and AZZLD 163.

Based on the performance of CNH 123 (2279 kg/ha), CNH 155 (1944 kg) and Hisar 3 (1716 kg) with CNH 36 (1792 kg) as check in large plot (10 rows) and closer spacings, their suitability for mechanical picking because of their dwarf compact nature and tolerance to pests and disease. Use of defoliant (ethrel @ 5000 ppm) on 150 DAS resulted in 90 95 per cent leaf shedding. About 85 100 per cent of seed cotton was harvested in most of the identified genotypes at 165 DAS.

RCPS-7 : **Promotion of productive high quality G . *arboreum* cotton to meet the needs of marginal cultivators of rainfed ecosystem vis-à-vis textile industry** (Vinita Gotmare).

The G. *arboreum* genotypes were cultivated in Institute farm as well as on the farmers' fields. Performance of G. *arboreum* genotypes was found to be better than *hirsutum* varieties / hybrids. The seed cotton yield of *arboreum* genotypes ranged from 1463 (MDL 2463) to 1698 kg/ha (DLSA 17) compared to 1290 kg/ha (Bunny) of upland cotton. Bunny recorded the highest GOT of 43.1% followed by 41.9 of PKV 081. Most of the genotypes tested were in the category of medium to long staple fibres. On farmers fields also, *arboreum* varieties such as PA 255 (810 kg/ha) and DLSA 17 (469 kg/ha) performed better whereas upland variety LRK 516 recorded the lowest yield of 413 kg/ha.

The redgram variety BSMR-736 was best suited for strip intercropping with *G. arboreum* genotypes. *Arboreum* variety PA 255 recorded seed cotton yield of 1134 kg/ha as sole crop and 1374 kg/ha as strip intercrop with tur variety BSMR 736.

RCPS-8 : **Characterization and identification of productive and high quality cotton species /genotypes including *G. herbaceum* suitable for different rainfed agroecological situation through farmers participatory programmes** (Vinita Gotmare).

There were six situations covering six districts :Deep soil and high rainfall (S-1), Deep soil and low rainfall (S-2), Medium soil and high rainfall (S-3), Medium soil and low rainfall (S-4), shallow soil and high rainfall (S-5) and shallow soil and low rainfall (S-6).

Trial : I

Twenty-three genotypes of *G.arboreum, G.hirsutum* and hybrids were tested under all the six situations. Under S 1, S 2 and S 4 situations, *G.arboreum* excelled in overall performance, where as under S 5 and S 6, hybrids NHH 44 and Bt hybrid MECH 162 dominated.

Trial : II

Under S 1, S 4 and S 6 situations, *G.arboreum* var. AKA 8401 showed highest response to split doses of fertilizer. In case of S 2, check H 10 recorded the highest response but variety AKA 8401 excelled in yield. NHH 44 showed positive response in split dose of fertilizer under S 5 situation.

Trial : III

Three high yielding genotypes were subjected to maximization of yield on farmers fields. Out of five situations, *G. arboreum* excelled under four (variety AKA 8401 S 1, S 2 S 6 and Jawahar Tapti in S-4), whereas (NHH 44) performed better under S 5.

Technology Mission on Cotton

MMA-1 : Identification and development of promising genotypes from introgressed material.

Nagpur - (Vinita Gotmare)

Hybridization between wild and cultivated species of *Gossypium*

Forty crosses involving 28 cultivars and 11 wild species were attempted with success per cent ranging from 12.5 to 100. Cross compatibility was good in crosses involving G. *lobatum* (58.3 %) G. *trilobum* (47.2 %) G. *anomalum* (36.3 %), G. *davidsonii* (27.8 %) and G. *stocksii* (31.2 %). Among ten reciprocal crosses attempted between eight wild species and three cultivars, success percentage was low ranging from 7.1 to 50.0.

In crosses between stable fertile introgressed selections and cultivated varieties and hybrids, more than 3000 flowers were pollinated, but only 105 crosses could set seeds.

Screening and evaluation of identified existing interspecific derivatives

Seventy six test entries received from nine collaborating centres and also selections developed at Nagpur were screened and evaluated alongwith 78 entries promoted last year.

Majority of the stable introgressed selections representing 69 % entries recorded poor to fair yield (100 to 1200 kg/ha), whereas 45 entries had high economic yield of 1200 to 2400 kg/ha. Two entries namely, Ponduru x *arboreum* ($F_{2\ 6}$) and Ponduru *x arboreum* ($F_{2\ 8}$) out yielded the entire collection of introgressed material and also the check.

The performance of various hybrid derivatives indicated that introgressive selections derived from G. *arboreum* were superior followed by G. *herbaceum* and G. *hirsutum*.

Fibre quality evaluation

Among 30 genotypes possessing long fibre, only four namely TCH 1650, GISV 213, MSH and AKH 2053 had good fibre strength, while among ten genotypes having superior length only, one entry viz. TCH 1653 possessed good fibre strength. Rai 9 was superior in staple length with very fine fibre and good uniformity.

Coimbatore - (S Manickam).

The segregating materials and other derivatives received from various cooperating centres were evaluated during the current kharif season for yield and other characters. Cultures viz., I.g.m.100, I.g.m.102, I.g.m. 105 and I.g.m.106 were found to be very early and compact. They were crossed with some agronomically superior lines for imparting earliness and compact plant type.

In MSH 345 sponsored by CICR, Nagpur, the flowers were cleistogamous (Plate 1.1) and did not open even after the fertilization was completed and the petals remained closed even after shedding. This culture is also characterized by big round boll (5.5 g) with 4-5 locules.

Sirsa - (Surender Kumar)

Trial 1:

Twenty two entires were tested against local check RS 810 in once replication. None significantly higher yielded over local check RS 810 . The five top yielding entries after local check RS 810 are Rai 7B 2 (1467.8 kg/ha), Rai 9 (1296.3 kg/ha), Rai 7B-1 (809.3 kg/ha), IH 35 (795.6 kg/ha) and MSH-SP-53 (768.2 kg/ha). The maximum GOT % was recorded by SAKA-01-5 (48.2). The highest boll number (25.33) and boll weight (3.3 gm) was recorded by SAKA-01-5 and IH 35 (HR) respectively.

Trial 2:

Eight genotypes of F_2 generation were evaluated, out of which ten promising single

plants were selected for further evaluation. The yield per plant ranged from 10 gm to 50 gm.

Trial 3:

Four genotypes of F_2 generation were evaluated, from which eleven promising single plants were selected for further evaluation. The yield per plant ranged from 28.2 gm to 109.0 gm.

Trial 4:

Four genotypes of F_3 generation were evaluated, out of which, fourteen promising single plants were selected for further evaluation. The yield per plant ranged from 25.0 gm to 100.0 gm.

MMA 2 : Identification and development of diploid cotton with high yield and fibre quality suitable for high speed spinning.

Nagpur (P. Singh and Punit Mohan)

Cultures CINA 316 (1944 kg/ha), G. Cot 15 (1817 kg/ha), PA 496 (1822 kg/ha) and PA 405 (1800 kg/ha) recorded high seed cotton yield. Both PA 255 and PA 405 recorded fibre length of more than 27.0 mm but in none of the cultures fibre strength was more than 22.0 g/tex. Three cultures CINA 303, 305, 317 and 318 were identified with high fibre length and strength. Culture CINA 318 has been entered in AICCIP Trials 22 (a & b).

Coimbatore - (K. N. Gururajan)

Of the twenty four *G arboreum* cultures tested, HD 440/02 recorded the highest seed cotton yield of 33.4 q/ha and a ginning outturn of 39.3 per cent against seed cotton yield of 24.3 q/ha and ginning out turn of 38.3 per cent in control var. PA 255.

Sirsa - (Surender Kumar)

Trial 1 (New):

Twenty five entries were tested against local check RG 8 in three replications. One entry namely PAIG-8/1 (1481.48 kg/ha), gave significantly higher yield over local check variety RG 8 (1246.9 kg/ha). The highest 2.5% span length (28.65 mm) recorded by CINA 329. In addition, two entries namely PA 255 (25.5 mm) and PA 405 (28.25 mm) gave 2.5% span length more than 28.00 mm. The maximum GOT % was recorded by DLSA 24 (34.0%). The highest boll number (18.8) and boll weight (3.0 gm) was recorded by PAIG 8/1 and DLSA 202 respectively.

Trial 2 (Old Trial): Sixteen entries tested against the RG 8 and LD 327in three replications. None gave significantly higher yield over best check variety RG 8. The maximum (32.4) and boll weight (3.5 gm) was recorded by LD 733 and CISA 24 respectively.

MMA3: Characterization of plant ideotype suitable for different agro-climatic zones

Nagpur - (V. V. Singh)

Four trials, two each under irrigated and rainfed conditions with dwarf, compact semi compact and robust genotypes (33) contributed by all the six cooperating centres were evaluated under different spacings. The results indicated that the dwarf and compact genotypes can give either equal or better yield than the robust types. Some of the best yielding genotypes include GJHV 163, GJHV 337, PH 802, CNH 132 and KH 117 in the robust group and NDH 1010, NDH 1001, Pusa 802 and CPD 745 in compact group. The seed cotton yield ranged from 634 to 1579 kg/ha in robust genotypes and 638 to 1985 kg/ha in compact types under both irrigated and rainfed conditions.

Coimbatore - (S. Manickam)

In the coordinated trial, 24 genotypes (18 robust types and 6-compact types) were evaluated and out of the top ten cultures for seed cotton yield, six were compact in nature while the other four were robust. The highest yield of 28.0 q/ha was recorded in the compact

genotype (CNH 120 MB) followed by a robust genotype, CCH 4 with 24.3 q/ha. Five other compact genotypes have also recorded over 20 q/ha of seed cotton yield. Of the seven compact and two robust genotypes evaluated for productivity, top four were compact types. The highest seed cotton yield was recorded in 70 E (18.8 q/ha) followed by RACH 16 (18.6 q/ha). Between the two robust types tested, Sumangala recorded higher yield (15.8 q/ha) than SVPR 2 (15.0 q/ha).

Sirsa - (Surender Kumar)

AVT 1:

Under the station trial two robust entries namely CISV 57 (2651.6 kg/ha) and CISV 68 (2483.3 kg/ha) gave significantly higher yield than the local check RS 2013 (2148.8 kg/ha). Maximum GOT (34.5%) was recorded by CISV 27. The highest boll wt. was recorded by CISV 68 (3.5 g).

AVT 2:

The entries CISV 34, 54 and 16 gave higher yield than the check variety RS 810 (1280.3 kg/ha). Minimum number of monopods were recorded by CISV 16 and maximum sympods by CISV 69 entry Highest boll weight was by CISV 16 and CISV 54. Highest GOT was recroded by CISV 34.

AVT 3:

All the entries in this trial surpassed the checks CNH 36 and RS 810 in respect of seed cotton yield. Minimum monopods were recorded by CNH 36 followed by CISV 53 and highest sympods by CISV 53. Highest boll weight was recorded by CISV 26. Maximum GOT was recorded by CNH 36 (34.9) followed by CISV 26 and CISV 58.

AVT 4:

Under this trial three entries namely CISV 5, CISV 3 and CISV 2 gave significantly higher yield than the check RS 810 (1275.7 kg/ha). Maximum GOT was recorded by CISV 6 (34.5%). Highest boll wt. was recorded by CISV 24 (3.5 g).

MMA 4: **Improvement of medium long and extra long staple fibre suitable for modern spinning**

Nagpur - (Vinita Gotmare)

Out of 85 G. *hirsutum* genotypes evaluated, 36 recorded significantly higher seed cotton yield than the best check variety PKV 081. The genotypes showed wide genetic variability for boll weight (1.7 to 3.9 gm.), boll number (6.7 to 23.4), GOT (28.9 to 44.9 %) and seed cotton yield (80 to 848 kg/ha)). Superior genotypes included TCHH 4352 for boll weight, Reba Pvt-9 for boll number and Meade 1930-D for ginning outturn. Genotype Macha recorded the highest yield i.e. 848 kg /ha. In G. *arboreum* out of 71 genotypes tested 36 showed significantly higher seed cotton yield than the best check variety AKA 8401. Genotype Burma C-19 recorded the highest yield of 1640 kg/ha followed by CC-1-1-37/PN 10 (1639 kg/ha) and 1882 (1513 kg/ha).

Coimbatore - (K. N. Gururajan)

Twelve cultures received from different participating centres were evaluated at five locations. Culture L(RCH x T13)511-4 recorded the highest yield of 19.7 q/ha and was consistently higher yielding than the control varieties (15.0 q/ha) at four out of five locations. It recorded a mean fibre length of 28.4 mm and a fibre strength of 21.9 g/tex (Table 6).

In the second trial, eight cultures received from different participating centres were evaluated at five locations. Culture TCH 1608 with a mean seed cotton yield of 18.1 q/ha, fibre length of 30.1 mm and fibre strength of 22.3 g/tex was found superior. However, it was found to be lower yielding than the local checks at TNAU, Coimbatore and CICR, Sirsa (Table 6).

Table 6 : Performance of superior cultures

Culture	Mean seed cotton yield (q/ha)	Ginning Per cent	2.5 % SL (mm)	Micronaire	Strength (g/tex)
L(RCH x T13)511-4	19.7	36.3	28.4	5.1	21.9
Local check	15.0	36.0			
TCH 1608	18.1	33.9	30.7	4.5	22.3
Local check	21. 9	33.7			

Sirsa - (O. P. Tuteja)

The trial consists of 35 entries and one check variety H1098. Highest seed cotton yield of 3704 kg/ha was found in CSH 2. Maximum percentage of GOT (34%) was recorded by five entries viz., CSH 8, CSH 10, CSH 14, CSH 22 and CSH 32 in comparison to 32 % of local check H-1098. Maximum 2.5% span length was recorded in CSH 29 (30.1 mm) followed by CSH 21 (28.9 mm) and CSH 17 (28.8 mm) in comparison to check H-1098 (25.9 mm). The micronaire value ranged from 3.3 to 5.5. Ten entries namely CSH 1,3,4,9,13,16,18,19,23 and CSH 24 recorded the bundle strength more than 24 g/tex at 1/8 gauge.

Local fibre strength Trial: This trial consists of 26 entries and two check varieties RS 810 and H 1098. Highest seed cotton yield of 3658 kg/ha was found in entry CSH 41 compared to 2835 kg/ha and 2423 kg /ha in H 1098 and RS 180, respectively. CSH 42 and CSH 47 showed GOT 35 % in comparison to check varieties H 1098 (33.0%) and RS 810 (32.0%). The entry CSH 49 recorded the highest 2.5 % span length (31.8 mm) followed by CSH 58 (31.2 mm) and CSH 50 (31.0 mm) . Maximum bundle strength was recoded to be 23.8 g/tex in entry CSH 55.

Screening for suitable sources for high GOT

Thirty-four entries were evaluated against local check RS 810. Highest seed cotton yield of 3772 kg/ha was found in entry CSH 90 compared to 3086 kg/ha in RS-810. The highest ginning out turn of more than 40 % was recorded by the entries CSH 81 followed by 39% in CSH 86 compared to 33% of RS 810. The 2.5% span length was found to be maximum in CSH 76 (31.3 mm) followed by CSH 87 (30.2 mm) in comparison with RS 810 (28.1 mm). Maximum bundle strength of 24.0 g/tex was recorded in two entries CSH 69 and CSH 95 as compared to RS 810 (21.5 g/tex).

Evaluation of G. *hirsutum* lines for fibre quality traits:

Five entries were evaluated in this trial against two checks H 1098 and RS 810. Seed cotton yield was significantly less in entries as compared to local checks. However, Maximum GOT of 33% and 2.5% span length of 34.0 mm were recorded in entry HLS 92-1. Only HLS-92-1 was found to have 24.1 g/tex of bundle strength.

Selection of single plants from segregating material for quality traits: Seven entries of segregating material were evaluated for fibre length and bundle strength. In single plant selection done on the basis of yield and quality parameters CSH 33 showed highest yield of 0.750 kg/plant followed by 0.650 kg/plant in TCHH-4554. The later recorded the highest ginning out turn of more than 37 % and HSCT 1 has given the highest 2.5% span length as well as bundle strength.

MMA 5 : **Quantitative and qualitative improvement of cottonseed oil.**

Nagpur - (D.K.Agrawal)

Multilocation evaluathion of breeding material

Five trials were conducted at three locations viz., Sirsa, Faridkot and Nagpur. Among the thirteen *G. hirsutum* advance cultures evaluated, the seed cotton yield varied from 278 - 960 kg/ha. TMOH 5 recorded the highest seed cotton yield (960 kg/ha) followed by TMOH 4 (936 kg/ha) and TMOH 2 (726 kg/ha). The seed oil content ranged from 19.2 to 23 %. Four *G. arboreum* cultures were evaluated along with one check. TMOA 3 recorded the highest seed cotton yield (2401 kg/ha) followed by TMOA 4 (2342 kg/ha). The seed oil % ranged from 18.5 - 20.8. TMOA 3 recorded the highest seed oil content (20.8 %) followed by TMOA 4 (20.7 %).

Twenty five *G. hirsutum* germplasm lines were evaluated. TMGH 4 recorded the highest seed cotton yield (1288 kg/ha) followed by TMGH 10 (7.64 kg/ha) and TMGH 14 (7.59 q/ha). Sizeable variability was also recorded for oil content (15 -24.9 %). A number of lines namely TMGH 3 (24.9 %), TMGH 2 (24.8 %) and TMGH 6 (24.3 %) recorded seed oil content more than 24.0 %. In G.*arboreum*, a total of sixteen germplasm lines were evaluated. The seed cotton yield varied from 10.0 to 53.0 g/plant. TMGA 5 recorded the highest seed cotton yield (53 g/plant) followed by TMGA 8 (48.91 g/plant) and TMGA 13 (48.4 g/plant). The seed oil content ranged from 20.1 to 24.7 %. TMGA 15 recorded the highest seed oil content (24.7%) followed by TMGA 12 (23.6%) and TMGA 11 (23.2 %).

Among ten *G. hirsutum* segregating lines evaluated, seed cotton yield varied from 317 to 923 kg/ha, the highest is line CSHH 86. Similarly, the seed oil content too varied from 16.53 % to 23.15 %, the line CSHH 86 recording highest.

Attempting new crosses

A total of 168 new cross combinations were attempted, out of which, 108 were aimed at converting good productive quality lines into one with high seed oil content. In addition 60 new cross combinations were attempted to study the inheritance pattern of seed oil quality.

Identification of new germplasm lines with high seed oil content

In a set of 43 *G. arboreum* lines evaluated for seed oil content, culture CINA 313 recorded the highest oil per cent (24.8 %), followed by CINA 327 (A) (24.8 %) and CINA 319 (24.7 %).

Evaluation of segregating breeding material

A total of 164 SPSs of *G. hirsutum* in various filial generations were evaluated. The SPS 34 K-SP2 recorded the seed cotton yield of 948 kg/ha with 2.5% fibre length of 25.6 mm and oil content of 19.7 %, while culture 26 DC SP_2 recorded good oil content of 21.55 %, 26.8 mm 2.5% span length and 24.3 g/tex bundle strength but was poor in seed cotton yield.

Evaluation of advance cultures

In a set of 15 advance cultures of *G. hirsutum* evaluated, cultures 3 HS, 12 ES and 23 ES recorded seed oil content around 21.0 %. For seed cotton yield, culture 1 HS (1079 kg/ha) ranked first and also recorded the highest 2.5% fibre length (26.2 mm), while cultures 2 HS and 26 B recorded the bundle strength of more than 24.0 g/tex.

Coimbatore - (N. Gopalakrishnan and K. N. Gururajan)

Genotypes identified earlier with high oil content were crossed with high oil genotypes received from Faridkot and other centres. New entries viz., Sumangala x F 776, M5KD 933 x F 776, CBR 3 x F 776, Anjali x F 776, Surabhi x F 776, Supriya x F 776, Sumangala x F 1861, CBR 3 x F 1861 were evaluated for oil

content. Along with these, twenty varieties from the participating centres viz., Faridkot, PAU and four cultures viz., COE -50, COE - 51, COE - 52 and COE - 53 from CICR, Nagpur and materials received earlier viz., HOC - 1, HOC - 2, HOC- 3, HOC-4, HOC-5 and HOC-6 were also evaluated.

Seventy four genotypes and high oil content lines supplied by participating centre Sirsa were analysed for their seed oil content. Among the genotypes analysed, many were found to contain more than 22 % seed oil content and cultures CRB 12, CIR 8, CISV 60, CSHH 238 and KH 2 possessed more than 23% seed oil content. These lines have also been used in the crossing programme for generation of high oil content lines with desirable characteristics. Three hundred IC lines available at CICR, Regional Station, Coimbatore were screened for seed oil content. Among these, the genotypes viz., IC 38, IC 44, IC 194, IC 336, IC 397, IC 416 possessed more than 22% and genotypes viz., IC 125, IC 308, IC 314, IC 370, IC 487, IC 539 possessed more than 23% seed oil content.

Biochemical estimations related to the carbohydrate and lipid metabolism and nitrogen assimilation have been carried out during crop phenophases in order to correlate the metabolic status of the genotypes and seed oil development. The nitrate reductase activity of the high oil genotypes ranged from 4 to 7 moles which evidently shows the dynamic nature of the enzyme activity in nitrogen assimilation during crop growth with resultant yielding ability in high oil content genotypes.

Sirsa - (O. P. Tuteja)

Evaluation of Germplasm lines of *G hirsutum*: Forty germplasm lines were evaluated against two local checks i.e. H 1098 and RS 810. Highest seed cotton yield of 3658 kg/ha was recorded in TMGH-39.

The highest ginning out turn of 35 % was recorded by the entry TMGH 19 followed by 34% in four entries viz.TMGH 17,21,22 and 37 as compared to 33% in both the checks RS 810 and H 1098. 2.5% span length was found to be maximum in TMGH 28 (30.6 mm) followed by TMGH 34 (29.9 mm) in comparison with check RS 810 (26.5 mm). The entry TMGH 40 recorded the highest bundle strength of 24.2 g/tex .

Evaluation of Germplasm lines of *G arboreum*: Twenty-six entries were evaluated against two local checks i.e. RG 8 and LD 327. Highest seed cotton yield of 3011 kg/ha was recorded in TMGA-22 compared to 2984 kg/ha in RG 8. The highest ginning outturn was found to be 42% in TMGA 20 followed by 40% in two entries i.e. TMGA 22 and TMGA 24 in comparison to 39 % in local check variety LD 327. Maximum 2.5% span length of 24.6 mm was observed in entry TMGA 23 followed by 23.2 mm in TMGA 8, whereas local checks could give less than 20 mm of span length.

Evaluation of Advance culture of *G. hirsutum:* Thirteen entries were evaluated along with H 1098 as local check. Highest seed cotton yield was found in F 1885 (3201 kg/ha) followed by 3052 kg/ha in local check H 1098. The highest ginning out turn of 35 % was recorded by the entries TMOH-1 and F 1861 in comparison to 34% in local check H 1098. 2.5% span length was found to be maximum in F 1945 (28.7 mm) followed by F 1885 (27.8 mm) in comparison to check H 1098 (25.4 mm). The bundle strength of 24.7 g/tex was recorded in TMOH 2 followed by 23.9 g/tex (TMOH 8) against 21.4 g/tex in local check variety H 1098.

Evaluation of *G hirsutum* cultures for seed cotton yield and quality traits: Nine entries were sown along with local check H 1098. Highest seed cotton yield was found in CSH 504 (3094 kg/ha) followed by CSH-508 (2835 kg/ha) as compared to 2591 kg/ha in H 1098. Maximum ginning out turn was recorded in

CSH 506 (35%) followed by 33% in entries namely CSH 501 and CSH 507 over check H-1098(32%) . 2.5% Span length found to be maximum in CSH 504 (27.4 mm) followed by CSH 505 (26.5 mm) as compared to 25.7mm in H 1098.

Evaluation of segregating material for seed cotton yield and quality traits: The trial consists of 10 entries and two check varieties RS 810 and H 1098. Single plant selection was done on the basis of yield and quality parameters. The highest mean single plant seed cotton yield of 0.750 kg/plant was found in entry CSHH 198 followed by 0.583kg/ plant in CSHH 238 in comparison to check varieties H 1098 (0.550 kg/plant) and RS 810 (0.417 kg/plant). Five entries showed more than 28.0mm of span length. The entry CSHH 4311 recorded the highest 2.5 % span length of 28.9mm compared to checks RS 810 (25.2 mm) and H 1098 (26.0mm). The micronaire value of these entries ranged from 4.2 to 4.9. The maximum fibre strength of 23.4 g/tex was recorded by the entry CSHH 348 followed by five entries, which showed more than 23 g/tex of fibre strength.

Estimation of oil content in different breeding material and germplasm lines

(1) Estimation of oil content in breeding lines of *G. hirsutum*

Among 29 genotypes analyzed, 13 were found to contain more than 23 per cent seed cotton oil content.

(2) Analysis of cottonseed oil of miscellaneous genotypes

Among 74 genotypes analysed, 22 lines were found to contain more than 22% seed cotton oil content, and cultures CRB 12, CIR 8, CISV 60, CSHH 238 and KH-2 possess more than 23% seed cotton oil.

MMA 6: **Overcoming incompatibility barriers in interspecific crosses of cotton**

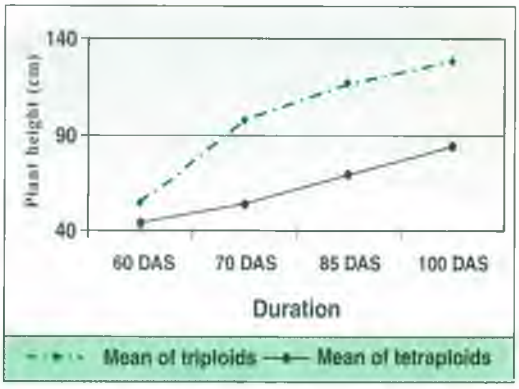
Coimbatore - (S. Manickam and A. H. Prakash)

Effecting crosses among wild and cultivated species

Crosses effected between cultivated and wild species and between *G. hirsutum x G. herbaceum* resulted in few crossed bolls with varying boll setting percentage.

Morphology of triploid plants and *G. hirsutum* parents

The triploids derived from crossing the *G. hirsutum* cultivars with wild diploid species were studied for their morphological characters at different days after sowing (DAS). In general triploids were taller (Fig.1), with more number of nodes, monopodia, sympodia, leaves, squares, leaf area, longer internodes and petiole length with thick stem girth. The mean pollen diameter of triploids was 64.8 µm, against 95.8 µm of wild diploids and 110.7 µm. of *G. hirsutum*.



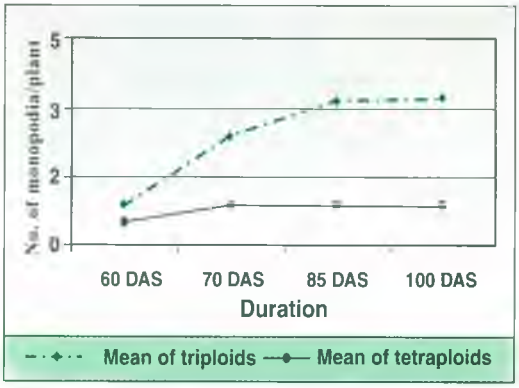


Fig. 1. Mean morphological difference between triploids and tetraploids at different duration after sowing

Pollen pistil interaction in wide crosses

When pollen-pistil interactions were studied in the pollinated buds of triploids, limited pollen germination and pollen tube growth was noticed (Plate 1.2). In some crossed flower buds the pollen tubes even reached the embryo sac (Plate 1.3). When these crossed seeds were raised, they were found to be true hybrids.

Isolation and culture of embryos in nutrient medium

Young bolls (2-5 days after pollination) were collected following pollination between *G. hirsutum* and wild diploid species and from few back crossed bolls and cultured on the medium. The bolls were cultured directly and / or ovules were isolated aseptically and cultured on semi-solid MS media with different hormone combinations. Callusing was noticed at different days after culture (8-16 days after culture) in different cross combinations and only very few ovules continued to grow after 4-5 days of culture.

Treatment with Colchicine to induce polyploidy

Colchicine treatment was given to the terminal buds of seedling to induce polyploidy in *G. arboreum, G. herbaceum* and a *desi* hybrid. Good response was noticed at 0.1% concentration of Colchicine. The doubled plantlets were characterized by thicker and larger leaves.

Seed Technology

MMB 1 : **Maintenance of genetic purity of popular varieties and parental lines of hybrids in cotton**

Nagpur - (R.K.Deshmukh, V. Santhy and Phundan Singh)

Comparative performance of various bulking methods

In LRA 5166, superior bulk produced more seed cotton (72 kg) than the inferior bulk. However, in Anjali yield differences were minimum.

Coimbatore - (K. Rathinavel)

A field experiment was conducted with superior bulk (A), model bulk (B), ordinary bulk (C) and breeder seed plants selected from Anjali and LRA 5166. The highest seed cotton yield of 2539, 3230 kg ha^{-1} was recorded in model bulk of varieties Anjali and Sumangala, respectively, whereas in LRA.5166, the maximum seed cotton yield was obtained in superior bulk (2639 kg ha^{-1}). In all the three varieties ordinary bulk plants registered the lowest seed cotton yield. Hence, it is suggested that progenies of single plant that constitutes superior bulk may be multiplied and bulked for the production of breeder seeds in the subsequent generations.

Sirsa - (R.A. Meena)

F_1 crosses made among selected five true to type progenies were evaluated for boll weight, GOT and fibre length and micronaire. The crosses between the progenies 16X7 and 86X36 showed traits similar to the true hybrid. Some of the other crosses noticed superior for yield but for poor fibre properties.

In addition, 27 progenies of female parent and 13 male parent were selected based on morphological parameters from large plant population. Using mean and standard deviation the progenies were grouped in to superior bulk (above mean + SD) and model bulk (mean $\pm$ SD). In superior bulk, nine progenies of female parent and four progenies of male parent and in model bulk five progenies of female and three of male parent were selected. Crosses among all the selected female and male progenies (27 of female and 13 of male) were also made.

MMB 3: **Pre and post harvest management technique for improvement of seed quality.**

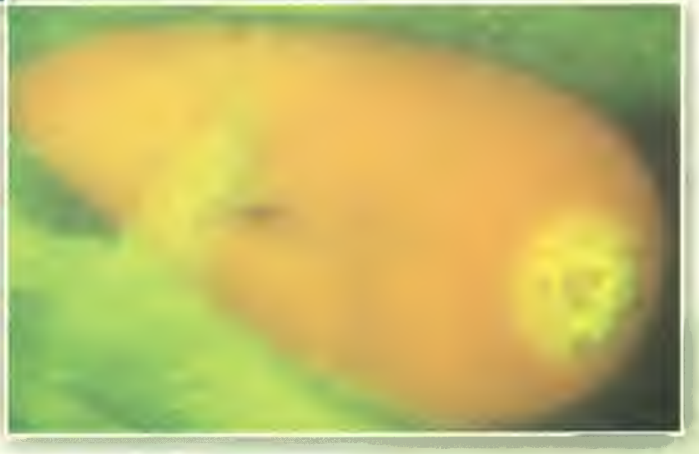
Nagpur -(R.K.Deshmukh and V. Santhy)

Plant population and foliar application of

MSH-SP-91 - Ideal plant type with zero monopodia

1.1 Cleistogamous flower

1.2 Pollen germination and pollen tube growth



1.3 Pollen tube growth near micropyle of embryo sac

ICAR

nutrient

Three spacing and six nutrient treatments DAP, $MgSO_4$, Boron, $ZnSO_4$ combination of all these and control were tried in variety LRK 516 (short compact).

Results revealed that 60 x 60 cm spacing with two plants per hill produced significantly higher yield closely followed by 60 x 60 cm spacing (one plant per hill). Foliar application treatments did not affect the yield significantly.

Storage of hybrids and varieties

Seed of four varieties (PKV Rajat, Sahana, Sumangala and L 604) and four hybrids (DCH 32, LHH 144, LAHH 4 and PKV Hybrid 4) obtained from different participating centres were packed in cotton cloth bags and were stored under ambient condition. After nine months, PKV Hy 4 exhibited the highest germination percentage of 80.8, while DCH 32 recorded the lowest germination percentage (44). Among varieties, Sumangala exhibited germination of 79.8 per cent and L 604 lowest germination percentage (67). Seed vigour index values were highest in PKV Hy4 (1974), followed by Sumangala (1907). The seed vigour index values were lower in DCH 32 (1030), LAHH 4 (1035) and LHH 144 (1087)

Coimbatore - (K. Rathinavel).

Wider spacing of 120 x 90 cm resulted in maximum number of bolls and boll weight followed by 120 x 60 cm. The spraying of Boron @ 0.1 % at 60 DAS increased the retention of maximum number of bolls, followed by combination of all the foliar application (DAP @ 2.0%, MgSO4 @ 1.0%, Boron @ 0.1%, and ZnSO4@ 2.0%). Spacing of 120 x 60 cm and foliar application of boron @ 0.1% registered 68.7 boll/plant, which was the highest among all the combination treatments. The seed quality parameters such as seed weight, lint weight, seed index, lint index, seed number and ginning percentage were found maximum in combined application of foliar nutrients.

Demonstration of quality seed production through improved techniques

The values for seed quality traits such as seed weight, lint index and seed number showed positive response to seed soaking treatment with succinic acid @ 0.2% and foliar spray of boron (0.1%) at 90 DAS. The ginning percentage of the seed soaking in KH_2PO_4 @ 100 ppm and foliar spray of boron @ 0.1% at 90 DAS (35.8%) followed by seed soaking in succinic acid @ 0.2 % and foliar spray of boron @ 0.1 % at 90 DAS (35.5%) were on par and significantly higher over control. Highest seed quality, measured in terms of germination and vigour, was obtained from plants whose parental seeds were soaked in succinic acid @ 0.2 % and given foliar spray of boron @ 0.1 % at 90 DAS.

Effect of seed soaking and foliar application of chemicals on performance of female parent (T7) of popular hybrid (Savita)

Seed soaking in Succinic acid @ 0.2 % before sowing and foliar application of boron @ 0.1 % at 60 DAS, $MgSO_4$ @ 1.0 % at 75 DAS registered the highest setting of 75.6 %, maximum cross boll weight, seed weight and lint weight per boll. The maximum values of above said parameters were obtained during 4^{th} to 6^{th} week of flowering.

Effect of crop management practices on seed quality of var. LRA 5166

Detopping at 120 days followed by spraying of ethrel at 160 days significantly registered the highest number of bolls/plant (43. 2), seed cotton yield (2342.6 kg/ha), seed weight (32.9 g/10 bolls), lint weight (18.9 g /10 bolls) while all other treatments were on par.

Sirsa - (R.A. Meena)

(A) Evaluation of effect of spacing, chemical spray for quality seed production of varieties

The effect of row to row spacing and foliar application of chemicals on the crop of variety 20013 was studied in split plot design. Highly significant increase in boll number, boll weight, seed index and lint index was recorded when crop was sown at 120 x 90 cm and sprayed with combination of all the chemicals i.e. DAP 2% at 45 DAS, MgSO4 1% at 50 DAS, Boron 0.1% at 60 DAS, $ZnSO_4$ 2% at 75 DAS.

(B) Effect of seed soaking and foliar application of chemicals on seed yield, quality and crossed boll setting percentage

The effect of seed soaking in succinic (0.2%) acid and KH_2PO_4 (100 ppm) and foliar application of Boron (0.1%) and $MgSO_4$ (1%) at different interval during crossing in Om Shankar and LHH 144 was studied. It is concluded that the seed soaking in KH_2PO_4 (100 ppm) before sowing and foliar spray of $MgSO_4$ (1%) at 60, 75 & 90 DAS increased the seed yield by increasing boll number, boll weight, seeds/ boll and seed index.

(C) Effect of crop management practices on seed quality

Topping of crop at different growth stages and spray of defoliant (ethrel) at different intervals, significantly improved boll number, boll weight, seeds/ boll, seed index, yield/ plant, germination percentage and vigour index.

(D) Post harvest management techniques:

Germination percentage, physical purity, genetic purity and seed health in the market-graded seed was much lower than institute seed .

Much improvement in germination and vigour index was observed when seeds were graded after delinting.

The effect of packing material was studied on seed viability during storage. In cloth bag up to nine month of storage, not much reduction in germination and vigour index was observed

Biotechnology

P1-96/1-ICR-F-30/0430:

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

Molecular evaluation of cotton germplasm

A total of 125 germplasm lines of working collection of *G. hirsutum* were taken up for isolation of DNA and molecular characterization. Twenty five lines were characterized based on two molecular marker system i.e. ISSR and RAPD along with six quantitative morphological traits (Fig.2). Optimized PCR reaction for RAPD and ISSR were used. Nineteen selected ISSR primers synthesized from Bangalore Genie and forty RAPD (random, 10mer) primers of OPA and OPB series from Operon Technologies were used.

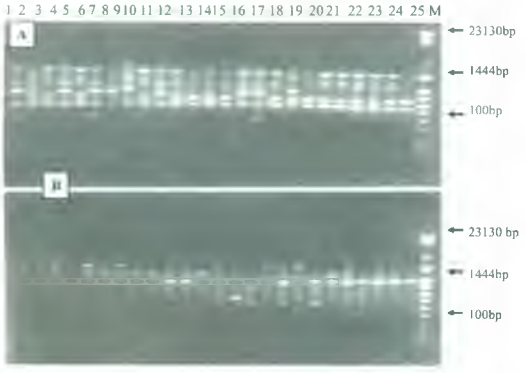


Fig.2: Amplification of cotton germplasm with primer ISSR-4 (Photo -A) and random primer OPA 11 (Photo B), M-Lambda/ *Hind* III, pUC18/*Sau*3A-pUC18/*Taq*I

Dendrogram generated, with ISSR showed three major clusters and that with RAPD showed four clusters. Similarities between ISSR and RAPD have been observed in major clusters of the dendrogram. No duplicates were observed in both the studies. Present study proved that ISSR is more preferable in terms of time and cost.

Molecular evaluation of the wild species of cotton by ISSR marker technique

The 22 wild species representing almost all genome (except one viz. K) were taken up for molecular analysis.

Selected nineteen ISSR primers were used for analysis of the wild species. Total 201 markers were generated , out of which 177 were polymorphic. Genome specific markers were observed. Dendrogram generated from ISSR analysis of wild species showed separate cluster for A and B genome while all members of D genome along with only member of AD genome have clustered together, showing mutual affinity.

Unique bands for few wild species were noticed, which are cloned and sequenced.

P1-91/1-ICR-F30-30/0430:

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

During current year, long stapled *arboreums* viz. PA 405, PA 255 and PA 183 were taken up for regeneration alongwith AKH 4, AKA 5, RG 8 and AKA 8401.

For regeneration, 7-8 days old explants were used. In all, 1260 explants were cultured with 180 explants in each cultivar. The media for regeneration consisted of MS basal composition supplimented with various combinations of Benzyl aminopurine and kinetin. Response to regeneration was attributed to induction of mass of multiple shoot buds. These shoot buds during subsequent passages were differentiated into well defined shoots. These shoots were removed aseptically and transferred in root induction medium.

The percentage of multiple shoots was higher (97.2%) in PA 405, followed by RG 8 and AKA 8401 respectively. Cultivar PA 183 also recorded moderately good response with 61.6

% regeneration percentage. In AKA 5, AKH 4 and PA 255, the regeneration percentage was below 60%. It has been observed that on an average each explant produced 8-13 shoots.

Induction of multiple shoots in two seedlings explants

Regeneration potentiality was investigated by multiple shoot induction from two explants namely shoot tip (ST) and coty node (CD) respectively. It has been observed that overall frequency of shoot regeneration was higher from coty node explants. The cultivars RG 8 and AKA 5 more or less recorded similar shoot number per explant with rooting percentage of 65.8 and 65.0 respectively.

Performance of R II progenies

LRA 5166, LRK 516, Stoneville, Coker 312 and Indore 2, regenerated by the formation of multiple shoots, were grown in field as R II plants. Considering the variability for yield attributes and other morphological characters, 89 single plant selection was made in each plot. Ten single plants were selected and their characters were assessed.

National Agricultural Technology Project

MM 4 : **Development of Bt Transgenic cotton for insect resistance** (A B. Dongre, S. B. Nandeshwar, G. Balasubramani and K.R. Kranthi).

Agrobacterium mediated transformation of Indian Cultivars (LRA 5166 and LRK 516)

Agrobacterium strain EHA 105 harboring a binary plasmid pBin Bt. 12.6 kb with Cry 1Ac, Cry 1IA5 and Cry Aa_3 was used separately as vector system for transformation. Two explants shoot tips and embryonic axis have been taken for co-cultivation and transformation.

After 10-15 days of shoot initiation, the explants were transferred on the selection medium containing 2 mg/l BAP + 0.5 mg/l kinetin + 0.1 mg/l NAA with 50 mg/l kanamycin for 30 days. Green healthy shoots were subjected to 2-3 more passes of selection by repeated excision of growing shoots and their subculture on the same medium. For shoot induction and shoot proliferation 3% glucose and for rooting of shoots 5% sucrose was used. The pH of the medium was adjusted to 5.8 before autoclaving

Out of three varieties used for transformation, LRK 516 responded well in both the explant sources. It was observed that embryonic axis responded better compared to shoot tips in all three cultivars.

Embryonic axis responded well for root induction compared to shoot tip. Large number of explants have been used for transformation. Explants of LRK 516 and LRA 5166 responded better with 46 and 29 out of 4108 and 3932 explants used putative transformants respectively. In variety MCU 10, five putative transformants were obtained from 1120 explants inoculated.

PCR based amplification using specific primers of npt-II and Cry 1Ac gene was done for all the putative transformed plants in 'T0' generation for testing its integration in the plant system. Three plants of LRA 5166 and two plants of LRK 516 were found positive for PCR based amplification.

ELISA performed for five putative transgenic of LRA 5166 and LRK 516 plants tested positive for all. However, one from LRA 5166 and two from LRK 516 showed high expression of Cry protein.

CGP-I: **Induction of para-nodules in cotton with nitrogen fixing bacterium *Azorhizobium caulinodans*** (G. Balasubramani and J Amudha).

Root nodules were induced in cotton (*G. hirsutum*) by *Rhizobium fredii* and 10-15 days after 30-nodule structures were observed. Initiation of leaf curling and crack entry

formation was noticed and recorded. The presence of *Rhizobium* (Bacteriods) was confirmed. *Rhizobium* was located in the nodular structure and it was re-isolated on the Congo red medium. To confirm the authenticity of invasion and nodule formation, root nodule extracted total DNA was subjected to 16S rRNA PCR with universal eubacterial primer. The rRNA amplicon from root extracted and culture extracted DNA amplicon were confirmed through ARDRA (Amplified Restriction DNA Ribosomal Analysis) pattern.

RCPS 10: Development of Bt-transgenic diploid cotton against bollworm (S. B. NandeshwarandA.B.Dongre).

Agrobacterium mediated transformation

Two gene constructs cry I A (b) and cry I A(c) were used. The seven day old *in-vitro* germinated seedlings of cvs. RG 8, PA 405, PA 255, PA 183 and AKA 8401 were taken up for transformation. The duration of Agrobacterium inoculation was 30 min - 72 hrs depending on the response of genotypes. Of the 7517 explants inoculated with Agrobacterium containing cry I A(c) gene, only 182 explants are finally growing on kanamycin medium. This showed average transformation frequency of 2.4 %.

Genotype response to Agrobacterium transformation

In cv. RG 8, out of 3402 explants, 266 were inoculated for 3 hrs, 30 explants for 12 hrs, 2030 explants for 24 hrs, 831 explants for 48 hrs and 245 explants for 72 hrs. These explants were screened on kanamycin medium and 63 shoots were obtained out of which 21 reached the maturity and six plants were obtained and established in the soil. The frequency of transformation in this genotype was 1.85%. In cv. PA 405, 648 shoot tips were inoculated for 12 hrs and 49 were selected on kanamycin medium. Out of 1576 explants excised from cv. PA 183 and inoculated for 24 and 48 hrs, 23 putative transformed shoots were obtained. In PA 255 however, 26 shoots were obtained. Lastly in cv. AKA 8401 out of 514 shoot tips transformed only 21 shoots were obtained, 7 could reach maturity and four plants were established in the soil.

Gene expression

The test of gene expression was carried out in the plants transformed with cry I A(b) gene by ELISA. In all 50 leaf samples were tested. Eleven samples tested positive with value of Bt-protein ranging from 1.02 µ g to 3.33 µ g per gm of tissue.

Technology Mission on Cotton

MMB 2 : **Molecular characterization of released varieties and parental lines of hybrids, germplasm and wild species of *Gossypium*** (A. B. Dongre).

DNA fingerprinting of notified and new varieties

Six notified *G. hirsutum* varieties viz., NH 545, PH 93, PH 325, NH 452, PH 348, and Purnima, two introgressed PAIG 8/1, PIG 27 lines and four *G. arboreum* varieties PA 255, PA 405, PA 402, PA 140 were used for this study. Pure lines of this material were grown in green house. DNA was isolated and subjected for PCR analysis.

Total 19 ISSR primers generated 101 out of which 83 were polylmorphic. twenty RAPD primers generated 123 markers of which 92 were polymorphic. Three RAPD primers amplified introgressed markers from *G.hirsutum* to *G.arboreum* while only one ISSR primer generated the introgressed marker.

Development of molecular diagnostic tool for testing of genetic purity of seeds of varieties and hybrids

DNA of five notified cotton hybrids and its parents were isolated and subjected for ISSR and RAPD analysis (Fig.3A & B)

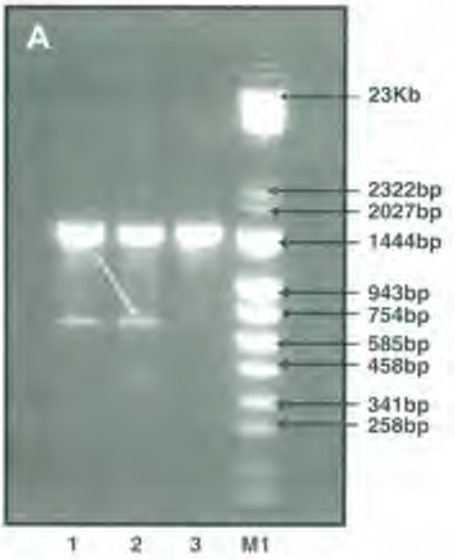


Fig.3A :ISSR analysis: Lane 1 G.Cot 10, Lane2- G.Cot10 X G. Cot 100, Lane 3 G. Cot 100 Lane 4 DNA bp Ladder

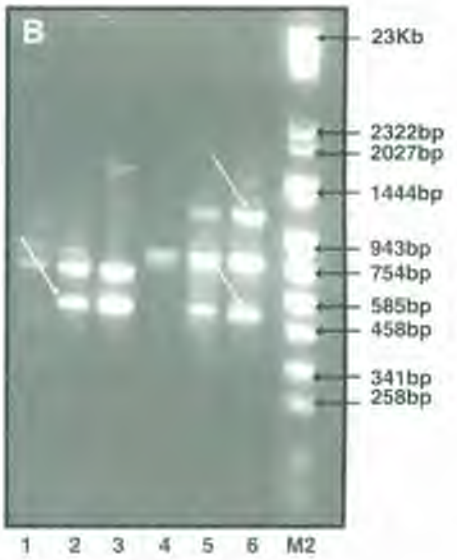


Fig.3B: RAPD analysis: Lane 1 American nectariless, Lane2- American nectariless X G-67, Lane 3 G-67

In view of development of the molecular marker diagnostic tool to test the genetic purity of cotton hybrids and their parents, five notified hybrids H 4, H 6, H 8, DH 7, and DH 9 and their parents have been taken for the study. Twenty one RAPD and 15 ISSR primers were tested for polymorphism. Unique band were screened, isolated, cloned in PCR script SK(+) vector for sequencing. It may be used as STS markers in identification of parents and hybrids.

MMA 6: Overcoming incompatibility barrier in interspecific hybridization

(S. B. Nandeshwar).

New Crosses: Nine new crosses were effected involving wild and cultivated diploid and tetraploid species. Out of nine crosses, AKA 5 x PKV 081, MCU 5 x AKA 8401, AKA 8401 x PKV081 recorded 2.0 and 1.7 % boll setting. The number of seeds set in this cross was very low. In another set of 20 new crosses, 14 involve *G.arboreum* as female parent and 6 involve *G.hirsutum* as male parent. Boll setting percentage in these was in the range of 1.4% to 10% respectively.

Buds and bolls in interspecific hybridization

To overcome the problem of buds and boll dropping, various treatments of Gibberlic acid and NAA with or without sugar was applied at the base of pollinated buds. The total drop in PKV 081 x AKA 8401 was comparatively less (57.7%) when applied with 50 mg GA coupled with 0.1 mg/L NAA. This was followed by the cross G cot 10 x AKA 8401 where total drop was 62.1%.

Culture of embryos on nutrient medium

The ovules/embryos from 5,8,12 and 15 DAP were cultured on MS medium supplemented with 1.5 and 2.0 mg/ L NAA coupled with kinetin (0.5 and 100 mg/l) . One lot of ovules/embryos was cultured on MS medium without any growth regulator. Ovules/embryos from 15 DAP responded most in all the crosses. In cross PKV 081 x G 27 there was formation of embryo axis and regeneration of plants was observed. The development of embryo axis accompanied by the formation of callus was noticed in rest of the crosses. In MS + NAA 2 mg/l + kin 1 mg/l response of ovules to regeneration was not uniform. There was mostly callus formation in all the combination. In the third combination response of ovules was negligible.

Crop Production

P1-85/1-ICR-F 25/0430:

Studies on the long term effect of nutrient management practices on the productivity, nutrient balance and sustainability of cotton based cropping systems.

Nagpur - (Jagvir Singh and Blaise)

Long term fertilizer experiment conducted for 18th consecutive year showed low dry matter yields in both the genotypes due to long dry spell after germination. Higher seed cotton yield of *hirsutum* (10.36 q/ha) and *arboreum* (9.16 q/ha) was observed by the application of organic fertilizer (15 t FYM/ha) as compared to RDF (N_{60} P_{13} K_{25}), yield of 7.83 q/ha (*hirsutum)* and 8.25 q/ha (*arboreum)* at N60 P13 K25 (RDF). Significant increase in yields of *arboreum*, *hirsutum* and sorghum was observed by the application of FYM with recommended dose of NPK or FYM alone over control and single application of N or P. Higher NP and K uptake at harvest stage was recorded in the treatment N 45 P 20 K 37+7.5 t FYM.

Higher agronomic efficiency of fertilizer N and P was observed in FYM treated plots in both the species followed by recommended dose of NPK fertilizer treatment. Cotton-Jowar rotation had a higher agronomic efficiency than monocropping of cotton at lower levels of NPK. Bulk density of surface soil was greater in plots with no or lower dose of manure inputs compared to plots with higher amount of organic matter applied. Mono-cropped cotton plots had greater bulk density (1.49 Mg /m^3) than the cotton-sorghum rotation plots (1.42 Mg /m^3).

Coimbatore - (S.Praharaj)

Cotton-jowar sequence produced 7.4 quintals more seed cotton yield per hectare over control (cotton-fallow) (Fig.4).

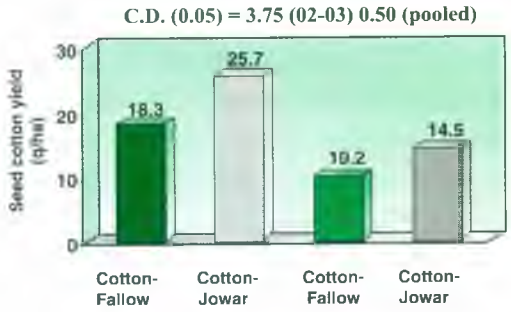


Fig. 4 : Performance of cotton in cotton-fallow and cotton-jowar cropping system over the years

Recommended level of N,P and K viz 60:13: 25 kg/ha (on par with 60:30:0 kg N, P & K/ha) gave significantly higher seed cotton yield (24.5 q/ha) over control (21 q/ha). Application of organic helped in realization of higher cotton yield; and maximum yield (25.3 q/ha) was produced with 19 kg P + 37 kg K along with 15 t FYM/ha (on par with that in 30:13:25 kg NPK + 5 t FYM/ha and recommended NPK).

Pooled data of ten years revealed that addition of K resulted in yield reduction of seed cotton, while addition of FYM with moderate N and P (along with K) improved seed cotton yield. Thus, the best organic (INM) treatment is 30:13:25 kg N, P and K per hectare plus 5 t/ha of FYM and the best inorganic fertilizer treatment is 60:13:25 (on par with 60:13:0) kg N, P and K per hectare .

Significantly higher yield of jowar (83.2 q/ha) was realized with N, P & K applied @ 30,13 & 25 kg/ha with 5 t/ha of FYM applied to cotton over control (78.1 q/ha).

Nagpur

Tillage and crop residue effects on soil, nutrient and cotton crop behaviour

(Blaise and Nandini-Gokte Narkhedkar).

Seed cotton yield was significantly lower in the reduced tillage plots (833 kg/ha), followed by conventional tillage with 919 kg/ha. Reduced primary tillage operations with two inter-row cultivation during crop

growth was the best with a seed cotton yield level of 1029 kg/ha. Among the genotypes, *G. arboreum* yielded significantly more (1015 kg/ha) than the *G. hirsutum* (840 kg/ha). Yield was also enhanced by application of 25% more N than the recommended dose. Except, for the staple length none of the fibre quality parameters were affected significantly by the tillage systems or application of N fertilizer at greater amount.

Adhoc trial : **Agronomical evaluation of Bt Rasi hybrid cotton in rainfed vertisol** (Jagvir Singh and M.R.K. Rao).

RCH 2 Bt, RCH 20 Bt, RCH 134 Bt, RCH 138 Bt, RCH 144 Bt, and their non Bt counterparts alongwith checks viz. NHH 44, H 10 and MECH 162 Bt (Mahyco) were tested.

Significant differences were not evident in Bt and non Bt hybrids for number of burst bolls. Numerically higher bolls were evident in NHH 44 followed by 138 Bt and the lowest in 162 Bt. The boll weight value was highest in 20 non-Bt which was significantly superior over all other hybrids including its Bt counterpart. Significant differences were not observed in seed cotton yield in the first picking though higher yield was recorded in 144 Bt, 144 non Bt and 138 Bt and the lowest in 2 non Bt. In the second picking 125 % RDF resulted in significantly higher yield as compared to 100 % RDF. Amongst the hybrids, 20 non Bt gave significantly higher yield (total of two pickings) as compared to all other hybrids including its Bt counterparts.

Adhoc trial: **Studies on the effect of micro-nutrient application on yield and fibre quality of Bt hybrid cotton under rainfed conditions** (Jagvir Singh and M. R. K. Rao).

A field trial was conducted to assess the impact of micro-nutrient application (Zn_{30} + B_{10} + Mn_{10}) on fibre quality of Bt hybrids.

Soil application of micro-nutrients with recommended dose of fertilizer increased the availability of N, P and K at harvest stage of crop. Leaf and seed showed no significant increase in micronutrient contents but Zn content was increased significantly in seed. A marginal increase in staple length and bundle strength was observed due to 50% soil and 50% foliar application compared to soil application of micronutrients.

Development of bullock drawn seed drill cum planter for cotton sowing in vertisols

(G. Majumdar).

Bullock drawn planter was tested at Telgaon - Tishti village on fields (each 0.4 ha) of eight farmer. The planter gave a higher benefit cost ratio with slightly higher yields over manual dibbling method. The farmers suggested some modifications to suit their conditions. Based upon their suggestions, sliding tynes in-lieu of fixed tynes, fertilizer attachment with seed box for uniform placement of both, slimming the equipment to reduce the draft required and the length and trajectory of delivery pipes are being modified.

Studies on the water use efficiency in rainfed cotton through drip irrigaton in vertisol (K. S. Bhaskar, A. R. Raju, J. V. Singh and G. Majumdar).

The optimum plant stand required for drip was standardised in two years at 27, 777 i.e. 120 x 60 cm with two plants per hill. At this plant stand a boll load of 66 with 107 g/plant and 1870 kg ha^{-1} was achieved. The target is achievable by advance planting, increasing the plant density and reducing the expenditure by cluster and paired row planting and optimal supply of major and micro nutrients (Zn, B, Mn) through drip/fertigation.

Higher yield with two plants $hill^{-1}$ was found to be associated with higher number of bolls $plant^{-1}$ and boll weight.

Adhoc trial: **Studies on the efficacy of Micro-nutrients application and moisture management in rainfed**

cotton (A. R Raju, J.V. Singh and Rao, M. R. K.).

Supplemental irrigations (twice) in October month improved seed cotton yield of rainfed hybrid cotton by 37% over control. The application of Zn, Mn and B @ 30, 30 and 10 kg ha^{-1} respectively every year either as soil application or foliar or together under rainfed or under supplemental irrigations could not bring statistically significant improvements in seed cotton yield of NHH 44. Bundle strength was significantly influenced by micro nutrients together as soil application under rainfed condition and foliar application under supplemental irrigations.

Improving the efficiency of cotton+arhar strip cropping (A. R. Raju).

Studies on the competition and production efficiencies as influenced by 12, 8, 6 rows of cotton with 1or 2 rows of pigeon pea indicated that seed cotton yield in both *desi* and *hirsutum* hybrid cottons were statistically non significant. The use of N fixing and P solubilizing bio-inoculants and foliar spray of 2% urea twice at 60 and 80 days after sowing in NHH 44 hybrid cotton (8 +2 rows) and pigeon pea strip cropping improved seed cotton yields by 13% and 6% respectively at 50% recommended dose of fertilizers (RDF). RDF alone produced 18% and with biofertilisers as seed treatment produced 40% more seed cotton yield over 50%RDF in NHH 44 cotton.

Coimbatore

Exploring suitable agrotechniques for Bt cotton hybrid (K. Sankaranarayanan, P. Nalayini and B. Dhara Jothi).

Agronomic requirements of Bt cotton hybrid in relation to plant density and fertilizer requirements

A spacing of 75 x 60 cm in Bt cotton hybrid registered significantly highest seed cotton yield of 31.7 q/ha. Application of 150 per cent of recommended level of fertilizers registered significantly the highest number of burst bolls per plant (24.8), per plant yield (84 g/plant) and seed cotton yield (30.9 q/ha) and it was on par with 125 per cent of recommended level of fertilizers.

Effects of time of sowing on productivity of the Bt cotton hybrid

Among the different dates of sowing of MECH 162 Bt cotton hybrid (August 15th, September 1st, September 15th and October 1st), August 15th sowing recorded significantly the highest seed cotton yield (25.0 q/ha), and was on par with other times of sowing except at October 1st (Table 7).

Table 7. Effect of times of sowing on seed cotton yield (q/ha) of Bt and non Bt cotton hybrids

Treatments	H1: MECH 162 Bt	H2: MECH 162 non Bt	Mean
T_1 August 15th sowing	26.2	23.7	25.0
T_2 September 1st sowing	23.2	19.0	21.1
T_3 September 15th sowing	25.0	22.2	23.6
T_4 October 1st sowing	21.7	14.9	18.3
Mean	24.0	20.0	
	Hybrids	Times of sowing	Interaction
SEd	1.1	1.6	2.0
CD (0.05 %)	2.8	3.5	4.9

Studies on intercropping in Bt cotton hybrids

Intercropping of Bt cotton with red gram, cowpea, onion, bhendi was compared in Bt cotton + 20% non Bt, Bt cotton alone and conventional cotton (Bunny). The experimental results revealed that none of the treatments significantly influenced seed cotton yield.

Influence of secondary and micro-nutrients on qualitative and quantitative parameters of cotton (K. Sankaranarayanan).

Soil application of Fe (Fe_2SO_4 @ 50 (kg/ha) registered significantly high ginning percentage (37.43%) as compared to control (35.38). Fibre length was significantly higher with the application of B (Borax 5 kg/ha; 30.17 mm) than control (29.38 mm). The uniformity ratio was significantly influenced by the soil application of Fe ($Fe_2 SO_4$ @50 kg/ha) and foliar application Zn (Zn SO_4 @ 0.5%) and B (Borax (a) 0.5%) at 60, 75 and 90 days after sowing. Seed index, lint index, micronaire value, fibre strength and fibre elongation were not significantly influenced.

AICCIP Trial - **Agronomic requirements of pre-release hybrids** (K. Sankaranarayanan).

The experiment conducted with three pre-release hybrids (VARCH 87, RAHH 92 and RAHB 87) at two spacings (90 x 60 cm and 90 x 75 cm) with two levels of fertilizers (100 and 125% of RD level of N, P and K / ha) revealed that RAHB 87 registered significantly higher yield. Recommended spacing (90 x 60 cm) was sufficient for all genotypes.

National Agricultural Technology Project

Nagpur

RCPS 2: Optimizing nutrient supply in relation to moisture availability for enhanced productivity and stability of rainfed cotton based production system (Jagvir Singh and Blaise).

Two experiments were conducted during 2002-03. On-station trial were conducted with 12 treatments of different N P levels, and on-farm trials, to refine the fertilizer recommendation. The INM treatment was found superior over lower doses of NP (60:30) in relation to seed cotton yield, boll weight, RWC , LAI at 80 and 110 DAS and available N P, micronutrients and Organic C .

N mineralization at different moisture regimes conducted in pot culture, revealed that RDF with 5t FYM and INM at 75% FC had better effect on increasing dry matter yield, seed cotton yield, N, P and Zn uptake and mineralization of N as NO_3 - N when compared to 50% FC, significant crop response to 50 % ASM as well as phosphorus applied with and without FYM. The magnitude of increase in seed cotton yield due to P applied along with FYM was markedly higher at 100% ASM than at 50 and 25% ASM, indicating a synergistic effect of applied P and soil moisture.

On-farm participatory trials conducted using different land configurations viz. flat bed and ridges and furrows in shallow and medium deep soils for moisture conservation viz. farmers practice, university recommendations, soil test based NPK with FYM and soil test based nutrients with green manuring @ 2t/ha through cowpea as intercrop (INM:80:40:40:NPK + 30Zn +2t/ha FYM + PSB +2%DAP) revealed that INM treatment by using ridges & furrows method significantly increased nutrient N and P mineralization and seed cotton yield over the farmers practice. Land configurations, increased the moisture by 3 to 4% in medium deep soils over flat bed system. Mulching of green manure like cowpea or greengram or sunnhemp as an intercrop in INM treatment increased the soil moisture ranging from 2 to 5

% in shallow soil and 2 to 3 % in medium deep soils and seed cotton yield over farmer's practice.

RCPS 11: **Impact of tillage, land treatment and organic residue management on drainage, soil health and productivity of rainfed cotton based cropping system**
(Blaise and G. Majumdar).

Trials were conducted in fourteen farmers' fields across six villages with farmer practice (T1), conventional tillage + broad bed furrows (BBF) + recommended dose of fertilizers (RDF) (T2), reduced tillage (RT) + green manure *in situ* (GM) + BBF + RDF (T3) and RT+GM+BBF+RDF+$ZnSO_4$ (20 kg/ha) (T4).

Plant Growth and Yield

The farmer practices recorded significantly lower yields of cotton and pigeonpea than the improved technologies.

Soil moisture determined on farmer's fields in the 0-15 and 15-30 cm soil depth, was, in general, greater in the plots, which had organic residue management (incorporation of green manure) in combination with broad-bed furrow.

ROPS 10: **Identification of research gaps in intercropping system under rainfed conditions in India** (M.R.K.Rao and Blaise).

The survey was carried out in 10 villages in six talukas of Nagpur district.

Strip intercropping with pigeonpea mostly in the ratios of 8:2 and 6 :2 of cotton : pigeonpea was found to be a predominant practice. The strip intercrop was found to provide monetary returns in addition to meeting the nutritional demands of the farm family without additional expenditure. Percentage adoption of strip intercropping system is more than 90%. In terms of the total cropped area of the surveyed farmers the area under strip intercropping system is around 50%, while the rest of the area is covered under different crops (jowar, soybean etc.).

Majority of the farmers expressed their apprehension for taking up intercropping with blackgram, greengram or soybean in terms of the difficulty likely to be encountered for intensive interculture. Some of the farmers felt that row to row intercropping may enhance the pest build up and consequently lead to lower yield in addition to additional expenditure.

PSR-36: **Adoption and refinement of cotton picker and cleaning system** (G. Majumdar and A.R. Raju).

Three promising genotypes namely, CNH 123, CNH 155, HISAR 3 were evaluated at 90 x 10 cm spacing in large plots of 9x12 m with regard to parameters affecting mechanical harvesting of cotton. Ethrel was applied on different DAS @5000 ppm. Spatial distribution of bolls were analysed to identify most compact genotype. Labour requirement for manual harvesting, time taken, harvesting losses, leaf shedding etc. were evaluated to identify the most suitable genotype for mechanical picking.

RCPS 5: Rain water conservation, harvesting and recycling / recharging techniques for enhanced productivity of cotton-based cropping system (K.S.Bhaskar, A.R.Raju, G. Majumdar and S.M.Wasnik).

Moisture Management Practices in Different Toposequences

At same level of management, soils moisture percentage varied with toposequence - lowest at the upper plain and the highest at the valley bottom and fluctuated with soil depth as compared to 15 cm soil depth.

Upper Plain : The maximum seed cotton yield was recorded in treatment T4 (T3+ supplemental irrigation + 100% RD of fertilizer), closely followed by T3 (Cotton + Sorghum on ridges + furrow + 100% RD of

fertilizer) and the minimum (5.33 q ha^{-1}) in T1 (farmers practices sole cotton [*hirsutum]* flat bed + 100% RD of fertilizer). The higher yield of cotton in treatment T4 was significantly improved by associated yield contributing characters such as number of bolls per plant, boll weight (g) and seed cotton yield per plant (g).

Middle plain: Inclusion of greengram as strip crop gave better yield over sole cotton in T1 (sowing of *hirsutum* as a sole crop on flat bed). Although there was an increase in seed cotton yield in T2 (*hirsutum* + green-gram in flat bed) and T3 (*hirsutm* on contour) over T1, the differences were not significant. The effect of recycling of water on the yield of cotton crop over T1 (sowing of *hirsutum* cotton as a sole crop on flat bed) was significant.

Lower plain: Moisture conservation measures such as ridge and furrow system was found beneficial in increasing seed cotton yield significantly over the other treatments.

The maximum seed cotton yield was recorded in T2 (cotton in ridges & furrow + soybean followed by chickpea) and the minimum in T1 (sowing of *hirsutum* as a sole crop on flat bed).

Excess moisture management in cotton

Valley bottom: Although this year was considered as drought year, the effect of moisture conservation measures, such as ridge and furrow, broad bed and sunken bed and raised and sunken bed in excess moisture soils was there, which influenced the seed cotton yield in all the treatment. Maximum (9.31 q/ha) seed cotton yield was recorded in T2 (T1+ridges & furrows at 30 DAS), followed by T4 (raised & sunken bed layout) and T3 (broad bed and sunken sowing [30-180-30]), and the minimum (7.39 q/ha) under T1 (sowing of cotton on flat bed), but the yield differences ware non-significant.

PSR-33 : **Evaluation of tillage, residue and nutrient management practices for cotton-wheat system** (K. S. Bhaskar, J.V. Singh, Blaise, S. M Wasnik, O. P. Tuteja and G. Majumdar).

Seed Cotton Yield

Tillage management in cotton: Yield showed significant improvement due to imposition of tillage treatment. The mean maximum (15.25 q ha^{-1}) seed cotton yield was recorded under T3 (Deep ploughing before cotton sowing once in two years + reduced tillage with rotavator + herbicide application for early season weed control) followed by T2 (14.27 q/ha) and the minimum (13.70 q/ha) under T1.

Residue management in cotton : While residue management showed no significant difference in seed cotton yield, location did with highest at Sirsa followed by Ludhiana and the minimum at Sriganganagar. Higher seed cotton yields in R2, R3 and R5 treatments where residue was incorporated was associated with high built-up of organic carbon and more bolls and boll weight over the other treatments.

Biomass management in cotton

Response of tillage: Biomass productivity per plant at 60, 80, 100, and 120 DAS at CICR, Sirsa was determined. Deep tillage treatment resulted in more biomass production at 80 and 120 DAS.

Among residue treatments, biomass was more in case of cotton stalk removed, but harvest highest biomass was recorded in treatment R3 and R5 where cotton / wheat residue was retained and incorporated in the soil.

Nutrient management in cotton

Nitrogen

Response of tillage : The nutrient content (N,P and K) was highest in case of seed, leaf and stem in T3, compared to the other tillage treatments. Among residue management practices, incorporating cotton and wheat residue resulted in increase in N and K content

of the various plant parts. P content was greater in the wheat residue burnt *in-situ* plots.

Wheat Yield

Response of tillage: Result showed that the yield of wheat varied across treatments and locations at the same level of management, variation in soil and climatic condition. At Sriganganagar centre, wheat yield was highest (41 q ha^{-1}) under conventional tillage (T1) and the lowest (36 q ha^{-1}) under reduced tillage (T2), while at Ludhiana and Sirsa centres yield was quite high (> 50 q ha^{-1}) but difference due to treatment effects were non-significant.

Trichoderma inoculation enhanced decomposition of the cotton stalks, but varied with species. *T. resei* and *T. viride* had mineralized the greatest amounts of residue-C during the first three days. The least amount was mineralized from *T. hamatum* followed by *T. piluliforme*. At the end of 45 days, the greatest amount of cumulative C mineralized was from stalks inoculated with *T. resei*, followed by *T. piluliforme* and *T. viride*, *Chaetomium* sp., and *T. hamatum*. Although *T. hamatum* inoculated stalks had mineralized lesser amounts of stalk-C when compared to the uninoculated stlaks during the first six days, the greater amounts of C mineralized after nine days resulted in a 4.7% increase in C mineralization. However, it also points out that *T. hamatum* may not be able to degrade the stalks effectively when compared to the native microflora. *T.resei* appears to effectively colonizing the stalks and degrade the residue-C.

RCPS-9 : **Develop and evaluate production technologies for the indigenous cotton in north-east region -** (A. R. Raju, M.K.Meshram, G. Majumdar, S.M. Wasnik and V. N. Wagmare).

In the varietal introduction trial at A.R.S. Mudhol, G-27 was out standing followed by Lohit and AKA 5 under medium deep black soils. The nutrients demand ranged from 45-60 kg N and 6-10 kg P_2O_5 ha^{-1}. In the on farm trials Veena (MDL-1875) yielding between 1000-1500 kg ha^{-1} even in drought year nearly doubling NHH 44, yield. The INM trials conducted conclusively demonstrated the efficacy of N fixing and P solubilising bio-inoculants as seed treament with 2% urea as foliar spray at 60 and 80 DAS alongwith 50% recommended fertilizers resulting in 1.25 q/ha in medium deep soils and 2.50 q/ha in shallow red soils.

PSR-4 : **Studies on the efficacy of Bio inoculants in cotton-wheat production system -** (A. R. Raju and D. Monga).

In cotton-wheat system at Sirsa, *A. chrococcum* heat tolerant strain Ht-54 (i) performed superior with an improvement of 16% seed cotton yield over 65% RDF which was statistically similar to that of 100% RDF. Among the strains introduced from Nagpur over last two seasons, Nagpur-2 of both *A. chrococcum* and *Azospirillum* were found superior. The N fixing *Pseudomonas* culture also performed similar to that of Nagpur *Azospirillum-2*. The N and P uptake of cotton with these cultures when supplemented with 65% RDF was more than that of 100% RDF.

A. chrococcum Ht 54 (i) performed better with wheat grain yield improvement by 150-200 kg ha^{-1} in Sirsa district under on farm trials. In the cotton wheat system *Pseudomonas* alongwith *A. chrococcum* could tolerate Mancozeb, Carbendazim, Imidachlorprid, *Azosprillum* could tolerate Carbendazim, Imidachlorprid and *Acetobacter* could tolerate only Carbendazim and also produce seed cotton yields similar to that of 100% RDF when supplemented with only 65% RDF.

Coimbatore

PSR 16: **Exploitation of *G.herbaceum* cotton for improving agricultural output and economy of the coastal agroecosystem** (N. Gopalakrishnan, K. N. Gururajan and S.E.S.A. Khader).

The high yielding ability of *desi* cotton hybrid G. Cot DH 7 could be demonstrated in coastal areas of Gujarat (Khapat - 14 q/ha and Danti 24 q/ha), Karnataka (Brahmavar 5 q/ ha and Ankola 9 q/ha), Tamil Nadu (Kovilpattti 6.6 q/ha) and Andhra Pradesh (Konanki 6.4 q/ ha and Uppugundur 5.4 q/ha) even under marginal and stressed conditions. Similarly, G. Cot. DH 9 established its high yielding ability in coastal areas of Gujarat (Khapat - 14 q/ha and Danti 31 q/ha), Karnataka (Brahmavar 5.5 q/ ha and Ankola 7 q/ha), Tamil Nadu (Kovilpattti 6.7 q/ha) and Andhra Pradesh (Konanki 7.0 q/ ha and Uppugundur- 5.8 q/ha). G. Cot DH 7 and G. Cot DH 9 registered very high yields (42-44 q/ha) in coastal areas of Karaikal.

G.herbaceum genotype RAHS 14 was found saline tolerant, high yielding (8 - 9 q/ha) even under very adverse conditions, early and well adapted at many locations. The high yield potential of *G.herbaceum* variety viz., DB 3-12 and G.Cot 21 could be demonstrated at several locations even under very adverse situations with average yield of 6 q/ha. By sowing *G.herbaceum* genotypes and *desi* hybrids in September, economical yields could be obtained in coastal areas of Goa.

G.herbaceum genotypes RAHS 14, RAHS 119, RAHS 101 and hybrids G.Cot DH 7 and G.Cot DH 9 yielded around 6- 9. 5 q/ha in highly saline areas of Ankola, wherein sea water intrusion was seen and crops like greengram and blackgram failed. The performance of *G.herbaceum* genotypes RAHS 132 and RAHS 14 under rainfed situation in Paramakudi (Tamil Nadu) was found superior with yield of 18 and 15 q/ha, respectively. GBhv 198, GShv 531/92 and RAHS 131 have been identified as drought tolerant genotypes with better yielding ability at Surat. Based on physiological and biochemical evaluation at Guntur, var. Dhumad, Jayadhar, G. Cot 17, G. Cot 21 could be categorized as saline and drought tolerant genotypes.

Desi hybrid cotton based inter cropping experiment was conducted at Coimbatore, superiority (G. Cot DH 9) with inter crops like black gram, cow pea and onion could be demonstrated with a cost benefit ratio of 1:2 as compared to 1:1.8 by sole crop of *desi* cotton hybrid. A net cotton equivalent yield of 23 to 25 q/ha could be obtained in cotton intercrop system as compared to 19 q/ha in sole crop of *desi* hybrid cotton.

Technology Mission on Cotton

MMC1: Nutrient dynamics in cotton and establishment of critical limits for secondary and micro-nutrients

Nagpur - (Blaise and J.V. Singh)

Laboratory studies revealed that P availability was greater when applied in combination with FYM. P alone treatments had greater P content than the control up to 45 days, but later the net P available declined with only 8 mg being recovered against the 20 mg applied. With FYM high biological activity increases decomposition of organic matter and produces organic acids, that desorbs phosphates from oxides and hydroxides. Microorganisms also produce exo-enzymes (alkaline phosphatase) resulting in decomposition of organic phosphates. However, microorganisms themselves compete for P, especially in low-P soils.

GOT was significantly improved in the balanced fertilizer plots and plots receiving FYM but not fibre quality parameters.

Nutrient uptake showed N, P and K removal as 1:0.6:1 ratio. Uptake was very low up to squaring stage, and high between squaring and flowering stages, which corresponds to the period of maximum biomass accumulation.

N balance was positive in the N-fertilized plots but slightly reduced when with P and K combination. While application of fertilizer resulted in net positive balance, non-application resulted in greater depletion of other nutrients.

On-farm trial conducted with Ankur-651 sown at a spacing of 0.75 x 0.75 m showed no significant response to zinc and sulphur in the calcareous soils, but response to Zn (2865 kg/ha) and S (2992 kg/ha) was highly significant over control (2666 kg/ha) in deep black soils. Differences between the 50 and 100% recommended dose of fertilizers (RDF) were not significant in both the soils. However, the seed cotton yields were greater by 2 to 3 q in the 100% RDF plots.

MMC-2: Evaluation of bio-inoculants for eco-friendly and economic nutrient management in cotton

Nagpur - (A. R. Raju)

Studies over three years confirmed that in hybrid cotton Azt. Ht 542, Ala-27, PSB as seed treatment with 2% urea alongwith 50% RDF can improve seed cotton yields similar to that of 100% RDF. The magnitude of response is 333-342 kg ha^{-1} (26-29%) under rainfed condition.

The bio-inoculants Asp. Nagpur 2 and Azt. Nagpur-2 significantly improved yield by 258 and 329 kg ha^{-1} in rainfed conditions. Two supplemental irrigations brought significantly higher seed cotton yield in all the bio-inoculants than control. There is no significant response for applied inorganic fertilizers beyond 50% recommended dose for hybrid cotton.

The effect of seed dressing agro-chemicals on colonization of rhizosphere bacteria studied in pot and field trials confirmed that the use agro-chemicals was not having a significant influence on rhizosphere colonization or seed cotton yield.

Coimbatore - (P. Nalayini)

Crop response studies of cotton cv. LRA 5166 to *Azospirillum* and *Phosphobacteria* revealed that application of 100 % N and P recorded significantly higher seed cotton yield and was on par with 75 % level but was found superior to 50 % and unfertilized control. The bio-inoculants did not influence the seed cotton yield significantly.

Enumeration of Rhizosphere population of *Azospirillum* and Phosphobacteria: All the three fertilizer treatments recorded reduction in rhizosphere population of *Azospirillum* as compared to unfertilized control indicating that available soil nutrients are sufficient to maintain the desired population of *Azospirillum* in soil.

The interaction of fertilizer levels and bio-inoculants was found significant and revealed that TNAU and Surat cultures of *Azospirillum* recorded higher population at zero level of N and P indicating the efficiency of these cultures to survive and multiply in the available soil nutrients, while HAU culture recorded maximum population level of *Azospirillum* at 75 % fertilizer level.

The fertilizer levels influenced the phosphobacterial population significantly and higher population was recorded at 75 % fertilizer level. Among the bio-inoculants, Surat and HAU cultures of *Azospirillum* recorded higher population of phosphobacteria, while TNAU culture inhibited the growth of phosphobacteria.

Interaction of bio-inoculants with agrochemicals : Seed treatment with Imidachloprid (7 g/kg of seed), carbendazim (1g/kg of seed), Thiram (4 g/kg of seed) and soil application of pre-emergence herbicide, pendimethalin (1kg /ha), revealed that none of the agrochemicals inhibited the growth of phosphobacteria in the rhizosphere, except carbendazim, inhibiting the growth of *Azospirillum*.

Plant Growth promoting rhizobacteria on vigour index of Cotton : The results revealed that seed treatment with either *Azospirillum* or PPFM recorded significantly higher vigour index as compared to rest of the treatments.

MMC-3: **Evaluation of soil suitability for cotton-based cropping system in India** (K.S. Bhaskar and S.M. Wasnik).

The effect of different levels of management on the yield of two genotypes was evaluated under shallow soils. Result showed that the lowest (7.69 q ha^{-1}) seed cotton yield was recorded in control and the highest (11.26 q ha^{-1}) in F_3 (100 % recommended dose of fertilizer). The yield under F_1 and F_2 was higher than F0.

Yield trend under medium soil showed increase with a level of fertilizers in NHH 44. However, mean maximum (12.70 q ha^{-1}) seed cotton yield was recorded in F3 closely followed by F_2 (12.27 q ha^{-1}) and the lowest (8.56 q ha^{-1}) under F0 .

Rajat showed better performance was at all the levels of management except in F0. Higher yield of cotton in F_2 and F_3 treatments was associated with more number of effective bolls and higher boll weight. This, showed that varieties performed better in medium deep soil as compared to hybrid cotton under uniform level of management.

Under deep soils NHH 44 performance was better. It was highest (18.26 q ha^{-1}) under F3 closely followed by F2 (17.97 q ha^{-1}) and the minimum (9.40 q ha^{-1}) under F0. Yield increased with levels of fertilizer, but the differences in F2 and F3 were not significant.

Rajat showed yield too increased with level of fertilizer, but total less than NHH 44. This showed that in deep vertisols, performance of hybrid cotton is better as compared to varieties.

This shows that varieties are found suitable and performe better in shallow to medium deep soil, while the hybrid cotton in very deep soil only. The maturity of the crop was also recorded early as compared to hybrid cotton. This may be due to shallow rooting depth of the cotton well fitted to toposequential conditions of the shallow soils including water-holding capacity.

MMD-1: **Methodology for prediction of regional level cotton yield by integrating remote sensing, GIS and simulation models**

Nagpur - (M.R.K.Rao and K.B.Hebbar)

GOSSYM model was validated under Nagpur condition using weather, soil and crop inputs from 2001-02 field experiment involving three dates of sowing and four nitrogen levels. The model is very sensitive to weather, however it underestimated yield, plant height, leaf area index, number of nodes, etc. INFOCROP a generic model too was tested using on historic data cotton growth and development for different agro climatic zones and incorporating for calibration. Genetic coefficients calculated for varieties and hybrids across the species were incorporated in the model. Model simulated yield was in agreement with the observed yield under rainfed condition. The LAI and total dry matter of late sown crop under rainfed condition and the simulated yield and other attributes under irrigated condition have deviated from the observed yield. Regression models using 22 years data based on rainfall and temperature for Nagpur and Dharwad districts revealed that September rainfall coinciding with flowering and minimum temperature and December rainfall coinciding with boll development are very important. Using these regression equations the earliest cotton yield estimation can be made by 1st fortnight of December.

The cotton area was estimated for Nagpur and Dharwad districts using the remote sensed data. The soil resource maps of Nagpur and Dharwad districts were already

digitized and superimposed with thespian polygons. WOFOST - a general simulation model was used to simulate the data for each of the polygons prepared on the soil resource map of Nagpur district.

Coimbatore - (A.H. Prakash)

Experimental trial with cv. LRA 5166 and four levels viz., 0, 60, 90 and 120 kg of N/ha and three dates of sowing (8th, 18th and 28th August, 2002) was laid in split plot design.

The solar radiation and day night temperature was almost identical during the first 50 days which was reflected in GDD of 583 upto 50 days.

The data generated were utilised to validate the already existing models like CALGOS, COTTAM and GOSSYM. During the present year one more model viz., InfoCrop was validated for cotton. The model could simulate accurately upto 120 days after sowing

MMD-2: **Mechanisation of tillage, sowing, inter-culture and spraying operations in cotton cultivation** (G.Majumdar, P. Mohan and S. Vennila).

Time sorting light and pheromone traps

A time sorting light trap was designed for studying the activity rhythms of insects in cotton ecosystem. Observations clearly demarcated the timing of activity of different groups of cotton insects. In addition, a time sorter has been used in conjunction with pheromone traps so as to make the study insect (bollworm species) specific.

Twelve compartments made of transparent sheets each covering two hours activities, mounted on a mechanical clock served as a time sorter. The catch attracted either by light or pheromone was directed into compartments through a funnel attachment. Presently the observations are being taken visually from each of the compartments before emptying.

Study on Spraying Techniques: LRA 5166 was sown at 60 X 60 cm spacing in an area of 22.8 x 8.4 sq. m. and was sprayed every 15 days with lever operated knapsack sprayer using NMDS nozzles at 40 psi. Analysis of three years data of LRA 5166, NHH 44 and PKV 081 revealed that the plant physical parameters did not vary more than 30 % under varying input, management and weather condition.

Study on Droplet Sizes: Three hydraulic nozzles commonly used for pesticide spraying NMDS, hollow cone and NMD 36450, were analysed for droplet sizes at varying heights i.e. 30, 60, 90 and 120 cm and at varying pressures i.e. 20,40 and 60 psi. The droplets were collected on glass slides smeared with grease oil matrix. Fifty droplets were observed under microscope at random for each treatment. Droplet numbers per unit area were also counted. Subsequently VMD and NMD out and ratio for each nozzle and setting worked out. The ratio closest to 1 was found for nozzles MMDS at 60 psi at 60 cm height and MMD 36450 at 20 psi and 60 cm height. The latter has a delivery rate of only 15 lit/hr, which is only half of the former indicating that it can be used in early part of crop growth with considerable saving in pesticide.

Development of a novel sprayer for cotton sowing in small holder situations

A novel manual sprayer for cotton was conceptualized and fabricated. The sprayer uses a peristaltic pump to atomize and deliver the spray fluid. The lab model of sprayer consists of two wheels of 60 cm dai. made of 12 mm dia. M.S. steel rods. The wheels have been kept 45 cm apart mounted on a frame of 85 X 50 cm M.S. angle. The spokes of the wheels are connected horizontally with cross shafts at 30 cm inside the outer dia of the wheels. Each cross shaft has a roller mounted centrally with oversize hole to rotate freely. The spray fluid is kept in a 10 lit. tank mounted on top of the frame assembly with a stop clock to regulate the spray fluid which is gravity fed

into a rubber cycle tube. The latter is wrapped around the periphery of the cross shafts to a spray boom mounted at the rear of the sprayer. As the fluid is gravity fed in to the tube and the sprayer is pulled behind the operator the wheels and cross shafts rotate and the rollers move pressing the fluid laden tube and forcing incremental columns of the fluid into the spray boom thus building up the pressure with each successive stroke. The fluid comes out atomized through the two hydraulic nozzles provided at two ends of the boom.

Development of a two row tractor drawn cotton stalk puller and remover

The theoretical force developed at the point of contact of pulling wheels when the wheels were vertical was 443.9, 345.27 and 282.41 kg at 140, 180 and 220 rpm wheel rotational speed respectively and it was 384.42, 299.01 and 244.57 kg at 140, 180 and 220 rpm wheel rotational speed respectively at 30 degree wheel tilt angle. The force developed is decreased when the wheel rotational speed is increased, this may be because of the fact that the force is inversely proportional to velocity.

MMD 3: Development of efficient farming techniques for higher productivity.

Coimbatore - (P. Nalayini)

Effect of irrigation scheduling through drip on cotton productivity :

Summer Cotton : Scheduling of irrigation through drip at 1.0 ETc recorded higher seed cotton yield in cotton cv Surabhi and was on par with 0.8 ETc and 1.2 ETc . The yield increase due to drip during summer ranged from 28.9 to 61.5 %. The Water Use Efficiency (WUE) ranged from 8.8 to 15.8 kg/ha cm under drip irrigation, while it was only 4 kg/ha cm under flood irrigation.

Winter Season : Scheduling of irrigation through drip at 1.0 ETc recorded higher seed cotton yield in cotton hybrid Savita and was on par with 0.8 ETc but found superior to 0.6 ETc and conventional irrigation. The yield increase at 1.0 ETc through drip was about 3 q more than conventional irrigation. The WUE during winter due to drip ranged from 56.7 to 62.9 kg/ha cm as against 12.8 kg/ha cm under conventional irrigation (Table 8).

Table 8. Scheduling of irrigation through drip and conventional irrigation on seed cotton yield and WUE of cotton

	Summer cotton cv Surabhi		Winter cotton cv Savita	
Treatments	Seed cotton Yield (kg/ha)	WUE (kg/ha cm)	Seed cotton Yield (kg/ha)	WUE (kg/ha cm)
I_1: 0.6 ET_c	562	15.8	2165	56.78
I_2: 0.8 ET_c	630	13.5	2703	62.91
I_3: 1.0ET_c	704	12.2	2722	56.94
I_4: 1.2 ET_c	609	8.8	-	-
I_5: Flood Irrigation	436	4.0	2465	12.81
SE_d	48.98	-	**103.65**	-
CD (p=0.05)	102.2	-	**225.83**	

Effect of fertigation on cotton productivity :

Summer Cotton : Fertigation influenced the seed cotton yield significantly in Surabhi. Application of either 100 or 75 % RDF at four splits recorded higher seed cotton yield of 863 and 848 kg/ha respectively as against the lowest seed cotton yield of 736 kg/ha recorded under conventional method (100 % RDF in two splits). The nutrient use efficiency ranged

from 3.63 to 9.42 kg/kg NPK and among the treatments, application of 75 % RDF in four splits recorded the highest NUE of 9.42 kg/kg NPK against 3.62 under conventional system.

Winter cotton : All the fertigation treatments recorded significantly higher seed cotton yield over conventional system and among the treatments, application of either 100 % or 75 % RDF in four splits recorded significantly higher seed cotton yield in cotton hybrid, Savitha. The FUE due to Fertigation ranged from 15.6 to 22.2 kg/kg NPK against 13.7 kg/kg conventional method.

MMH-1: Cotton information and documentation

Nagpur - (G. Majumdar and S. Vennila)

Development of an expert system on cotton insect pest management (ICOTIPM)

ICOTIPM is a computer based software package to assist cotton extension functionaries and farmers in making insect pest management decisions. It constitutes the three most important parts of a system viz. a knowledge base, search method and a user interface. The knowledge base in this case is the domain knowledge of entomologists engaged in research and management of cotton insect pests in India, encoded in the form of rules and heuristics. The search method is by firing rules in the access data sheets by responses of the user given in the forms in Visual Basic. The user interface has been deliberately kept simple by way of providing all possible scenarios and with pictures keeping in mind the clientele who would be using the system and who may not be well versed with the language the system uses to communicate with him. ICOTIPM diagnoses the insects pests either through the descriptions of damaging stages or through damage symptoms to any of the plant parts, using rules as well as images of insect pests. Once the diagnosis of insect pest is done, program directs to the methods of sampling and specifies the established ETL to assist in decision making on the use of insecticides. Insecticidal control options for each insect pest with their dosages and application techniques are furnished for recommendations once the ETL is exceeded. COTIPM is a stand-alone program, works on the computer system having Microsoft Office 2000. It is not linked to crop or insect simulation model(s) and is ready for use at the production level.

Coimbatore - (M. Sabesh).

Data on all aspects of cotton have been collated and digitized. The user-friendly cotton information retrieval system under development contains information on all facets of cotton. The system uses Microsoft Visual Basic as a front-end tool and Microsoft Access as a back-end tool. Different query options have been furnished with this system, which is extremely accessible for the user to filter and retrieve their information.

The Basic Module mainly covers the primary information on cotton area, production; the varieties and hybrids released over the year with fiber technological characters, seed production, variety wise, staple wise area fertilizer and pesticide usage; and agro meteorological data of the cotton growing areas of India.

The industry module mainly highlights the secondary information on cotton like sector-wise cloth production; state-wise yarn/cloth production; count-wise fiber production; state-wise cottonseed pressed as well as information of economic importance.

International module is to spot the International scenario of cotton like cotton area, production, yield; consumption; import and export; of raw cotton, yarn an fabric with sources and destinations around 115 countries since 1924.

Crop Protection

P1-93/1-ICR-H10/0430 :

Screening of cotton germplasm against key pests to find out morphological and biochemical basis of resistance (T. V. Kathane and Sandhya Kranthi).

Twenty five parent lines and six new germplasm lines of *hirsutum* cotton along with 234 F_1, 79 F_2 and 36 F_3 were screened under natural condition to find out their reaction to key pests. Normal agronomic practices were followed except that no control measures were adopted against sucking pests as well as bollworms.

Forty three F_1, ten F_2 and five F_3 respectively were found to be very promising with regards to all parameters taken for selection i.e. boll number, size, weight, staple length and strength etc.

Out of these 43 F_1, 10 F_2 and 5 F_3 the bollworm incidence ranged between 2.53 % to 22.22 % in F_1, 6.58 to 15.66 in F_2 and 6.67% to 14.08% in F_3

P1-93/1-ICR-F60/0430:

Biochemical basis of induction of defense related proteins in cotton against the gram pod borer *H.armigera* (S.Kranthi and S.B.Nandeshwar).

PeeDee 095, an exotic germplasm line, demonstrated the presence of protease inhibitors in seedling and bolls. Using RTPCR and specially designed primers a 400bp fragment was amplified from the mRNA isolated from injured bolls. The same fragment sequenced on CEQ 2000 comprised approximately 340 bases. The putative protease inhibitor fragment was checked for sequence homology with known protease inhibitor sequences using Clustal X.

Crosses were made between PeeDee 0695 (as male parent) and G.cot 10, Bikaneri Nerma and Mahalaxmi as female parents. By backcrossing with the female parent and screening of segregating progeny by single radial diffusion assay it is being attempted to introgress the protease inhibitor gene from PeeDee 0695 into the above cultivars.

P1-94/1-ICR-H10/0430

Interaction effects of cultivars, agrotechniques, insect pests and entomophages of cotton ecosystem (S.Vennila).

Seasonal dynamics of sucking pests:

Heavy infestation by thrips was noticed in Imidacloprid plots over and above the unprotected plots. Aphids attack was observed between 3rd and 4th weeks of August, after which their population had declined to almost nil.

Mirid bug : An emerging sucking pest

Mirid bugs of *Ragmus* spp. (*Ragmus importuniatus*, *R. morosus* and *R.flavomaculatus)*, commonly referred to as tarnished plant bugs, recorded as a minor sucking pest on cotton is increasing in its abundance and damage.

Incidence and infestation of mirid bugs coincided initiation until cessation of squaring. Hairy and early squaring cultivars were found to be preferred.

Seasonal dynamics of bollworms and their damage

Square damage by *Helicoverpa armigera* was between mid September to 10th October, and square and boll damage by *Earias* during November and boll damage by *Pectinophora gossypiella* beyond mid November. Eighty per cent of developing bolls had pink bollworm infestation during the December month.

Seasonal dynamics of natural enemies

Although aphidophagous coccinellids' adult population was less in protected plots, the predatory grub stage was high because of

density-dependent occurrence. Similarly higher levels of oviposition by *Chrysopa* was seen in protected plots. Mean larval parasitisation on *H.armigera*, *E.vittella* and *P.gossypiella* by *Campoletis chlorideae*, *Rogas aligarhensis* and *Apanteles angaleti* was 25.1, 34.2 and 14.1 per cent, respectively.

Study on cultivar insect pest interactions

Genotypic variability in the degree of compensation to insect damage has been documented. It was more for early maturing and short season cultivars than the highly indeterminate genotypes. For *arboreum* cultivar the compensation worked out to be highest. From pest management point of view these studies have indicated that there is scope for increasing thresholds especially for *H.armigera* and to device plant growth based economic threshold/injury levels.

Spatial and temporal distribution of larval instars of *H.armigera* and *E.vittella*

Frequency distribution of *Helicoverpa armigera* larval instars in cotton fields over time revealed a higher proportion of (40 - 80%) 1st and 2nd instars surviving between mid September to mid of October causing damage to an equal proportion of squares. The cumulative dynamic curves indicated only 14% eggs transforming in 1st instar larvae. Survival of 2nd, 3rd, 4th and 5th instars in relation to the neonates were 40%, 27%, 16.2% and 2%, respectively.

Development of decision support system

First version of ICOTIPM - an expert system for Indian cotton insect pest management has been developed for diagnosis of insect pests, determination of population size or damage through sampling methods using ETLs, and selection of ETL based insecticidal control measures for the aid of pest control advisors /extension functionaries.

PI-96/1-ICR-H 10/0430 :

Estimation of losses due to major pests of cotton (S.K. Banerjee).

Variety: LRA 5166: The complete control of major pests in LRA 5166 had minimum square damage (11.33%), boll damage (10.24%) as well as loculi damage (6.90%) and recorded highest seed cotton yield to the tune of 9.02 q/ha. The avoidable loss estimated was to the tune of 28.93 per cent. The treatment with complete control of sucking pests recorded yield of 6.76 q/ha and 5.17 per cent avoidable losses. Wherein, the control of bollworm complex recorded yield of 8.37 q/ha with avoidable yield loss of 23.41 per cent. This plot had 12.59 per cent boll damage and 10.72 per cent of loculi damage as compared to untreated control where highest per cent of boll and loculi damage and minimum yield (6.41 q/ha) was recorded.

Avoidable loss due to all the major pests in NHH 44 was estimated to the tune of 32.02 per cent. Whereas, due to bollworm complex it was 29.36 per cent. Due to sucking pests, *H. armigera,* and pink bollworm the avoidable losses in the seed cotton yield was estimated to be 4.63, 13.06 and 23.31 percent, respectively. The loculi damage of 8.49 per cent was recorded in the plot of complete control of major pests as against 24.68 per cent in untreated control. Wherein, when the control measures were adopted at ETL the loss in the yield could be avoided by 27.93 per cent.

AICCIP Trial: **Efficacy of newer insecticide molecules against bollworms of cotton** (S. K. Banerjee).

Field experiment was laid out in the Randomized Block Design with seven treatments, Emamectin benzoate 5 WSG at different doses (i.e., 8 g, 9.8 g and 11 g a.i./ha), Omite (600 g a.i./ha) + Cypermethrin (60 g a.i./ha),Spinosad (75 g a.i./ha), Indoxacarb (75 g a.i./ha) and untreated control in three replications. The variety used was LRK 516. Totals five sprays were given at the interval of fifteen days. The data on the square damage, green boll damage and locule

damage revealed that all the treatments were significantly superior over control. In respect of square damage and the treatments were on par with each other. Whereas, the lowest per cent of green boll damage was recorded in the treatment with Spinosad (8.90%) and Emamectin benzoate @ 11 g a.i./ha (10.32%), the latter was also found at par with Indoxacarb and Omite + Cypermethrin. The untreated control recorded highest boll damage to the tune of 18.08 per cent. The data on the locule damage revealed that Omite + Cypermethrin recorded lowest locule damage (10.99%) and it was closely followed by Spinosad (13.60 %). The Spinosad was found on par with the treatments of Emamectin benzoate @ 8.0 and 11.0 g a.i./ha. The treatment with Spinosad recorded maximum seed cotton yield (15.12 q/ha).

It was followed by Emamectin benzoate (@ 11.0 g a.i./ha), Indoxacarb, Emamectin benzoate (9.8 g and 8.0 g a.i./ha) and Omite + Cypermethrin. Whereas, untreated control plot recorded lowest seed cotton yield of 5.35 q/ha.

P1-89/1-ICR-H20/0430 :

Studies on multiple disease resistance in upland cotton (Sheo Raj, N.K.Taneja and V.V.Singh).

An experiment was laid out to evaluate MDR cultures viz.,CNH 911, CNH 2713 and CNH 4736 with LRK 516 local check. All performed much better (5.62, 5.91 and 5.69 q/ha) than LRK 516 (3.95 q/ha).

Among different crosses made, one F_1 was observed to be promising. This was entered as CHH 9012 in National Hybrid Trial of AICCIP during 2002-03. Only at Sriganganagar it topped and yielded 41.67 q/ha. The mean span length was 29.2 mm (range 27.3 to 31.7 mm). Besides, it was observed to be moderately susceptible to bacterial blight, resistant to Alternaria and Myrothecium leaf spot, tolerant to jassid and bollworm.

P1-89/3-ICR-H.20/0430:

Studies on seed transmitted pathogenic infections and other seed microflora of cotton (P.M.Mukewar).

Diseases development during seedling stage

The cotyledonary leaves showing necrotic spots, oil-soaked watery spots and suspected disease infection were collected from the field. After the dry examination under the stereobinocular microscope for possible fungus growth and their fructifications, the diseased leaves were subjected to laboratory isolations. The laboratory isolations revealed light to moderate boll infections of various fungi viz., *A. macrospora* (Chandrolla, NAS-5), *Botryodiplodia theobromae* (LRA 5166), *Colletotrichum gloeosporioides* (AKH 4), *Macrophomina phaseolina* (G. Ageti, Suman) and that due to bacterial blight pathogen *X. a.* pv. *malvacearum* in LRA 5166 .

Detection of pathogenic infections in 2001-02 seed samples :

Seed-cotton samples of the previous crop season were separated and were examined for seed discolouration, presence of fungus conidia and their fructifications and bacterial yellow slime mass. The leaf and boll spot pathogen *Alternaria macrospora* was detected to the extent of 5% in variety Chandrolla. In general, infection of *A. macrospora* ranged between 1 to 3%. The varieties/germplasm lines affected were AKH 4, AKA 53, JD 415, G 27, LD 327 and NAS 5. In red pigmented *G. arboreum* variety LD 327 besides *A. macrospora*, the presence of *Rhizoctonia bataticola* (= *Macrophomina phaseolina*) and *Phomopsis malvacearum* was observed.

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

Five races viz. 3, 8, 10, 15 to 18 were identified from the isolates made from infected leaves of susceptible varieties Ganganagar Ageti, LRA 5166, LRK 516, PKV 081 and Rajat. Races 10 and 18 were predominant. Fifty four isolates made from the bacterial blight infected leaves from Coimbatore revealed the presence of races 4, 7, 10 and 18. Race 18 was predominant by 85.19%.

Identification of resistant sources

Out of one hundred ninety seven germplasm lines of *G. hirsutum* inoculated with race 18 of *Xam* under pot culture test, six viz. Aleppo-1 x Acala 1-1-7-7-25, AR-9. B-57-260 CT. B 181 (ST 904), CB 2482 (ST 574) and CPH 1834 exhibited the resistant reaction.

Of the one thousand two hundred and eighty seven lines of *G. hirsutum* evaluated under field conditions, 87 lines observed to be free and 64 were resistant.

Out of 98 lines of *G. hirsutum* of Br01 trial evaluated under field conditions, two viz., SGNR 14 and Cotton - 10 were free of incidence whereas nine viz. Badanawar 1, Cotton-3, F 1050, SGNR-6, SGNR-25, SGNR-28, SGNR-28-1, SV 418 and VC 17 exhibited the resistant reaction.

Utilization of resistant sources

Progenies involving four immune lines Tamcot SP 21, Tamcot SP 23, Tx ORH15 1-78 and Tx Bonham as resistant donors with susceptible cultivars Ganganagar Ageti, LRA 5166, LRK 516, PKV 081 and SRT 1 were tested in the field against bacterial blight. Based on their resistance and other quality parameters, 187 single plant selections were advanced for further testing. The seed cotton yield of these selected plants varied from 37.9 67.4 gm/plant with an average of 12.7 - 18.9 bolls/plant and boll weight of 2.54 3.48 gm/bolls.

P1-93/2-ICR-H20/0430:

Evaluation of cotton germplasm against *Alternaria* and *Myrothecium* leaf spot diseases (N.K.Taneja).

Out of 590 *G. hirsutum* germplasm lines evaluated under natural incidence of diseases in the field, 16 were resistant, 293 moderately resistant, 100 moderately susceptible and 152 susceptible to Alternaria leaf spot while no incidence was observed on 29. One was resistant, 40 moderately resistant, 36 moderately susceptible and 87 susceptible reaction to grey mildew while 426 were free from infection. Two lines showed resistant, 175 moderately resistant, 17 moderately susceptible and 25 susceptible reaction to Myrothecium leaf spot with no symptoms.

Out of 134 *G. hirsutum* germplasm lines screened against fungal foliar diseases under pot culture, all were susceptible to Alternaria leaf spot, 20 showed resistant and 114 susceptible against grey mildew while 25 resistant and 109 susceptible to Myrothecium leaf spot.

Out of 99 *G.hirsutum* germplasm lines evaluated under natural incidence of diseases, no incidence of Alternaria leaf spot was observed on 3, 9 resistant, 64 moderately resistant, 17 moderately susceptible and 6 susceptible to Alternaria leaf spot while no incidence was observed on 84, 1 resistant and 14 moderately resistant to Myrothecium leaf spot.

Out of 97 *G. arboreum* germplasm lines evaluated under natural incidence of diseases, no incidence was observed on two lines, eight resistant, 66 moderately resistant, 16 moderately susceptible and five susceptible to Alternaria leaf spot, while 11 showed moderately resistant reaction against Myrothecium leaf spot and the remaining lines were free from the disease in the

breeder's field.

P1-94/1-ICR-H.20/0430:

Effect of mix-microflora antagonist on control of cotton foliar diseases (R. C. Ukey).

Spraying was done on cotton variety, LRK 516 with 1 mixmicro-antagonist, *Pseudomonas, spp.* of *Mucor*, spp of *Penicillium Streptomyces* and *Trichoderma*, 2. 0.24% Copperfungicide plus streptomycin sulphate, 0.01% and 3. The antagonist microflora was found causing lysis of the pathogenic fungus spores of *Alternaria macrospora, Myrothecium roridum* and *Xanthomonas axnopodis pv. malvacearum* cells. The antagonist and chemical gave nearly equal control of the foliar diseases. The foliar diseases were controlled to the extent of resistant grade as compared to susceptible reactions in the control treatment.

P1-96/2-ICR-H10/0430:

Studies on plant parasitic nematodes associated with cotton (Nandini Gokte-Narkhedkar and S.K.Banerjee).

Damage due to reniform nematode estimated

A pot experiment was set up to simulate field conditions and estimate threshold level of damage. Root weight reduced by 30% and shoot weight by 21%.

Association of parasite *Pasteuria penetrans* with root-knot and reniform nematodes

A bacterial parasite, *Pasteuria penetrans* recorded with juveniles of root-knot and reniform nematodes was species specific with an average frequency of occurrence of 3-5% for reniform and it 6-8% for root knot nematode.

Phenomenon of phased infectivity studied

It was observed that irrespective of inoculum levels , per cent nematode penetration ranges between 9 to 35%. Inspite of sufficient root systems available, all nematodes do not exhibit infectivity with some nematodes not infecting. As this has bearing on infectivity of PPN cotton experiments were set up to test this hypothesis. Cotton seedlings were germinated on agar under aseptic conditions and exposed to pre-adult females of *Rotylenchulus reniformis*. Penetration of reniform nematodes increased with root availability having 7-9% showing no infectivity despite availability host root. Individuals exhibited staggered infectivity, which has significance that in case of invading juveniles not completing their life cycle, a small percentage of population always remains to ensure survival and perpetuation of species.

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 and B. Dhara jothi).

The pest incidence was low due to prolonged drought this year. Aphid was more during October, November and January.

Jassid incidence persisted throughout the cropping season both under unprotected and protected conditions, with a maximum of 8.3 jassid per plant recorded during first week of November. Whitefly incidence was 2-3 per plant in protected field during the middle of January.

H.armigera appeared in the month of October. The maximum damage to reproductive parts was in January under unprotected conditions. Beneficial insects like coccinellids and spiders were recorded throughout the cropping period. The natural egg parasitism was 14 per cent in the month of October. The larval parasitism of *H. armigera* was less than 10 per cent.

H.armigera moth catches started in the month of October and a maximum of 29 moths / week / trap was recorded during the first week of

December. Similarly, *Spodoptera litura* moth collection started in the month of October (4.0 per trap) and a maximum of 125 moths/trap was recorded during the first week of December. Pink bollworm moth catches were recorded in the month of September and a maximum catch of 47 per week was recorded in the last week of December.

P1-89/6-ICR-H10-0430:

Studies on the host-plant relationship anddevelopment of resistant/ tolerant varieties to insect pests of cotton (T. Surulivelu, K. Natarajan and S. Manickam).

A : Bollworms

Fifty seven promising cultivars of *G.hirsutum* were screened in the field under no protection against bollworms. The boll damage ranged from 24.0 to 71.7 %. Thirteen entries (IC 395-1, IC 379-1, IC 430-1, CCHH-1055, LK-17 (Hy), IRH-II-1, LRA 5166, BRS 23-2, Sumangala, Abadhita 4,CP 15/2, Delcerro and Deltapine) were found to be moderately tolerant and recorded 24.3 to 34.8 % while rest of the entries were found to be either susceptible (21 entries with 35.1 to 50.0 % damage) or highly susceptible (23 entries with 50.1 to 71.7 % damage).

Sub Project : Sucking pests

The germplasm cultures viz., IC 248, IC 268, IC 276, IC 298, IC 323, IC 368, IC 379, IC 384 and IC 432 recorded resistant reaction to jassids, while lines IC 270, IC 395, IC 396, IC 421, IC 428, IC 433, IC 440 and IC 457 registered moderately resistant reaction. Thirty cultures derived from Israel recorded resistant reaction.

P1-89/4-ICR-H10/0430:

Studies on the role and effect of insecticides in cotton ecosystem (T.Surulivelu and K. Natarajan).

The reduction of square damage over control in indoxacarb, spinosad and emamectin benzoate were 78.6, 75.4 and 57 - 76 %, respectively. They were significantly superior to omite plus cypermethrin and control in respect of reduction of green boll damage also. They also recorded a reduction of 75.8, 73.4 and 75.0 % incidence of *H.armigera* respectively. Treatment with omite plus cypermethrin recorded significantly higher population of aphid while all other treatments including control had significantly low population. The predators (Coccinellids and Spiders) activity was significantly affected in all the treatments except control by 31.0 to 49.0 per cent.

The seed treatment chemicals thiamethoxam 350 FS at two doses (2 and 5 g. ai/kg of seed) and chlothianidine at three dosess (5,7 and 9 ml/kg of seed) were effective against jassids and aphids upto 50 days. With regard to seed cotton yield, there was no significant differences between the treatments.

P1-2001/1-ICR-H10/0430:

Studies on bioecology and management of cotton stem weevil *Pemphereulus affinis* Faust (B. Dhara jothi and T. Surulivelu).

Maximum infestation level of 86-100% was noticed at Bhavanisagar in Tamil Nadu. All the eight varieties/hybrids tested were preferred by stem weevil, and a range of 2-5 eggs/plant was recorded.

Neem cake + Neem oil + earthing up at 20 and 25 DAS recorded minimum percentage of infestation of 12.79 and 12.95 respectively. However, the treatments were on par with Chlorpyriphos, 0.05%, Neemcake, Neemcake+Neemoil+earthingup at 30 and 40 DAS and superior than the control.

Among the two different fertigation treatments namely 100% recommended dose of fertilizer (RDF) applied in 4 splits, 75% RDF applied in six splits, significant reduction of stem weevil incidence was recorded in the former. The number of split application of fertilizer has not influenced the

incidence of stem weevil. The different irrigation treatments recorded significant difference with minimum percentage of incidence recorded in the treatment 0.6 ETC followed by 0.8 ETC and 1.0 ETC.

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:

There was only mild to moderate incidences of both alternaria leaf spot and grey mildew diseases, during the season.

B. Evaluation of Germplasm

One hundred new germplasm lines each of *G.hirsutum* and *G.arboreum* were separately evaluated for their reaction against *Ramularia areola* and *Alternaria macrospora*. Among arboreum lines, AKA 61 and AKA 62 showed immune reaction to *R.areola* and 12 lines viz.,AKA 12, AKA 13-1, AKA 13-2, AKA 28, DH 149, AKH 496-1, AKH 580, AKH 590, 7307 SC 136, 78 / 1a 1, AK5 and AK 590 1 were resistant. In *hirsutum* lines, the development of grey mildew was slow and hence proper assessment could not be made.

C. Management of the diseases

i) Development of resistant lines

Grey mildew : Eleven progeny selections of the crosses involving IC 629, IC 710, IC 751, IC 1017, (resistant germplasm lines) and RKR 4145, LRA 5166 and Sumangala were evaluated in the field following artificial inoculation with *Ramularia areola*. Twenty seven resistant single plant progenies were selected based on boll number, ginning percent, lint and seed index and advanced for fiber quality evaluation.

Altenaria leaf Spot : Seven advanced resistant selections derived from the crosses involving several resistant germplasm lines and LRA 5166, RKA 4145 and CSH 1071 were evaluated in the field for their reaction and quality parameters, and 15 single plant selections were advanced for further tests.

The resistant selection CCH 4 (RR 1007/124-3) came first in yield in both central and south zone yielding 13.22 and 25.74 q/ha of seed cotton, respectively. This has since been advanced to AICCIP CVT (Br 04a) in both zones. Another resistant selection ALR 20 came first in the 2002-2003 institutional trials

Induced Systemic Resistance : Induced systemic resistance was studied initially by applying the bioagent *P.fluoresens* Pf1 and subsequent challenge inoculation with different isolates of *R.areola* on resistant genotypes. The peroxidase activity increased in the plants sprayed with *P.fluoresens* and challenge inoculated with the *arboreum* isolate of *R.areola*. Susceptible genotypes exhibited high activity in the sprayed and subsequently inoculated plants ranging between 200 to 250 O.D units /min/ g, while the unsprayed and uninoculated plants recorded activity of 95 170 O.D units /min/ g. In the resistant genotypes like GMR 9 and IC 629, around two-fold increase in peroxidase activity was noticed when compared with their respective control plants.

P1- 89/1-ICR-H20/0430:

Studies on soil borne diseases of cotton (Kannan, A, K.N.Gururajan and N. Gopalakrishnan).

Verticillium wilt

Seven progeny derivatives involving Surabhi, MCU 7, Mian 8, LRA 5166, Anjali, Suman and Nazili 85 screened for resistance by 'stem-prick' inoculation method in the conidial suspension of *V. dahliae*, were found resistant. Twenty two single plants based on boll number, ginning percent, lint index and seed index have been selected.

Evaluation of select resistant cultures through multi location testing under

AICCIP

Culture CCH 342 (VLV.3) registered a mean seed cotton yield of 2347 kg/ha across locations in South Zone. This has been advanced to Coordinated Varietal trial. Culture VLV.6 was evaluated in summer season at four location viz., Srivilliputhur, Aduthurai, Karaikal and Rahuri. Culture VLV.6 recorded a mean seed cotton yield of 1505 kg/ha as compared to the check MCU 7 (1307 kg/ha).

P1-89/2-ICR-H20/0430:

Studies on bacterial blight of cotton

(Kannan, A., P. Chidambaram and K. N. Gururajan).

Development of resistant lines

Thirteen crosses involving parents 101-102 B, Badnawar-1, RKR 4145, CBR.1, CBR.2, MCU.10 and LRA 5166 were screened for resistance. Forty seven single plant selections based on boll number, ginning per cent, seed index and lint index have been made.

Evaluation of select resistant progenies

Six resistant progenies were evaluated for yield. Culture MAR 1 recorded the highest yield of 30.8 q/ha (Sumangala 28.3 q/ha).

Sirsa

Evaluation and refinement of IPM module for irrigated cotton

(P. Jeyakumar, D. Monga and S.K.Banerjee).

Utilisation of *Trichogramma* egg card (two releases) from 90 days after sowing along with other plant protection aspects yielded better compared with the six releases in pure bio-intensive module. In biointensive module the cost : benefit ratio was very less (1 : 1.32) than even untreated control.

Incorporation of Neem Seed Kernel Extract (5 %) along with insecticides has helped in reducing the insect pests and cost without affecting the yield significantly in the IPM plots. In case of farmers' practice the yield was very high (1072.5 kg / ha) than all the other plots, followed by IPM (978.53 kg / ha), recommended spray practice (935.98 kg / ha), biointensive module (789.94 kg / ha) and control (640.08 kg / ha). Though the yield is more in farmers' spray practice the B:C ratio is less (1 : 1.49) than the IPM odule (1 : 1.70).

Studies on cotton leaf curl virus disease and development of resistant varieties and hybrids for its management

(D.Monga, O. P. Tuteja, R.A. Meena , S. K. Verma and P. Jeyakumar).

Development of screening nursery

A screening nursery by development of a hedge of susceptible varieties (two rows of F-846 and one row of HS-6) on three sides has been created. The data obtained show more than 90% disease incidence in the screening nursery.

Screening of germplasm lines

One hundred *G. hirsutum* lines received under Br0 1 trial were screened against cotton leaf curl virus disease. The disease incidence ranged from 7.7 -100 %. Sixty six lines were identified to be free from the disease.

Breeding for disease resistance

Two promising CLCuV resistant advanced cultures (CSH 35 and CSH 36) sponsored in AICCIP trials, showed significantly higher yield and better quality parameters.

Out of 47 F_1 and 40 F_1 cultures, 10 promising disease resistant cultures have been identified and further advanced. One hundred and sixty eight single plants were selected from 98 F_2 cultures based on their resistance to CLCuV disease and out of this, sixty four cultures have finally been selected for promotion based on quality parameters. One hundred and twenty four F_1 cultures were evaluated and twenty seven promising disease resistant crosses advanced for F_2 generation. Thirteen backcrosses have been further advanced. Thirty fresh F_1 crosses involving CLCuV resistant lines and popular varieties were attempted during the season.

National Agricultural Technology Project

Nagpur

RCPS 4 : **delineating the efficient productive zones for cotton production system using GIS based crop models** (S.Vennila and K.B.Hebbar).

Data of various experimental trials conducted at different research stations under All India Co-ordinated Cotton Improvement Project from Guntur, Nandyal, Dharwad, Akola were collected for using as inputs in models for calibration as well as validation. Various available cotton crop models like GOSSYM, WOFOST and an indigenously developed model INFOCOT are being used to estimate the cotton yield using the spatial information details like weather and soil parameters. Maps of predicted yields (by WOFOST model) for cotton crop were generated for Abhadita and NHH-44 for Nagpur district at the lead centre.

PSR-26 : **Control of leaf curl viral disease in cotton and development of protocols for mass multiplication of predators, parasites and insect pathogens**

Nagpur - (Sheo Raj)

Development of molecular marker to identify CLCuV resistance

A modified Murry and Thompson (1980) protocol for isolation of DNA from cotton plants was standardised. Random Amplified Polymorphic DNA (RAPD) analysis was carried out to see the polymorphism in CLCuV resistant and susceptible genotypes. Twenty random primers of OPA kit (Operon tech., USA) were tested. The RAPD marker OPA -1, 2, 5, 10 , 11 and 16 were found to be useful for amplification. First of all, OPA 10 was used to characterize resistant and susceptible genotypes showing molecular weight of 0.75 kb to 1.75 kb band in resistant ones (RS 875 and CNH 4736) which clearly amplified the DNA of resistant and susceptible varieties. Thus, the molecular marker was developed to identify resistant plants in cotton germplasm and segregating population.

OPA 16, 10 mer primer tested consistently generated strong amplification. Reproducibility of RAPD-PCR result was verified by conducting repeated experiments. This primer amplified a range of template DNA fragments varying from 0.5 to 2.3-Kb bands (Fig. 3). Analysis of PCR data revealed that out of 13 genotypes, a group of four (RS 875, RS 810, RS 2013 and PIL 8, all *G. hirsutum* resistant) had one banding pattern whereas LD 327, RG 8; both *G. arboreum* have one pattern and three *G. hirsutum* resistant ones viz.; CNH 911, CNH 4736, CNH 2713 have one set of banding pattern.

The change in banding pattern of two groups of resistant types in *G. hirsutum* may be due to level of resistance. On the basis of these results, the primers OPA-10 and OPA-16 may be selected for characterizing and differentiating susceptible and resistant genotypes.

Development of molecular probe to locate latent infection in cotton and other hosts

The gemini viruses share a significant amount of conserved sequence on their DNA. Based on the available information on the highly conserved base sequence in the coat protein gene and AC-1 gene sequence of plant infecting gemini virus, specific primers were designed and custom synthesized for selected PCR amplification of complete CLCuV-A genome. The details are given below.

Oligonucliotide base sequence of custom primers

S.No.	Primer	Base sequence 5'-3'	Region of viral DNA / gene amplification
1.	(CP)PALIV1978	GCATCTGCAGGCCCACATYGTCTT YCCNGT	Cp, AC1, AC 2, AC 3 1.2 kb
2.	(CR)PAR IC 496	AATACTGCAGGGCTTYCTRTACAT RGG	
3.	DNA 1-F	TgGGGATCCTAGGATATAAATAA CACGTC	Cp, AC 1 1.5 kb
4.	DNA 1-R	CTAGGATCCgGACAAATTATAAG CGTACC	

Studies on bio types / markers of whitefly

Ramdom Amplified Polymorphic DNA (RAPD) analysis of whitefly DNA was carried out to study polymorphism in whitefly populations. Twenty random primers of OPA kit Operon Tech., USA, were tested out of which OPA 5, OPA 9, OPA 11 were found to be better as compared to OPA 1, 7, 8 and 13. For subsequent numerical analysis of host associated genetic variation in whitefly population, reproducibility of RAPD-PCR result was verified by conducting replicated experiments. RAPD pattern of different populations of whitefly from north India were considered for amplification. Though few bands show variation in relative DNA intensity, these primers amplified a range of template DNA fragments varying from base pairs. OPA 5 rimer was good for amplification and the number of amplified bands ranged from two to four.

Screening of cotton germplasm for resistance against CLCuV and whitefly

Thirty four genotypes observed to be resistant to CLCuD and tolerant to whitefly earlier were screened during this year also. Screening of germplasm lines at Sirsa for three years showed that eight lines were resistant to both CLCuD and whitefly.

Comparative economics of manual and automatic production system of Corcyra (T.P.Rajendran).

The saving in raw material, labour and other running costs of the new units would offset the initial fabrication cost in addition to the advantage of housing more number of units in smaller space than the conventional system which invariably needs one room of 24' x 20' at least. With one or two new units, the same egg productivity could be achieved in one room, which can be used as parasitization room too. It is hence recommended that Unit II with wider glass-covered hopper would provide economically viable Corcyra production unit for sustained production of grain moth eggs.

Mass production protocols of bioagents (N.K.Taneja)

Modifications were made in the prototype of the multicell plastic tray which is used for rearing *Helicoverpa armigera.*

It was observed that CFU in liquid formulation of *Metarhizium anisopliae* could be maintained upto six months while in powder form, it could be maintained upto three months. In field testing, *M. anisopliae* was quite effective against *H. armigera* on gram.

Sirsa - D.Monga and P. Jeyakumar

Screening of cotton germplasm for resistance against CLCuV and whitefly

One hundred and forty seven lines observed to be resistant based on the screening of previous two years were sown during 2002-03 season. Twenty two lines did not germinate and 45 showed leaf curl virus disease varying from 3.6-100%. Eighty lines were free from leaf curl virus disease. White fly population

ranged from 0.2-3.3 and only one line was free from white fly. However, based on three years data eight lines tolerant to white fly with one or less white fly /leaf were identified. Seed cotton yield of these lines in general was poor. Seventeen lines showed no seed cotton yield and there were only 11 lines which showed seed cotton yield more than 10 q/ha.

The whitefly incidence was first noticed in second fortnight of June, 2002. Among the seed treatments the Thiomethoxam treated plot recorded less population of whitefly (0.03-0.44 / leaf) compared to Imidacloprid treatment (0.05-0.57 / leaf) till the first fortnight of September, 2002. Among the insecticides Triazophos was found effective (0.06-1.02 whitefly / leaf) followed by Difenthuron (0.13-1.22 / leaf), Ethion (0.03-1.47 / leaf) and Acetamiprid (0.01-1.66 / leaf). Both the neem products were found effective on par with insecticides. The *Beauveria bassiana* spray also recorded very less population of whitefly 0.06-1.33 / leaf).

NATP PB : **Screening of cotton germplasm against root-knot and reniform nematodes** (Nandini Narkhedkar).

Nearly 400 working collection samples of cotton germplasm were evaluated against reniform nematode, *Rotylenchulus reniformis*. Eighteen lines were found resistant, of which six accessions viz. 1142 Cly M-4 LyBly, 2547 Lycmh PRS-72, 116 TLYC Macha, 1039 kekichand, 2536 1412-A and VPA(57) were confirmed for resistance. The accessions were found to be resistant to entry of nematodes. Accession 116 TLYC Macha was also found to be resistant to root-knot nematode as well.

MM III-17: **Development of weather-based forewarning systems for crop pests and diseases-Cotton**

Nagpur - (S. Vennila)

The historical data on bollworms, bacterial blight and Alternaria blight at various centres for a minimum period of ten years and in some cases for 3-4 decades have been compiled and digitised. The field experiment was conducted for generation of data sets for use in validation. An on-farm trial was carried out at village Mhasala Tah-Warora, Dist. Chandrapur.

Sixty prediction equations were developed for various pests of different centres and the derived equations were validated with the current year's data. The predictive accuracy varied between pests and weather stations (centres). The developed models predict the regional occurrence of pest variables with high accuracy except for *H. armigera* larval infestation and BLB. In general, the accuracy of prediction was low (50%) for Lam center except for whitefly population. Validation using data sets of future years, (two years) showed mixed trends. The results of the Lam centre indicated that the light trap catches of *H. armigera* cannot be a tool in prediction of its epidemics or otherwise. With the almost monophagous pest of *Pectinophora gossypiella*, the validations were negative with predicted values more than the observed values and vice versa.

Sirsa - (P.Jeyakumar and D. Monga).

Whitefly :

The whitefly population observed and predicted (current season) showed lot of variation throughout the season in Hisar . But in case of Sirsa though the variation is less during the early part of the season but tallied from 38th to 43rd standard week .

Pink Bollworm :

Minimum temperature of week concerned and morning RH of two lagged week acted as the predictors for boll damage in Hisar. Though both the observed and predicted lines showed the similar trend the variation was less except the beginning of incidence and from 36th to 38th week. However in case of Sirsa the

boll damage by pink bollworm was predicted by evening RH of current week only. In this case the predicted value was too high than that of observed value. They also did not share any appreciable similarity in trend line between them. Whereas in case of loculi damage by pink bollworm evening RH of current and two lag week and minimum temperature of two lag week acted as the predictors but both the observed and predicted values did not share much similar trend

***Alternaria* leaf spot :**

This disease was being predicted using maximum temperature and morning RH of two lag week as predictors . The observed and predicted values almost followed the same trend without much variation throughout the observation period except from 33rd to 37th week.

Technology Mission on Cotton

MME-1 : **Evaluation of location specific IPM modules for eco-friendly and sustainable cotton production.**

Nagpur - (T.P.Rajendran)

Two to five different chemicals were used by the farmers of non-IPM village. All had invariably used Endosulfan as one or more sprays. There were cases of mixing the systemic insecticides against sucking pests.

There were no differences in sucking pests load between IPM and non IPM villages. Despite the insecticidal use the chrysopid grub and adults were relatively high in non IPM than IPM plots due to the pest density dependent natural enemy dynamics. The insecticide protected plots of non IPM village had significantly higher oviposition of *H. armigera* and more survival of its larval population. Similarly, the damage to fruiting structures-square, flowers and bolls were significantly higher in non IPM village than in IPM adopted village.

Although IPM fared well in terms of cost benefit ratio (1:2.1 as against 1:1.6 in non IPM), the mean productivity remained low in the IPM villages. This appraises the need for refinement of IPM practices aiming to increase the per hectare yield in addition to reduction in production costs.

Coimbatore - (T. Suruli Velu)

The main components of IPM strategy are : (i) seed treatment with thiamethoxam @ 5 g / kg of seed, (ii) growing of cow-pea as border crop, castor as trap crop and maize as eco-feast crop (iii) application of fertilizer based on soil testing (iv) use of biorationals (neem products, egg parasite, HNPV) during the early fruiting periods (v) removal of terminals (topping) at 90-100 days of growth (vi) hand picking of bigger bollworms (vii) erection of bird perches (ix) insecticide application based on ETL (x)ensuring correct dose and right choice of insecticide, uniform coverage and alternation of various chemical groups.

It helped to reduce the number of sprays from 5.12 to 2.16 and plant protection cost from Rs 5120 to Rs 2160 / ha over control village. Besides, there was yield increase of 14.2 % and a net profit of Rs 10,076 /ha to the project farmers as against Rs 3366 /ha realised by farmers in control village. Cost : benefit ratio was 1 : 1.50 and 1 : 1.15 to the project and control village farmers, respectively.

Sirsa - (P.Jeyakumar and D. Monga).

The IPM components such as selection of released varieties /hybrids, dead bird perches, clipping off of 4 -5 top leaves to reduce the egg laying by the middle of July, pheromone traps for American bollworm and spotted bollowrm, mechanical collection of eggs and larvae of American bollworm was done by engaging labourers, three sprays of NSKE 5 % was done to scare away bollworm adults, besides, insecticides sprays such as endosulfan, quinalphos, cypermethrin, acephate.

The population of sucking pests was found more in non-IPM plots compared to IPM plots. The egg of *Helicoverpa* range 0.02-0.26/plant in IPM and 0.25-0.54 /plant in non-IPM plots. *Helicoverpa* larva load population was (0.02-0.28 / plant) in IPM and (0.14-0.37/ plant) in non-IPM, *Earias* larvae (0.02-0.40/ plant) in IPM and (0.84-0.90/ plant) in non-IPM. The coccinellid population was found in traces in IPM plots while in non-IPM it was mostly zero throughout the season. The population of all natural enemies was observed in non-IPM plots, however at lower level.

The average yield of seed cotton in IPM plots (17.8 qt./ha) is high against non-IPM plots (16.2 qt./ha). Though the number of sprays in both IPM and non-IPM plots were same, three neem sprays were done in IPM plots. This is because of the reason that high population of natural enemies in IPM plots. The expenses on plant protection in IPM plots was Rs.1865/- and that of non-IPM was Rs.2947/-. The cost : benefit ratio was more in IPM farmers (1 : 3.15) than non-IPM farmers (1 : 2.62) .

MME-2 : Development of pests and disease forecasting system.

Nagpur - (M.K.Meshram)

Bacterial blight :

The development of bacterial blight was monitored since its appearance in the fourth week of July on susceptible cultivars. The progress of the disease was observed during the month of August and September and highest disease intensity was recorded during the fourth week of September.

Sirsa - (P.Jeyakumar and D. Monga)

Life table studies of *Helicoverpa armigera* revealed that per cent mortality in egg, small larvae, big larvae and pupae were observed to be 23.28,40.92,28.68 and 20.42 respectively. The mortality factors in different stages were identified as fungus, parasitism, NPV and unknown factors.

The generation survival value was 0.247, whereas trend index showed positive value (1.71). This indicates that the mortality factors operating during this period were not effective in causing decline in the population of *Helicoverpa*. The maximum contribution towards generation mortality was of small larvae, followed by big larvae.

MME- 3: Development of diagnostic tools for differentiation of biotypes/ races of pathogen and insect pests.

Nagpur - (C.D.Mayee, M.K.Meshram and S.Kranthi)

The new synthetic media alone or in combination with either of cotton leaf decoction or carrot juice or their combination was observed to be better for the maximum growth of *Ramularia areola*.

The protocol was standardized for the extraction of DNA from the isolated culture of *R. areola*. Total 20 commercial primers (operon Technologies, Alameda, CA) from kit OPA were screened for their RAPD pattern by using genomic DNA from four isolates viz. Jayadhar, SRT 1, AKA 5 and LRK 516. Primer OPA-3 amplified all four isolates producing multiple bands up to 6 - 8 in number ranging in size between 0.25-2.0 kb. Polymorphic pattern of amplification of three isolates was also obtained with OPA-9 and OPA-13 barring SRT 1.

Sequencing

Primers to amplify specific regions of the mitochondrial genome of *H.armigera* were designed on Jellyfish version 3. Of the three primer sets designed to amplify the insect CO1 (Cytochrome oxidase) region that is approximately 1.2 Kb in size, two worked well under the standardized PCR conditions giving fragments of 645bp and 569bp respectively.

Two parts of the CO1 region were sequenced using forward and reverse primers on CEQ 2000. A 620 base pair sequence was derived that showed homology with the CO1 sequence of *Drosophila yakuba* with some base substitutions. Conserved primer sequences were identified. The same region was also sequenced in *H.assulta*. Differences in base pairs in 26 positions were observed between the two species. The partial CO1 sequence of the putative cotton and non- cotton strains (strains that were separated on the basis of RAPD profiles) was elucidated (Fig.5). No mutation was detected in one strain with respect to the other in the region sequenced.

Fig. 5: Primer sets amplifying the CO1 region of cotton and non- cotton strains of *Helicoverpa armigera* 1-cotton strain 2- non- cotton strain

RAPD markers

The reproducibility of at least five primers in distinguishing cotton and non- cotton strains was determined. Of the twenty tested at least four showed variation in the banding pattern with that particular primer. Hence the RAPD data could not be directly used for the generation of SCAR marker.

Relationship of cotton and non- cotton strains

Based on the RAPD data sets with eight primers, the phylogenetic tree was constructed using NTSYS 2.11 employing the SAHN algorithm and the UPGMA method of clustering. The similarity matrix between the two strains ranged from 0.75- 0.85 and the two groups were distinguished at 0.746.

Coimbatore - (P.Chidambaram, B. Dhara Jothi and N.Gopalakrishnan).

Isolation of DNA from *Helicoverpa armigera* collected from cotton and other hosts and PCR studies

The primer number C-7 specifically amplified a 750bp region in the DNA samples of the *H.armigera* larvae. In the primer number C-4 maximum amplification was recorded at 730-bp region in the DNA of the larvae collected from cotton. Maximum amplification was recorded at 769bp region of all the samples by the primer number E-15 except the samples collected from Bhavanisagar. It could be observed that the sequence of primers that yielded amplification had a higher GC content.

Interaction between *Ramularia areola* and cotton genotypes

The *arboreum* isolate was able to infect most of the *G. arboreum* and *G. herbaceum* hosts and produce typical areolate mildew spots except in case of the line AC 26 where the development was slow. On *G. hirsutum* lines, this isolate was able to produce typical symptoms only on the susceptible cv. LRA5166 and few spots on the resistant lines viz., IC 629, IC 710 and IC 1017. The same pattern of reaction was also observed with arboreum isolate under field conditions.

The *hirsutum* isolate was less virulent and produced typical symptoms only on the susceptible cv. LRA 5166. On resistant hirsutum lines as well as on the arboreum and herbaceum lines, it was able to induce hypersensitive reactions or no reactions at all. Both isolates did not produce any symptoms on *G. barbadense* lines. The results confirm that these two isolates are two different strains of *Ramularia areola* having distinct pathogenic capability.

Sirsa - (D.Monga).

Pathogenecity of isolates:

Twelve isolates of *Rhizoctonia solani* were initially subjected to pathogenicity test against cotton variety RG 8. Experiment was conducted in poly house with controlled environmental conditions. The highest mortality (91.6 per cent) was found in isolate PB-5 and lowest (31.3 percent) in HR-10.

RAPD analysis:

The genomic DNA isolations were standardized based on the method of Raeder and Baroda , 1985. For studying polymorphism, DNA extracted from twelve isolates of *R. solani* was used as template in PCR coupled with 10- mer universal primers (Operon technology Inc. Almeda, California) for amplification of different DNA sections. Using these primers PCR conditions were standardized through a series of experiments in a PTC-100 programmable thermocycler (M.J. Research Inc.). The data from each primer was analysed on gel manager programme software. Twenty, 10- mer universal primers used for amplification of template DNA. All primers except one showed polymorphism in different isolates.

The polymerization products showed varied numbers of bands among the twelve isolates of *R.solani*. The representative RAPD analysis of amplified bands by primer OPN-02 of different 12 isolates (Fig.6)

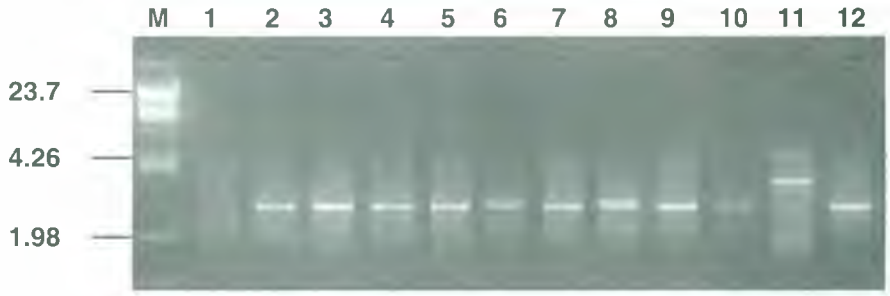


Figure-6: RAPD banding pattern of twelve isolates from *Rhizoctonia solani* with OPN-02 primer

was analysed with help of matrix and dendrogram. The general observations from the RAPD studies were that the isolate no.11 had a distinct DNA profile with most of the primers when compared to other isolates. The genetic distance coefficient was compared for all combinations. The isolate no.11 recorded the highest genetic distance 0.07. The next highest genetic diversity was shown by the isolate no1 which was at the other end of variability spectrum and the variability expressed by the other isolates was in between these isolates. Other isolates no.2,5,4, 7,9,12, and 3 were closely related and expressed more diversity from isolate no.6,10 and 8.

***Rhizoctonia bataticola* Pathogenicity Tests**

Fifteen isolates of *Rhizoctonia bataticola* were initially subjected to pathogenicity test against cotton variety RG 8. The highest mortality was observed in isolate HR-25 and PB-2 (88.6 %) and lowest in RJ-19 (19.8 %).

RAPD analysis:

The polymerization products showed varied numbers of bands among the fifteen isolates of *R. btaticola* (Fig.7). The representative RAPD analysis of amplified bands by primer OPN-04 of 15 isolates was analysed with the help of matrix and dendrogram. The general observations from the RAPD studies were that the isolate no.11 had a distinct DNA profile with most of the primers when compared to other isolates. All the isolates were categorized according to matrix and dendrogram in three groups as group I contained isolate no.1,13,12,9,10 group II contained isolate no.2,3,4,14,5,15,6,7and 9 and group III contained only one isolate no.11.

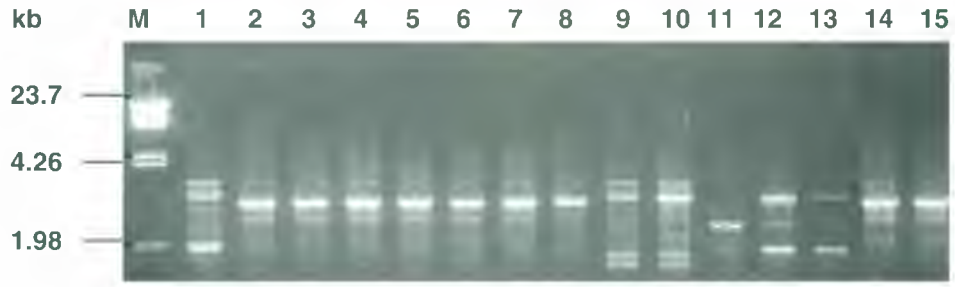


Fig.- .7 : RAPD banding pattern of fifteen isolates from *Rhizoctonia bataticola* with OPN-04 primer.

MME-4: Development of efficient strains of bio-control through molecular manipulations/ techniques

Nagpur - (M.K.Meshram and N.Narkhedkar)

One hundred and forty eight bacterial cultures were isolated from apparently healthy leaves of cotton cultivars. Antagonistic nature of these phylloplane bacteria (PLB) was tested *in vitro* against highly virulent race 18 of the pathogen *Xa* pv. *malvacearum*. Seventeen isolates were observed to be promising inhibitors showing the inhibition zones ranging from 9-15 mm. The most promising antagonistic phylloplane bacteria (Plb 17, Plb 20 and Plb 112) belong to *Pseudomonas* spp.

Entomopathogenic nematodes (EPN) have recently gained recognition as potential bioagent against bollworms of cotton due to their ability to cause mortality within 24-48 h. Nematodes with their locomotory ability offer unique advantage of ability to chase insect hosts. The nematodes are associated with bacterium of the genera *Xenorhabdus* or *Photorhabdus*. The rapid insect mortality is achieved due to interaction between toxin produced by bacterium and the nematode.

EPN or bacterial symbiont alone were not as effective as their combination though there was found to be variation in efficacy. There was found to be enhanced mortality when most effective EPN were inoculated alongwith most effective bacterial symbiont. However, there was reduced retention of alien bacterial symbiont by EPN.

Coimbatore - (B. Dhara Jothi, P.Chidambaram and N.Gopalakrishnan).

Field evaluation of temperature tolerant and multiple insecticide tolerant strains of *Trichogramma chilonis* against *Helicoverpa armigera* Hub.

Temperature tolerant strain performed better as compared to the insecticide tolerant strain. The percentage of parasitisation by the strain ranged from 8-28 and 4-12%, respectively during the release period (November-December). The fruiting body damage was reduced in the parasite-released field when compared to control, the reduction continued during subsequent releases also.

Evaluation of temperature tolerant strains of *Trichogramma chilonis* on implanted eggs of *Corcyra cephalonica*.

Searching ability and dispersal behavior of the temperature tolerant strain of *T.chilonis* was found high. Hence fixing the Corcyra cards in between the period of release of *Trichogramma* cards under field condition could be useful for the multiplication of the emerged parasites from the previous releases.

Efficacy of various bio-agents against Alternaria leaf spot

Cultures of several bio-agents were tested in the laboratory. The talc powder formulations of *Trichoderma viride* (CBE), *T. harzianum* and Pf1 and CHAO isolates of *Pseudomonas fluorescens* were tested and found effective against Alternaria leaf spot and grey mildew.

There was reduction in the Alternaria leaf spot disease incidence after first spray. Even though there was an increase in the incidence after subsequent sprays, the rate of disease development was much lower than the check.

Among the bioagents, *T. viride, T. virens* and the combination sprays of *Trichoderma* and *Pseudomonas* were as effective as the fungicide Propiconazole in restricting the disease development.

MM II : **Dissemination of Insecticide Resistance Management**

Coimbatore - (T. Surulivelu)

Effective dissemination of IRM strategies was ensured in ten selected villages of Avinashi Taluk of Coimbatore. Resistance monitoring revealed (Table 9) that the pyrethroid resistance levels were higher (cypermethrin 97.3 % and fenvalerate 95.0 %), while conventional insecticides resistance levels were moderate to low (quinalphos 35 to 58.6 % and endosulfan 12.2 %).

Adoption of various strategies of IRM in the project villages resulted in reduction of number of sprays from 6.6 to 1.3 and plant protection cost from Rs. 7673 to Rs. 1309 / ha over control village. In addition to increasing the build up of natural enemies it also increased the seed cotton yield by 3.2 q/ha. Further growing of intercrops (cowpea and blackgram) by the project farmers enhanced their income by Rs 1500 / ha. The project farmers obtained a net profit of Rs 14,486 / ha while the farmers in control village met with loss of Rs 738 /ha. The cost : benefit ratio was 1 : 1.80 and 1 : 0.97 to the project and control village farmers, respectively.

Table 9. Resistance level of *H.armigera* to different insecticides

Standard week	Survival (%) SE			
	Cypermethrin (0.1g)	Fenvalerate (0.2g)	Quinalphos (0.75g)	Endosulfan (10.0g)
48-51 (Nov.25 - Dec.22)	97.3 ± 1.9	90.7 ± 3.1	35.0 ± 4.8	12.2 ± 5.1
52 (Dec.23 - 29)	97.1 2.0	95.0 2.8	58.6 5.9	-

Sirsa - (D.Monga).

In Haryana, Sirsa, Hisar and Fetehabad districts were selected for project implementation. Ten villages were identified in each district and 100 hectares were covered under project.

The sucking pest particularly whitefly population remained well below ETL in all the three project districts. The population of whitefly surged to maximum of 3.4 per three leaves in non-participatory farmers fields at Hisar, against 1.9 to 3.3 in participatory farmers fields per three leaves. The jassid population was also below ETL in both participatory and non-participatory farmers fields .

The maximum spotted bollworm damage observed was 6.29 percent and 8.55 percent in participatory and non-participatory farmers fields respectively at Hisar.

The damage by American bollworm was very less during the initial stage in all the three districts. The maximum damage observed to be 2.19 to 2.53 percent in participatory and non-participatory farmers fields respectively at Fatehabad. The bollworm population in participatory farmers fields was ranging from 0.15 to 2.19 percent , but it was 0.69 to 2.53 percent in non-participatory farmers fields.

The natural enemies population was also found to be more in participatory farmers fields and less in non-participatory farmers fields. During the crop season, the insecticide resistance monitoring was done only once or twice, because of less incidence of american boll worm. In general the resistance to cypermethrin , quinalphose and fenvalerate was very high .

Externally funded projects

DBT: **Development of sensitive molecular diagnostic tools for rapid**

detection and differentiation of races of *Xanthomonas axonopodis* pv. *malvacearum* (C.D.Mayee, Sheo Raj and M.K.Meshram).

Two highly specific diagnostic tools are designed for detection of *Xam* strains infecting cotton.

PCR : A set of DNA primer was designed to successfully amplify *Xam* strains by amplification of a 0.4 kb DNA fragment. The primers amplify a part of genes present in *Xam* and as such can detect all strains of this pathogen irrespective of their racial status. The PCR protocol is simple, rapid and throughout could detect the pathogen in the infected tissue even without the extraction of template DNA for PCR reaction.

Southern Hybridisation : The protocol is standardised to specifically detect strains of cotton, irrespective of their geographical area of origin. Genomic DNA from Xam strains is extracted, digested with restriction enzymes and transferred to a nylon membrane. The blots containing the DNA fragments are hybridised with the pathogenicity gene *pthN* labeled either radioactively with ^{32}P or non-radiactive DIG hapten. The *Xam* strains of cotton are detected by the strong hybridisation signals on autoradiogram.

Race-specific diagnostic tool : Differential amplification of 191 isolates of *Xam* belonging to different races were done using several primers viz., 17-mer stand alone primers designed on the basis of inverted repeats flanking the pathogenicity genes, and repetitive primers viz., BOX, ERIC and REP primers. All these primers, except BOX primers, delineated polymorphism not only between isolates of different races but also amongst isolates of the same race. The Box primers however, amplified same sets of amplicons from 13 out of 15 isolates of Xam. Thus apparently the BOX primers can be used as race 18-specific primer having a profound diagnostic significance.

Biotypes of Race 18 : A clear molecular as well as pathological evidence of existence of biotypes within race 18 was observed. Twelve race 18 isolates of *Xam* were observed for RAPD profiles using OPA 13 primer. A clear polymorphism was observed among the isolates. The isolates also exhibited variability in their growth pattern on susceptible as well as resistant cotton lines. OPA 13 can be used for detecting variability (biotypes) amongst race 18, with further standardization.

NRI/ICAR/CFC/ICAC/14 : **Sustainable control of the cotton bollworm *Helicoverpa armigera* in small scale production systems.** (K.R.Kranthi).

Resistance Monitoring

Resistance was monitored in *H. armigera* across 44 sites in the country. While Pyrethroid, endosulfan and quinalphos resistance was high in Punjab, A.P. strains showed high resistance to Pyrethroid alone.

Predominance of resistance mechanisms

Two hundred isofemale lines were established in an attempt to isolate strains with unique mechanisms. An esterase isozyme identified was unique to quinalphos resistant strains and selectively inhibited by quinalphos. Insensitive acetylcholine esterase was also found to be associated with most insects (80%) that exhibited resistance to quinalphos. Both the mechanisms were found to be important in conferring resistance to quinalphos.

An esterase isozyme and insensitive acetyl choline esterase were also found to be associated with resistance to methomyl. However the frequency of insensitive acetyl choline esterases in resistance populations was 30% as compared to 90% which had the unique isozyme associated with methomyl resistance and not present in the susceptible strains. The isozyme was inhibited by methomyl in a dose dependent manner.

Nerve insensitivity to pyrethroids was found to be localized in only some populations in Andhra Pradesh and Central India Metabolic resistance to pyrethroids was ubiquitous.

Genetics of Resistance

1. Resistant strains were developed through selection pressure for several generations in the laboratory. Attempts were made to generate homozygous parent lines through high-dose selection of F_2 population from isofemale lines of the resistant colonies.

The resistant strains were crossed (reciprocal) with the German (susceptible strain). Test crosses were performed for the F_1 progeny with each of the parents. Bioassays were carried out on the F_1, F_2 and test cross progeny. Native PAGE gels were run using parents and F_1, F_2 progeny to ascertain the genotypic and phenotypic nature of the resistance associated isozymes. Enzyme assays were carried out. Pyrethroid resistance was confirmed to be semi-dominant and autosomal. Resistance to pbo and profenophos suppression of pyrethroids resistance, was incompletely dominant with 0.75 to 0.88 dominance showing a pre-dominant paternal influence. Resistance to methomyl was either dominant or semi-dominant depending on the mechanism involved. Resistance was dominant if the resistant parent strain was homozygous to the unique esterase, and semidominant if the resistant parent was homozygous for insensitive AchE. Resistance to quinalphos was incompletely dominant with estimate of dominance at 0.57-0.59, and autosomal. Endosulfan resistance was incompletely dominant (estimate of dominance 0.58 to 0.64) and resistance was influenced to a greater extent by the maternal parent.

Development of insecticide quality detection immunodiagnostic kits

Pyrethroids:

Rabbit polyclonal antisera to the KLH-conjugate was found to be useful in detecting cypermethrin, permethrin and fenvalerate. The antisera is more specific to the parent molecules and has extremely low avidity towards the phenoxy-benzyl metabolite. ELISA kits with various formats have been designed to detect and quantify the insecticide in unknown samples. The ELISA with ALP has a sensitivity of detecting cypermethrin at 2ppb.

Resistance detection kits

Pyrethroid resistance: Pyrethroid resistance is semi-dominant and is controlled by more than one mechanism. Metabolic mechanisms were found to be the most important resistant conferring traits in majority of field populations.

Molecular kits:

1. The PCR-RAPD based SCAR marker developed for pyrethroids resistance was confirmed for its linkage to resistance through F_2 testing. However when it was tested on field populations, the co-segregation was weak and was found to be associated only with a small section of the surviving population, thereby indicating that the marker may be mapping to some specific locus, which was predominantly present in the resistant parent used to generate it. The SCAR marker was found to be mapping resistance in oxidase strains.

2. RAPD markers were developed for methomyl resistance, as they are dominant and hence more applicable to resistance, which is either dominant or semi-dominant.

Immunodiagnostics:

1. Antisera was raised against a unique pyrethroids resistance associated esterase. The IgG was found to have a high level of cross reactivity to other esterases and thus was responsible for a heavy background in ELISA. It is unlikely that the polyclonal system would be of any use in the current format. Monoclonal development may be useful.

2. Antisera to pyrethroids was found to detect the parent compound and with extremely less affinity for the phenoxy-benzyl metabolite. The IgG was used to develop ELISA and the immunochromatographic strips. Both the kits are being fine-tuned for their being exploited in resistance detection.

Biochemical diagnostics:
Methomyl resistance was found to be mediated through a unique dominant esterase isozyme and a semi-dominant insensitive acetyl choline esterases. However 90% of the resistant larvae were found to have the resistant associated esterase. A dot-blot kit was designed and developed. The kit works well for field populations, and is suitable for use by extension workers.

Studies on resistance breaking properties of Triazophos in combination with deltamethrin on pyrethroid resistant *Helicoverpa armigera* (K.R.Kranthi).

Two *H. armigera* strains with esterase and oxidase mechanisms for pyrethroid resistance were tested through bioassays with deltamethrin and triazophos. Biochemical assays with 'pyrethroid resistance associated esterase' revealed that triazophos is a strong inhibitor of esterases.

Dissemination of Insecticide Resistance Management programme (K.R.Kranthi).

The project was implemented in 260 villages of 26 districts in 10 cotton-growing states of India. Training programmes were conducted for all co-ordinators. The project dissemination resulted in a 30-65% reduction in insecticide use and a 0-15% increase in yields. Fifteen out of 26 resistance monitoring centres were fully functional.

Studies on toxicity of Bt (Cry) toxins to cotton pests, Assessment of impact of Bt transgenic cotton plants on the ecosystem and development of resistance to Bt toxins in cotton bollworm *Helicoverpa armigera* (K. R. Kranthi).

Joint toxic action studies: Eight Cry toxins (Cry1Aa, Cry1Ab, Cry1Ac, Cry1B, Cry1C, Cry1D, Cry1F and Cry2Aa) were tested individually and in all possible combinations on Cry1Ac resistant and susceptible strains of H. armigera. Cry1Ac was found to be the most toxic followed by Cry2Aa, Cry1Aa and Cry1C. The joint toxic action data indicated either an overlap or additive effect and was not synergistic in any of the combinations.

Cross-resistance studies: Resistant strains to Cry1Ac and Cry2Aa were developed through constant selection pressure. Cross-resistance studies indicated that resistance to Cry1Ac confers cross-resistance to Cry1Ab, Cry1Aa and Cry1C but not to Cry2Aa.

Generation of near-isogenic lines for resistance: Cry1Ac resistant strains were back-crossed (BC-4) into a susceptible background (world susceptible strain), to obtain a near isogenic line. The near-isogenic line is being used to isolate 'resistance associated specific mechanisms, such as brush border membrane vescicles and specific proteases', and also resistance associated molecular markers.

Estimation of frequency of Cry1Ac resistance alleles in field population: Two hundred isofemale lines were established from *H. armigera* collected from all over the country. F_2 screens using discriminating dose of 1 µg Cry1Ac were carried out on the F_2 progeny of the isofemale lines. The frequency of Cry1Ac resistance alleles in field populations was found to be 1.2-3.6 x 10^{-3}. The resistance alleles were confirmed through bioassays on F_3 and F_4 selfed surviving progeny.

Evaluation of refugia: A field trial was laid out to determine the feasibility of having non-Bt-refugia in rows, mixed and centered locations in Bt-cotton fields as 1:4, 1:9 and

1:19 ratios. Larvae were released thrice in the plots. It was found that interplant movement was minimum. There was a survival of 5-15% in Bt-cotton and 70-85% in non-Bt cotton. Yield disadvantage was significant only in the 1:4 plots.

Development of resistance to cry1Ac in the spotted bollworm: Colonies of spotted bollworm have generated individuals which demonstrate capabilities of 0.52µg/g of diet of the toxin. Currently such colonies are in the F_3 generation. A corresponding unselected laboratory strain is being maintained for comparision. Out of 1000 larvae dosed, 35 survived the toxin dose used for bioassay.

Monitoring for shifts in baseline susceptibility (development of tolerance or resistance) in cotton bollworms *(H.armigera, E.vittella and P.gossypiella)* against Cry1Ac in various cotton growing regions of the country

(S. Kranthi)

Collection of target insects

A total of 76 spotted bollworms, 720 pink bollworm and 1150 *Helicoverpa* were collected from 22 districts of Central and southern India. PBW and SBW were collected from damaged bolls that were sampled while *Helicoverpa* was found occurring on cotton, pigeon pea and chickpea.

Bioassay protocols

Colonies of the spotted bollworm have been well established on a synthetic diet in the laboratory and currently are in the F_3 generation. A new method of bioassay with Cry toxins has been standardized with coating diet-incorporated toxin on paper strips making bioassay procedures highly replicable and relatively simpler.

Toxicity of Cry 1Ac against spotted bollworms

The LD50 values of Cry1 Ac against the SBW ranged from 0.01 to 0.284 µg/g of diet. Khammam, Nalgonda and Warangal populations were comparatively more susceptible to Cry1Ac compared to the Vijayawada or Adilabad populations. Central India populations of the spotted bollworm recorded comparatively lower LD_{50} values over their southern counterpart ranging from 0.024-0.036 µg/g of diet.

AP Cess Fund

Studies on the Effect of Insecticides on Cotton Plants and their Interactions with American Bollworm *Helicoverpa armigera* (Hubner) and its Parasitoid *Campoletis chlorideae* Uchida

(S.Vennila and M.Chakrabarthy).

Cotton plant insecticide interactions without insect damage :

Imidacloprid seed treatment had caused 42% increased internodal elongation, higher rate of square production during first three weeks and 26% increased fruit load compared to untreated plants.

Contact insecticides *per se* did not alter the plant growth or fruiting parameters. Leaf phenols were found to be higher in imidacloprid seed treated plants at 30 and 60 days of crop growth (DCG). Increased concentration of reducing sugars in leaves of 30 days old crop and significant reduction in flavanols in squares of 60 days crop were observed.

Cotton plant insecticide interactions with insect damage :

Under field conditions, increased square production besides higher fruit shed due to *H.armigera* along the treatments *viz.*, untreated control, control of sucking pests and bollworms on ETL basis, complete control of sucking pests and bollworms and complete control of sucking pests was observed with LRA 5166 and NHH 44. *H.armigera* larval survival had been the greatest on plants that had received imidacloprid seed

treatment + systemic insecticides.

Cultivar insecticides and *H.armigera* interactions :

Growth and survival indices of *H. armigera* on the cultivars were higher under sucking pest control treatment with imidacloprid and systemic foliar insecticidal sprays on LRA 5166 and NHH 44.

Cultivar *H.armigera* C.*chloridae* interactions :

Per cent field parasitisation by *C. chloridae* on *H. armigera* was 10, 3.3, 5.88 and 4.55 in LRA 5166, CNH 36, NHH 44 and PKV HY2, respectively. The differential parasitisation is due to differences in the crop phenology causing differential synchrony between *H. armigera* and *C. chloridae* populations.

Use of Entomopathogenic nematodes for biological control of *Helicoverpa armigera*, cotton bollworm

(Nandini Gokte-Narkhedkar and S.K.Banerjee)

Standardization of protocols for mass propagation

Of various modifications of three protocols viz. Egg medium, Wouts's medium, Peptone kidney medium and Dog-food medium tried against five effective isolates of *Heterorhabditis,* population build up was recorded only in media with chicken / pork kidneys and Wout's media.

Standardization of nematode stage for mass production:

It was observed that best uncontaminated EPN culture could be obtained on inoculation of adult females obtained from infected insects. Various other aspects as choice of nematode stage for inoculation, optimal inoculum levels and environmental conditions have also been standardized.

Standardization of formulation:

Three formulations were tested for viability and infectivity of EPN. Results show that viability was better with suspension with slurry close behind while for infectivity both suspension and slurry were at par.

Study of factors affecting bacterial phase change:

Studies have been initiated on factors affecting phase change of associated bacterial symbiont. EPN owe their efficacy to a large extent on associated bacterial symbiont- *Xenorhabdus* or *Photorhabdus spp.* that serves as food for the nematode.

The results show that media composition and ph were found to influence phase change. *H. indica* and *H.bacteriophora* isolates from hot cotton growing regions better adapted to higher temperature and had higher proportion of primary colonies at 28°C compared to 22.5 or 25°C while *S. glaseri* which is adapted to lower temperatures had higher proportion of primary colonies at lower temperature of 22.5°C.

Plant Physiology and Biochemistry

Nagpur

Physiological evaluation of cotton germplasm under rainfed conditions (M.R.K.Rao and N.K.Perumal).

Of the seventy six G. *hirsutum* and fifty G. *arboreum* lines evaluated, G. *arboreum* performed better inspite of the drought in July and abundant rains in August. Paramaters such as biomass, dry weight of plant parts, RWC, photosynthetic rate, stomatal conductance, transpiration rate, LAI, SLA, SLW etc. were recorded during the peak growth phase and correlations were worked out. The correlation was high and positive for biomass and dry weight of plant parts with yield as compared to RWC and other morpho parameters except plant height which had a slightly higher positive correlation with yield. Leaf area had a positive correlation with biomass. Top ten lines for some important characters were identified in both the species and it was noted that few lines had a combination of two or three important traits. Photosynthetic rate, stomatal conductance and transpiration rate were assessed in a limited number of lines showing marked difference in morpho-frame and productivity expression. Inspite of variability for all the three parameters in G. *hirsutum* as well as G. *arboreum*, clear association of three parameters either with yield or biomass were not visible.

P1-89/2-ICR-F 60/0430:

Physiological studies on abiotic stress with particular reference to heat and drought in cotton (N.K.Perumal and M.Chakrabarty).

Screening of genotypes belonging to three species

Eighteen genotypes belonging to *G.arboreum*, *G.herbaceum* and *G.hirsutum* were grown in a pot experiment and screened for moisture stress tolerance during flowering. Two moisture stress cycles were inducted. The study revealed that the leaf water potential decrease due to the stress was more conspicuous in genotypes belonging to *G.arboreum* and *G.herbaceum* species. The transpiration rate was relatively higher in *G.herbaceum* genotypes. The root-shoot ratio remained higher in asiatic genotypes due to the stress environment. Yield stability is more pronounced in *herbaceum* lines.

The results further indicate that *arboreum* and *herbaceum* genotypes were more efficient with regard to nitrate reductase activity, a trait related to drought tolerance. *Herbaceum* lines G cot 13 sp 19, V797 sp 8 Wagad sp 7 and *arboreum* lines- ACC 6779, ACC 6787 possessed higher nitrate reductase activity under stress conditions. On the other hand, genotypes belonging to *G.hirsutum* were found to be less tolerant as compared to the asiatic cotton. *G.hirsutum* genotypes possessed significantly higher stomatal resistance coupled with enhanced leaf water potential and relatively higher dry matter production. Among the genotypes under study, Cat 391 cy and Wagad sp7 were found to possess relatively higher moisture stress tolerance.

Effect of plant growth regulators and nutrient foliar sprays

In a field experiment NHH 44, non bt and bt hybrids (Mech 12,162 and 184) were given foliar sprays of indoleacetic acid, gibberellic acid (100 ppm) and DAP 1 per cent during flowering. The results indicate that the Bt hybrids maintained relatively higher transpiration rate and photosynthesis. The response of hybrids to plant growth regulators

and DAP sprays was non-significant. However, GA application increased square production while DAP 1 per cent spray has enhanced seed-cotton yield. There was not much variation with regard to fibre characters. The amino acid content in bolls did not vary markedly in the hybrids-NHH 44 , non bt and bt 12 and 162. It remained comparatively lower in bt 184 hybrid.

Plant physiological and biochemical basis of salinity tolerance in cotton plant (K. B. Hebbar).

Studies on salinity stress tolerance indicate that leaf relative water content did not vary significantly with salinity level. The total protein content increased with salinity. Protien was found to be more in tolerant varieties under stress condition. Tolerant genotypes also accumulated higher osmotic solute proline. The study point out that salinity tolerance in cotton could have been imparted by the accumulation of osmolyte proline as well as the higher activity of free radical scavengers catalase and peroxidase.

Seed-cotton yield in most of the gyenotypes was stable upto 10 EC beyond which it was drastically reduced. *Arboreum* and *hirsutum* cultivars were more tolerant as compared to germplasm lines and derivatives of wild species. Amongst the genotypes tested PKV 081, LRK 516, MAHALAXMI, DHARWAD JK 91, G.COT 100 were more tolerant as compared to LRA 5166, 320 F, Deviraj, Sharada

Physiological and biochemical adaptation of cotton plant to water logging tolerance in cotton (K. B. Hebbar).

Water logging in the field due to heavy rain under cloudy weather resulted in stunted plant growth and with the continued water logging the bottom leaves turned yellow and shed. Some of the young squares were also shed. Growth was immediately recovered upon withdrawal of water logging treatment.

On the other hand, imposition of water logging in the field at peak flowering and early boll development stage under bright sunlight and high temperature caused wilting of plants similar to parawilt. Leaves were drooped, dried and abscised prematurely. All the squares were shed and bolls were prematurely opened. Wilting was mostly seen in hybrids and early maturing *hirsutum* varieties. The photosynthesis (Pn) and transpiration (Tr) of waterlogged plants remained high for one day and later started declining. The decline was steep in waterlogged wilted plants while it was gradual in waterlogged non-wilt and shade grown plants.

Exposing 60 day and 90 day old plants to water logging for a period of 17 and 30 days respectively, significantly reduced the yield of all the genotypes. In *arboreum* and *herbaceum* the decline in yield ranged from 73 to 75 % while in *hirsutum* and hybrid the decline in yield ranged between 50 to 69 % (Fig.8).

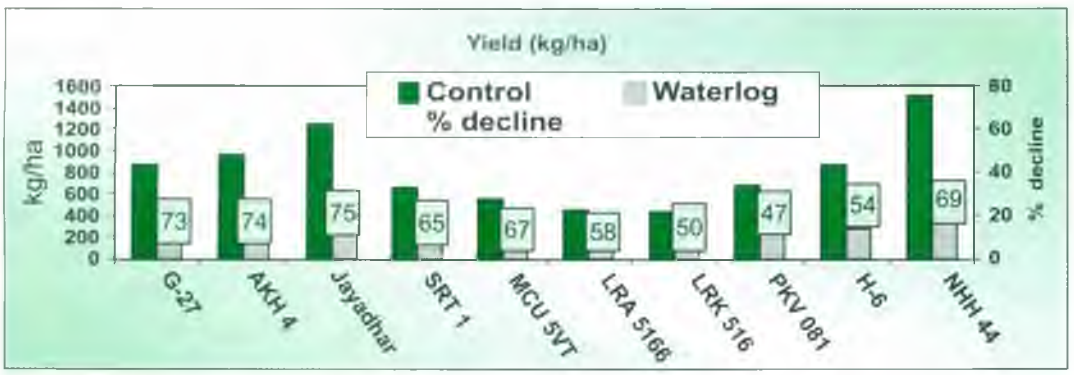


Fig.8: Effect of water logging on the yield of hybrid and varieties of *G.hirsutum* *G.arboreum* and *G.herbaceum*

Source-sink alteration with reference to flower induction as a tool to improve physiological efficiency and productivity in cotton.

Nagpur - (K.B.Hebbar)

A field experiment was conducted involving two genotypes LRA 5166 and H6 in order to study the effect of early square removal on yield and to see the efficacy of chemicals in delaying the fruiting activity.

Mechanical removal of early-formed squares for a period of 20 days significantly increased the yield both in LRA 5166 and H6 (Fig.9). Ethrel application at low concentration significantly increased the yield in both the genotypes. However, higher concentration of ethrel application led to stunted plant growth, senescence and abscission of leaves and alteration of morpho frame of the plant and drastically reduced yield. Removal of early formed squares either mechanically or using low concentration of ethrel brought about more vegetative growth and more number of nodes Maleic hydrazide acted as a growth promotor.

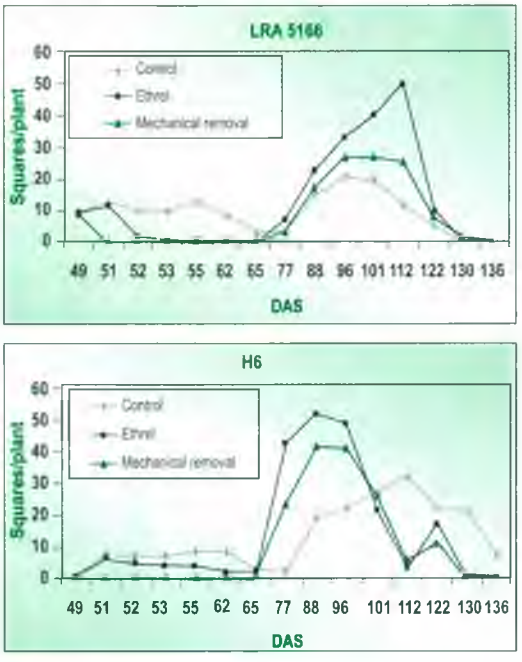


Fig.9. Square production as influenced by the removal of early formed fruiting forms either mechanically or through chemical.

Coimbatore - (A. H. Prakash and N. Gopalakrishnan)

Application of Ethrel at 30 ppm completely inhibited squaring and brought about shedding of already formed squares. This led to vigorous vegetative growth and in 15-20 days, there was a spurt in reproductive activity. This induced synchronous flowering led to uniform boll bursting. The picking of seed cotton was completed through 1-2 pickings as compared to 3-4 pickings normally.

Maleic hydrazide was applied at 35 DAS only. The chemical overcame the apical dominance and the plant showed stunted growth, therefore the second spray on 45 DAS was not taken up. After a period of 25 - 30 days, the plants showed symptoms of recovery.

Application of two sprays of ethrel reduced the yield by 35 - 40%. Similarly, application of Maleic hydrazide at all concentration brought down the yield.

Coimbatore

P1-95/ICR-F-25/0430:

Physiology of fibre growth and development

(A. H. Prakash, S.E.S.A. Khader, N. Gopalakrishnan and K.B. Hebbar)

All the genotypes studied maintained higher levels of soluble proteins in the seeds. The 13.5 to 68.5 mg/g FW in seed against 0.88 to 19.45 mg/g FW in fibres over the growth periods.

The total free amino acid content increased in seed for 15 to 35 days based on the genotypes. In G 27, the seed amino acid increased from 4.98 at anthesis to 9.72 at 15 DAA and maintained around 8.6 mg/g FW till maturity. Similar trend was observed in proline content with seeds accumulating higher levels of proline till 30 DAA and then reducing drastically. The peroxidase activity was high at anthesis and then reduced by 5th day. After a short dip, the peroxidase activity continued

to increase till maturity in both seeds and fibres.

Ovules isolated aseptically from three day old bolls were found suitable for in vitro culture. Among numerous hormonal combinations and basal media tried, the best culture media identified was TM medium. Ovules cultured initially on TM medium with IAA (1.0 mg.L-1) + GA (1.0 mg.L-1) + BA (1.0 g.L-1) and later sub-cultured on to medium containing IAA (2.0 mg.L-1) + GA (0.0 mg.L-1) + BA (0.5 g.L-1) led to profuse fibre growth. The fibre growth was found to be better under suspension culture than on semi-solid medium.

P1 95/1-ICR-60/0430:

Identification and utilization of adaptive responses to abiotic stress in cultivated species of cotton (S.E.S.A. Khader, N. Gopalakrishnan and K.N.Gururajan).

Six genotypes viz., LRA 5166, LRK 516, CNHPT-2, CNH-38, CSH 683-1 and H 777 were tagged for heavy boll load (> 15 bolls per plant) medium (> 8 bolls per plant) and low (< 5 bolls per plant) under irrigated and unirrigated conditions. Irrespective of the boll load and water stress condition, genotypes H 777 and LRK 516 photosynthesized significantly at a higher rate of 23.2 to 23.8 (mol CO_2 .m^{-2}.s^{-1}). Plants grown under irrigated conditions recorded significantly higher rate of photosynthesis regardless of the varieties and boll load in the plant. Under irrigated condition, all the genotypes that were laden with heavy boll number, photosynthesized comparatively at lesser rate (21.4 mol CO_2 .m^{-2}.s^{-1}) compared to plants with medium number of bolls (> 8 bolls per plant) with photosynthetic rate of 23 mol CO_2 .m^{-2}.s^{-1} (Table 10). Similarly, plants that had poor boll set of less than 5 bolls per plant photosynthesized significantly at a higher rate of 24.7 mol CO_2 .m^{-2}.s^{-1}. Interestingly, the differences in photosynthetic rate between plants with heavy number of bolls and low boll number were very apparent under irrigated condition than under unirrigated condition.

Influence of night temperature on photosynthetic rate and nitrate reductase activity

Exposure to night temperature regime of 10, 15 and 20°C was ensured under pot culture conditions. The plants were subsequently brought to ambient conditions and photosynthetic rate and nitrate reductase activity were measured at periodic intervals between 08.00 hrs and 16.00 hrs. The mean photosynthetic rate was significantly affected in plants that were exposed to 10 2C (8.6 mol CO_2 .m^{-2}.s^{-1}).

Effect of leaf reddening on photosynthesis and related parameters

Photosynthesis, transpiration and stomatal resistance were measured in leaves of cotton cv. LRA 5166 with the onset of leaf reddening symptoms due to jassid injury or physiological causes at five day intervals. Irrespective of the nature of leaf reddening, the photosynthetic rate started declining significantly from 21 to 6.2 mol CO_2 .m^{-2}.s^{-1} with in 15 days, with a decline in rate being faster due to jassid injury than physiological reddening. Similar trend was seen in respect of transpiration rate which declined from 5 to 2.1 mol H_2O.m^{-2}.s^{-1} by 15th day in leaves affected by jassid incidence. However, stomatal resistance increased substantially from 13.3 to 27.6 m^{-2}.s^{-1}mol -1 compared to 17.3 m^{-2}.s^{-1} mol -1 in normal case. The observations indicate that the photosynthetic rate and transpiration are drastically affected in reddened leaves due to jassid injury than physiological reddening in cotton.

Table 10 : Photosynthetic Rate (mol $CO_2.m^{-2}.s^{-1}$) as influenced by boll load in cotton cv. LRA 5166

Boll Load	Irrigated			Unirrigated			Mean
	Heavy	Medium	Low	Heavy	Medium	Low	
LRA 5166	21.5	22.2	25.4	18.6	19.9	21.5	21.5
LRK 516	23.8	24.1	26.1	20.8	21.9	22.6	23.2
CNHPT 2	19.7	21.4	24.1	17.8	19.5	20.5	20.5
CNH 38	19.8	20.9	23.1	18.6	20.4	20.8	20.6
H 777	24.1	24.5	26.3	20.2	23.6	24.3	23.8
CSH 683	20.0	20.8	23.2	17.5	20.2	24.3	20.3
Mean	21.4	22.3	24.7	18.9	20.9	21.7	
CD @ 5%Varieties 0.77; Irrigation 0.89; Boll load - 0.55; Interaction - 0.87							

P192/1-ICRF-60/0430:

Studies on the response of elevated carbon dioxide on physiology and productivity attributes of cotton genotypes (S.E.S.A. Khader and N. Gopalakrishnan).

Impact of elevated CO_2 on productivity of *G.herbaceum* cotton genotypes

All the eight *G.herbaceum* genotypes responded favorably to elevated CO_2 atmosphere in terms of morphophysiological and productivity attributes. GCHV 820 / 91 and G.Cot.13 yielded of 66.1 and 64.6 g/plant under normal conditions against 103-107 g/plant under elevated CO_2 atmosphere.

Influence of dew fall on photosynthetic rate and nitrate reductase activity of cotton grown under elevated CO_2 atmosphere

Plants grown under elevated CO_2 atmosphere always photosynthesized at a higher rate with an overall mean of 11.75 mol CO_2. m^{-2}.s $^{-1}$compared to ambient grown plants with a rate of 9.4 mol $CO_2.m^{-2}.s^{-1}$. Plants that received dew fall during the night had a temporary set back in the photosynthesis upto 10.00 hours. Thereafter, the rate of photosynthesis was even more than the plants devoid of dew fall irrespective of the CO_2 atmosphere. Nitrate reductase activity increased gradually from 8.00 hours with an activity of 3.18 mol NO_2/g fr.wt. /h to 4.94 mol NO_2/g fr.wt. /h at 14.00 hours and declined thereafter. The activity of the enzyme was found to be significantly more in plants grown under elevated CO_2 atmosphere with or without dewfall as compared to respective ambient grown plants.

P1- 89/1-ICR/F60/0430:

Studies on biochemical mechanisms of resistance to bollworms of cotton (N. Gopalakrishnan and T.Surulivelu).

Eight hybrids developed by involving wild species viz., *G.armourianum*, *G.aridum* and *G.raimondii*, and four popular cultivars viz., LRA.5166, Sumangala, Anjali and Surabhi (*G.hirsutum*) were subjected to RAPD analysis for hybridity confirmation and elucidation for gene transfer from wild parents. Random primers were used in the PCR to identify potential polymorphism among parents and the introgression of genome from wild male parents. The primers used were found to be polymorphic among parents. Introgression of genomic regions from male parents has also been noticed by the presence of male specific amplified fragments in the hybrids (Fig.10). Attempts are under way to develop boll worm tolerant derivatives

from these introgressed hybrids combining better biochemical and productivity attributes.

Cotton genotype BRS 23, was observed to have higher boll number per plant under unprotected condition with an average of 23 bolls per plant at 100 days after sowing and on par with the protected control. Bollworm tolerant genotypes yielded 40-60 g/plant under unprotected conditions as compared to 50-95 g/plant under protected conditions.

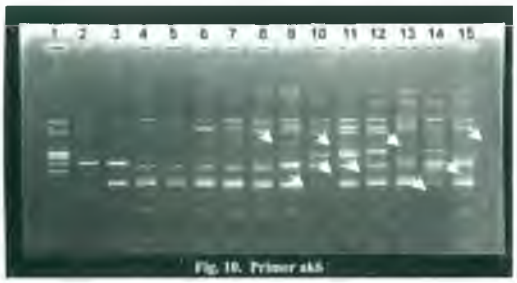


Fig. 10: RAPD profile of introgressed materials

Legend to lanes of the Gel

1. *G.armorianum*, 2. *G.aridum*, 3. *G.raimondii*, 4. LRA5166, 5. Sumangala, 6. Anjali 7. Surabhi , 8. Anjali X *G.aridum*, 9. LRA 5166 X *G.raimondii* , 10. Anjali X *G.armorianum* 11. LRA 5166 X *G.armorianum*, 12. Surabhi X *G.aruidum*, 13. Surabhi X *G.armorianum*, 14. Sumangala X *G.armorianum*, 15. LRA 5166 X *G.aridum*

P1-97/1-ICR-F60/0430:

Studies on developmental biochemistry of cotton pest/disease interaction (N. Gopalakrishnan, T. Surulivelu, K. Natarajan and P. Chidambaram).

The impact of seed treatment insecticide Poncho (Chlothianidine) on the metabolic status of young cotton seedlings was studied using varying doses (5, 7 and 9 ml / kg seeds). In general, the seed treatment chemical was found to enhance the activity of acid and alkaline phosphatases in *G.hirsutum* and *G.herbaceum* genotypes studied.

Accumulation of soluble protein and phenols was evident upto a dose of 7 ml/kg , with slight reduction in constituents at 9ml/kg treatment. Enhanced peroxidase activity was also observed due to the influence of the chemical. Speedy release of essential nutrients like reducing sugars and soluble protein to the developing young seedlings from the reserve storage ensured vigorous and healthy seedlings. Imidacloprid seed treatment was seen to influence the activity of nitrate reductase in the leaves to an extent of 25-30 % during initial stages of growth.

Analysis of plant samples obtained from field trials for study of control of bollworms revealed that repeated application of pyrethroid combination chemicals viz., Omite plus Cypermethrin led to lowered levels of total phenols as compared to control, Spinosad and Indoxacarb treatments. On the other hand, repeated sprays of Emamectin benzoate did not bring about any drastic changes in phenolics or reducing sugar content.

National Agricultural Technology Project

RCPS 3: **Assessment of gossypol content in working collections of cotton germplasm** (M. Chakrabarty).

In working collections of cotton germplasm lines belonging to *G.hirsutum, G.arboreum,* and *G.herbaceum* species, the range of gossypol content (%) in different plant parts is summarized in table 11 :

Table 11 : Range of gossypol content in different plant parts

Plant parts	Gossypol (%)	Plant parts	Gossypol (%)
G.hirsutum squares	0.022 - 0.221	*G.arboreum* squares	0.0220 - 0.099
G.hirsutum leaves	0.009 - 0.178	*G.arboreum* leaves	0.0019 - 0.050
G.hirsutum flowers	0.020 - 0.442	*G.arboreum* flowers	0.0082 - 0.102
G.hirsutum bolls	0.040 - 0.076	*G. arboreum* bolls	0.0270 - 0.271
G.hirsutum seeds	0.129 - 1.974	*G. arboreum* seeds	0.4470 - 2..915
G.herbaceum Seeds	0.298 - 0.920	*Wild species*	0.4910 - 3.840

On an average, seed gossypol content remained high in *G.arboreum* lines as compared to the rest. Gossypol content is considerably less in plant parts compared to seed, and within the lines, the gossypol content has been found to increase from leaves to squares to flowers to bolls to seeds (in most of the cases) in case of *arboreum* lines. (Fig. 11 & 12).

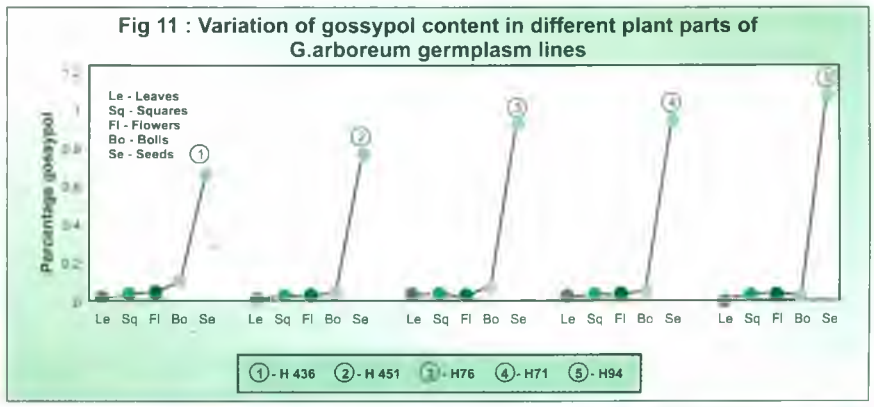


Fig 11 : Variation of gossypol content in different plant parts of G.arboreum germplasm lines

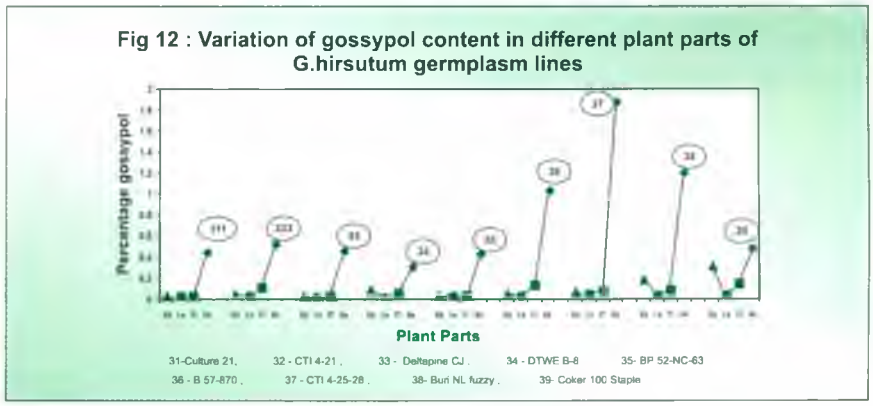


Fig 12 : Variation of gossypol content in different plant parts of G.hirsutum germplasm lines

A wide variability exists in the gossypol content among the germplasm lines and this index has been utilized in categorising the lines as high (above 1 %), medium (0.5 to 1 %) and low (<0.5 %) gossypol content for further utilization in various breeding programes.

Executive Summary

Crop Improvement

Nagpur

- In *G. hirsutum*, 625 core collections, 400 working collections, 1540 base collections, 580 exotics, 130 new collections and 1200 accessions for regeneration were grown and evaluated for economic and fibre attributes.
- One set each of 100 accessions of *G. hirsutum* and *G. arboreum* was evaluated in coordinated trial (Br 01) at Nagpur (rainfed), Sirsa and Coimbatore (irrigated) and ten superior accessions in each species were identified.
- A set of 930 accessions from *G. hirsutum* and 530 *G. herbaceum* was stored in cold storage.
- Two cultures, viz. one CLCuV resistant culture of upland cotton (CNH 123) and one grey mildew immune culture of *G. arboreum* (30838) were registered with NBPGR with INGR Nos.02021 and 02020 respectively.
- The culture CINA 316 (*G. arboreum*) was promoted from Br 22 to Br 24 and one new culture (CINA 318) was entered in National trial (Br 22 a and b).
- *Arboreum* cultivar AKA 8401 recorded good performance under deep soil and high rainfall, deep soil and low rainfall and shallow soil and low rainfall. Another cultivar Jawahar Tapti recorded good performance under medium soil and low rainfall.
- Five intra *hirsutum* Bt hybrids (RCH 2, RCH 20, RCH 134, RCH 138 and RCH 144) and their non Bt counterparts were evaluated. The Bt hybrids recorded higher seed cotton yield than non Bt hybrids and check.
- One quintal breeder seed of LRA 5166 and 51 kg of Anjali was produced.
- In male sterility programme 36 CMS, 7 R and 13 GMS were maintained. Four GMS hybrids viz. NGMSH 11-03, NGMSH 13-03, NGMSH 1-03 and NGMSH 7-03 were found promising. One GMS hybrid CNHHG 2003 was sponsored in coordinated trial (Br 05 Cb2). Hybrid seed of two GMS based hybrids was produced for sponsoring in coordinated trials. A newly developed GMS line with LRA 5166 background was registered with NBPGR as INGR No. 02012.
- In three explorations conducted in Mizoram, Orissa and Andhra Pradesh and 268 samples were collected belonging to *G. hirsutum* (80), *G. arboreum* (119), *G. herbaceum* (41), *G. barbadense* (25) and unidentified (03).
- In *G. arboreum* three advanced cultures developed at CICR, Nagpur viz. CINH 316, CINH 323 B and CINH 329 are being proposed for registration. These cultivars have high boll weight, earliness, medium fibre length, high fibre strength and locule holding capacity.
- Four crosses viz. P 3 x SP 3892 (c), LL56 x SP 3892 (c), SP 4626 x SP 3892 (cy) and Badnawar x SP 3892 cc were found drought tolerant. Two cultures i.e. DST 25 and DST 28 were found tolerant to soil salinity. Two new cultures i.e. CNH 3003 and CNH 3004 were sponsored in coordinated national trial (Br 02 a & b).
- The seed oil content ranged from 15-24.9 % in 25 germplasm lines of *G. hirsutum*, from 20.1 to 24.7 % in 16 germplasm lines of *G. arboreum*, from 19.2-23% in 13 advanced cultures of *G. hirsutum*, and from 18.5-20.8 % in four cultures of *G. arboreum*.

- The dwarf and compact genotypes gave either equal or better seed cotton yield than the robust types. In the robust group, the better performing genotypes included GJHV 163, GJHV 337, PH 802, CNH 132 and KH 117. In the compact group, four genotypes viz. NDH 1010, NDH 1001, PUSA 802 and CPD 745 gave better performance.
- After nine month storage under ambient condition, PKV Hy4 exhibited the highest germination percentage (80.8 %). Similarly, variety Sumangala exhibited highest germination percentage among cultivars (79.8 %).

Coimbatore

- In the Coordinated hybrid trial in North Zone, Hybrid CCHH 10555 recorded a mean seed cotton yield of 23.9 q/ha and ranked second as compared to the check hybrid LHH 144 with 22.0 q/ha.
- In the AICCIP trials, culture CCH 4 recorded the highest yield in both central (25.79 q/ha) and south zone (13.29 q/ha) trials. The culture was also resistant to Alternaria leaf spot disease.
- Culture CCH 526612 recorded a mean seed cotton yield of 24.6 q/ha and was superior to both MCU 12 (22.1 q/ha) and Sumangala (22.9 q/ha) in coordinated trial.
- Inter racial derivatives (9 x 1)x(14b x 4)-3 with a seed cotton yield of 28.5 q/ha (check variety Sumangala, 18.9 q/ha), IRH 1-9-131 with 29.0 q/ha (check variety LRA 5166, 15.8 q/ha), 12-32 HS-(3) with 28.4 q/ha (check variety LRA 5166, 15.8 q/ha), IRH 1-10-(3) with 37.9 q/ha (check variety LRA 5166, 21.3 q/ha), recorded significantly higher yield than the check varieties.
- Under natural aged conditions, in four-year aged seed lots, seed quality improvement was noticed due to halogen based formulations. The seed viability improvement either due to Chlorine or Iodine treatment was 11% and 9%, respectively.
- Coating of delinted cotton seeds with polykote, a starch based water soluble seed coating polymer, at 5 ml kg^{-1} of seed significantly enhanced germination up to 5% over uncoated seeds.

Sirsa

- Based on yield and quality parameters the hybrid CSHH 198 was found best among the tested entries. Out of 175 CMS crosses of *G. hirsutum*, 128 crosses have shown the fertility restoration. One GMS based hybrid CSHHG 966 has been sponsored for multilocation testing in National Trial under AICCIP.
- One hybrid CISAH-3 (MS based) having fibre length more than 24 mm performed well in National AICCIP Trial. Hybrids having span length of more than 25 mm from crosses between long linted strains and local cultivars have been identified. A number of cultures of *G. arboreum* have also been identified for long span length and strength (25 mm and 21 g/tex).
- In varieties, significant increase in seed yield and seed quality parameters was observed when crop was sown at 120 x 90 cm and sprayed with DAP 2% at 45 DAS, $MgSO_4$ 1% at 50 DAS, Boron 0.1% at 60 DAS, $ZnSO_4$ 2% at 75 DAS. The topping of the crop at 90 days after sowing and defoliant sprayed at 140 DAS was also observed beneficial in varietal seed production plot.
- The period from 15th August to 25th Sept. was found suitable for crossing programme with respect to yield and quality. The improvement in cross boll setting percentage, boll weight, seeds/ boll, seed index, seed germination and vigour was also observed when seed of female parent

was soaked in KH_2PO_4 (100 ppm) before sowing for six hour and crop was sprayed with $MgSO_4$ (1%) at 60, 75 and 90 DAS.

Biotechnology

Nagpur

- About 100 germplasm lines were analysed by RAPD analysis.
- Twenty five separate germplasm lines (*G. hirsutum*) and 23 wild species were analysed by using 19 ISSR primers and 40 Randam primers from A and B group.
- RAPD analysis was carried out to establish polymorphism among the grey mildew resistant and susceptible cultivars.
- Unique amplified bands were isolated and cloned for sequence from some of the parents of hybrid in view of development of molecular diagnostic tool for testing of genetic purity of hybrid.
- Large number of putative transformed plants of LRA 5166 and LRK 516 with Bt Cry I (A)c regenerated by shoot organogenesis and embryogenic axis have been obtained.
- Gene integration and expression have been confirmed in transgenic plants on the basis of ELISA.
- High Bt protein expression has been observed in RG-8 plants with Cry I (A)b.
- In the interspecific hybridization some of selective crosses attempted with wild and cultivated diploid and tetraploid showed significant increase in percentage of boll setting.

Crop Production

Nagpur

- Wide range of variability was evident for most of the morphological and physiological parameters. The correlation values were much higher and more positive for boimass and dry weight values of plant parts with yield as compared to RWC and other morpho parameters excluding height which had a slightly higher positive correlation with yield. Leaf area had a positive correlation with biomass.
- The INFOCROP model was validated using the weather, soil and crop inputs from the 2002-03 field experiments involving three dates of sowing and four nitrogen levels at different agroclimatic regions of cotton growing zones. Model simulated yield was in agreement with the observed yield under rainfed condition for the first date of sowing.
- The strip intercropping with pigeonpea mostly in the row ratios of 8:2 and 6 :2 of cotton : pigeonpea was found to be the predominant practice adopted. The strip intercrop was found to provide monetary returns in addition to meeting the nutritional demands of the farm family without additional expenditure by way of inputs etc.
- Higher seed cotton yield by combined application of FYM with chemical fertilizer was recorded in both the genotypes of cotton. There was no clear cut differences in yields by nutrient application due to moisutre stress during the crop season.
- Soil application of micronutrients with 60 x 60 cm spacing gave higher dry matter yields as compared to 90 x 60 cm spacing. Soil application of micronutrients with recommended dose of fertilizer increased the availability of N, P and K at harvest stage of crop.
- N mineralization data at different moisture regimes, revealed that treatment RDF with 5t FYM and INM at 75% FC (moisture regimes) had better effect on increasing dry matter yield, seed cotton yield, N, P and Zn uptake and mineralization of N as NO_3- N when compared to 50% FC.

- Impact of the land configurations, ridges and furrows system moisture conservation technology was found beneficial in terms of increasing the moisture percentage from 3-4% in medium deep soils under rainfed conditions. Mulching of green manure like cowpea or greengram or sunhump as an intercrop in INM treatment increased the moisture percentage ranging from 4- 6% in shallow soil and 3-5% in medium deep soils, nitrogen availability and build up of Organic C over farmer's practice.
- Among the tillage systems (T1 : conventional tillage, T2 : reduced tillage and T3 : reduced tillage 2), T1 was the best option. Cotton genotypes did not differ in their response to tillage systems. Seed cotton yield was significantly improved when supplied with 75 kg N/ha over the 60 kg N/ha.
- Soil nutrient status was assessed at the end of 8th year. In general, the data indicated a depletion of the nutrient status with depth (0 0.1, 0.1-0.2, 0.2-0.3, 0.3-0.6 and 0.6-0.9). There was a significant build up of organic C and nutrients, except Fe and Mg, in the organic system compared to the modern fertilization systems. Most of the accumulation was noticed in the top 0-0.3 m. Seed cotton yields were slightly greater in the organic plot compared to the synthetic plot.
- Available P was greater when fertilizer-P was applied in combination with organic materials.
- Among the soils analyzed for micronutrients, zinc was deficient in Nagpur district. While in Yavatmal and Hingoli, 30 % of the sample farms were deficient in Zinc. Fe, Mn and Cu content were above the critical limit.
- On-farm trials were conducted in 14 farmers fields. The best management package (BMP) of green manure + BBF + RDF + limiting nutrient, had better plant growth (plant height, dry matter) more number of open bolls and significantly greater seed cotton yields than the farmer practice.
- A bullock drawn 2-row cotton planter for cotton developed and tested earlier and found promising was further tested in IVLP villages. The planter gave a higher benefit cost ratio with slightly higher yields over manual dibbling method.
- In cotton-wheat system under irrigated conditions at Sirsa *A. chrococcum* heat tolerant strain Ht-54 (i) performed superior over all the seasons with an improvement of 16% seed cotton yield over 65% RDF which was statistically similar to that of 100% RDF.
- *Azospirillum* + PSB as seed treatment produced significant yield and biomass improvement with fertilisers at 75% RDF only. The soil moisture was more efficiently used by 50 and 75% RDF treatments for production and conversion of biomass with the available nutrients which was reflected in seed cotton yield levels in both the years.
- Bio-inoculants as seed treatment produced significantly more seed cotton yield from 235-391 kg ha^{-1} by *Azospirillum* strains without statistically differing among each other.
- The maximum seed cotton yield (18.75 q ha^{-1}) was recorded in two plants hill^{-1} closely followed by 17.58 q ha^{-1} in three plants hill^{-1} and the minimum 13.66 q ha^{-1} under one plant hill^{-1}.

Coimbatore

- A spacing of 75 x 60 cm and application of 125 per cent of recommended level of fertilizers and bhendi intercropping was found to be the best for Bt cotton hybrid even under delayed sowing conditions.
- Soil application of Fe ($FeSO_4$ @ 50 kg/ha)

registered significantly higher ginning percentage. The 2.5 % of span length was significantly increased by the application of Borax @ 5 kg/ha. Micronaire, fibre strength and elongation were not significantly influenced by the application of the secondary and micronutrients.

- None of the agochemicals at the rates tested inhibited the growth of phosphobacteria in the rhizosphere. However, except carbendazim, all other agrochemicals inhibited the growth of Azospirillum.
- Higher seed cotton yield in cotton cv Surabhi was on par with 0.8 ETc and 1.2 ETc. The yield increase due to drip during summer ranged from 28.9 to 61.5%. The Water Use Efficiency (WUE) ranged from 8.8 to 15.8 kg/ha cm under drip irrigation while it was only 4 kg/ha cm under flood irrigation.
- In Winter Season, scheduling of irrigation through drip at 1.0 ETc recorded higher seed cotton yield in cotton hybrid Savitha and was on par with 0.8 ETc but found superior to 0.6 ETc and conventional irrigation. The yield increase at 1.0 ETc through drip was about 3 q more than conventional irrigation. The WUE during winter due to drip ranged from 56.7 to 62.9 kg/ha cm as against 12.8 kg/ha cm under conventional irrigation.
- Additional seed cotton and jowar grain yield to the tune of 4.3 and 79.2 q/ha respectively were realized following cotton-jowar cropping system over cotton mono-cropping system (pooled data for 10 years) because of higher growth and development of plants, higher yield traits and root biomass and lower weed population and its dry weight.
- Annual combined addition of P and K @ 19 and 37 kg/ha along with FYM @15 t/ha could sustain the productivity of both cotton and jowar at higher levels followed by combined application of N, P & K @ 30,13 & 25 kg/ha respectively along with FYM @ 5 t/ha (on par with recommended practice).
- Continuous cropping of cotton and/or jowar reduced both soil P and K availability over the years in black clay loam (slightly alkaline) soils of Coimbatore region although minor build up of organic carbon and available N was noticed in this soils.

Crop Protection

Nagpur

- Out of 234 F_1 crosses, 79 single plant selections from F_2 and 36 from F_3, 43 from F_1, 10 from F_2 and 5 from F_3 showed tolerance to sucking pests and bollworms as well as possessed good fibre qualities.
- Mirid bugs of *Ragmus* spp. commonly referred as tarnished plant bugs, recorded as a minor pest on cotton is increasing in its abundance and damage have been reported upon.
- First version of COTIPM - an expert system for Indian cotton insect pest management has been developed for diagnosis of insect pests, determination of population size or damage through sampling methods to use with ETLs and selection of ETL based insecticidal control measures for use by the pest control advisors viz., extension functionaries.
- A time sorting device has been developed with light and pheromone traps for studying insect behaviour with respect to time.
- Imidacloprid seed treatment had caused 42% increased internodal elongation, higher rate of square production during first three weeks of squaring and 26% increased fruit load compared to untreated plants.
- Differential parasitisation of *H. armigera* by *C. chlorideae* in relation to cultivars due to the result of differences in the crop

phenology causing differential synchrony between host and parasitoid populations was established.

- The avoidable losses due to insect pests in LRA 5166 was 28.93% and in NHH 44, it was 32.02%.
- Treatments with Spinosad and emamectin benzoate (11 gm a.i./ha) were found superior to other new molecules tested in controlling the bollworms and increasing kapas yield.
- The MDR cultures namely CNH 911, CNH 2713 and CNH 4736 performed much better than LRK 516. Based on fibre stength, 95 plants were selected from 4 cross combinations.
- Analysis of bad seed-cotton lots of 2001-2002 crop season revealed pathogenic infections due to 8 fungi and the bacterial blight pathogen *X.a.* pv. *malvacearum*.
- Out of 197 *G. hirsutum* germplasm lines screened under glass house conditions, 6 were resistant, 17 moderately resistant, 71 moderately susceptible and 103 lines susceptible to bacterial blight. One hundred and eighty seven single plant selections were made from different crosses possessing resistance to bacterial blight.
- Out of 134 *G. hirsutum* germplasm lines screened against fungal foliar diseases under pot culture, all the lines were susceptible to Alternaria leaf spot, 20 lines showed resistant reaction against grey mildew and 25 were resistant against Myrothecium leaf spot.
- The mix microantagonists and chemical were equal in controlling of the foliar diseases.
- Frequency of occurrence of *Pasteuria penetrans* was found to be 3-5% for reniform nematode while for resistant nematode, it was 6-8%.
- PCR/DNA probe based test was developed for CLCuV by designing and synthesizing primer for amplification of coat protein (CP) gene of CLCuV. The amplification of viral genome was confirmed by cloning of amplified product. This is highly sensitive assay for the detection of virus in the cotton plants. The molecular marker (OPA-10) was developed to identify resistant plant in cotton germplasm. OPA 5 can be used as molecular marker for differentiating whitefly population. Thirty four *G. hirsutum* genotypes were observed to be resistant to CLCuV and tolerant to whitefly.
- Grey mildew pathogen was successfully cultured with the method of inoculation of healthy leaf tissue. The new synthetic media along or in combination of these was better for the growth of *R. areola*. Three phylloplane bacteria observed to be promising inhibitors of *X.a.* pv. *malvacearum*.
- Insecticide resistance was monitored for *H. armigera* strains collected from 44 locations. Insecticide resistant strains were developed through laboratory selection and genetics worked out through crosses. The resistance conferring alleles for pyrethroids, organophosphates, carbamates and Cry1Ac were introgressed into a suceptible strain by repeated backcrossing upto BC-6. The BC-5 progeny was selfed and homozygous near isogenic lines were developed. Cross resistance was studied using these lines. An F_2 screen was used to estimate the frequency of resistance alleles to insecticides in field populations. Molecular studies were used to develop RAPD and SCAR markers linked to resistance. Two kits were developed to detect resistance.
- The genetics of resistance to Cry1Ac in *H. armigera* was elucidated through crosses. The expression of Cry1Ac in transgenic plants was assessed throughout the season to understand the temporal and spatial

variability in Cry1Ac expression. An F_2 screen was used to estimate the frequency of resistance alleles to Cry1Ac in field populations.

- Triazophos was tested with deltamethrin at various doses to understand its role as a synergist. Two *H. armigera* strains with esterase and oxidase mechanisms for pyrethroid resistance were tested through bioassays with deltamethrin and triazophos. Biochemical assays with 'pyrethroid resistance associated esterase' revealed that triazophos is a strong inhibitor of esterases and could be involved in synergism through an esterase inhibitory role.
- Training programmes were conducted for all co-ordinators of area wise IRM dissemination project. Despite a drought season, the project dissemination resulted in a 30-65% reduction in insecticide use and a 0-15% increase in yields.
- Two strains of *H. armigera* were characterized based on their host-feeding preference. These were designated as a cotton-race and a non-cotton race. The mitochondrial CO1 region was sequenced for both races. Based on the anatomical differences of cornutal spines, feeding preference on hosts, response to allelochemicals and RAPD-PCR phyllogenetic analysis it was concluded that both the races may be genetically distinct.
- Baseline toxicity studies were conducted on field strains of *H. armigera* and *E. vittella* collected from 20 sites from north, central and south India. A new bioassay system was standardized for the spotted bollworm. The LD50 values of Cry1 Ac against the SBW ranged from 0.01 to 0.284 ug/g of diet. Khammam, Nalgonda and Warangal populations were comparatively more susceptible to Cry1Ac compared to the Vijayawada or Adilabad populations. Central India populations of the spotted bollworm recorded comparatively lower LD_{50} values over the South Indian populations with it ranging from 0.024-0.036 ug/g of diet.

Coimbatore

- Loss of seed cotton yield upto 63 per cent in *G hirsutum* varieties and 71 per cent in intra *hirsutum* hybrids was noticed due to bollworm complex.
- Neemcake + Neemoil + earthing up at 20 and 25 DAS recorded minimum percentage of stem weevil infestation of 12.79 and 12.95 respectively and were on par with Chlorpyriphos 0.05%, Neemcake, Neemcake + Neemoil + earthingup at 30 and 40 DAS and superior than the control in the management of *P.affinis*.
- Emamectin benzoate graded dosage levels 8, 9.5 and 11 g a. i. / ha were effective against bollworm complex and were on par with indoxacarb and spinosad in reducing boll damage and increasing seed cotton yield.
- The successful implementation of location specific IPM and IRM strategies resulted in significant reduction in number of sprays and plant protection cost, additional seed cotton yield and additional income from inter crops besides increasing the build up of natural enemies in the ecosystem.
- Among the new germplasm lines of *G. arboreum* screened against grey mildew following artificial inoculation with *Ramularia areola*, two lines viz., AKA 61 and AKA 62 showed immune reaction and 12 lines viz., AKA 12, AKA 13-1, AKA 13-2, AKA 28, DH 149, AKH 496-1, AKH 580, AKH 590, 7307 SC 136, 78/la-l, AK5 and AK 590-1 were resistant.
- When *G. hirsutum*, *G. barbadense*, *G. arboreum* and *G. herbaceum* were inoculated with different isolates of *R. areola*, there were distinct differences in

their ability to infect the host plants.

- Bioagents *Trichoderma viride*, *T. virens* and combination of *T. viride* and *Pseudomonas fluorescens* have been found to be as effective as the fungicide propiconazole in the management of Alternaria leaf spot.

Sirsa

- The incorporation of Neem Seed Kernel Extract (5 %) along with insecticides were helpful in reducing the insect pests and cost without affecting the yield significantly. Though the yield was more in farmers' practice B:C ratio is less (1 : 1.49) than the IPM module (1 : 1.70) in the station trials. The IPM participatory farmers obtained average yield of (17.8 q / ha) compared to that of non IPM farmers (16.2 q / ha) under large scale (50 acre) demonstration of IPM technologies in Pannihari village in Sirsa district. The cost : benefit ratio in IPM farmers (1 : 3.15) was more than that of non-IPM farmers (1: 2.62).
- The regression equations were developed with historic pest weather data for whitefly, pink bollworm damage and *Alternaria* leaf spot incidence. The seed treatment with imidacloprid and foliar spray of neem preparations and insecticides such as triazophos and difenthuron were found effective in the management of whitefly and subsequently CLCuV.
- Differentiation of twelve isolates of *Rhizactonia solani* and fifteen isolates of *R. bataticola* was carried out using RAPD technique. The analysis of amplified bands by primer OPN-02 was done with the help of matrix and dendrograph and *R. solani* isolates were categorised into four groups. Similarly in case of *R. bataticola* the amplification was done by primer OPN- 04 and the isolates were categorised in three distinct groups.

Plant Physiology and Biochemistry

Nagpur

- Genotypes with relatively higher drought tolerance were identified. *G.arboreum* and *G.herbaceum* genotypes possessed lower leaf water potential, higher root-shoot ratio and higher nitrate reductase activity. Transpirational cooling of leaves and yield stabilty were well marked in *herbaceum* lines. On the other hand *G.hirsutum* genotypes showed higher stomatal resistance, leaf water potential and dry matter production.
- With regard to salinity tolerance, yield in most of the genotypes was stable up to 10 EC salinity level beyond which considerable yield reduction occurred. PKV 081, LRK 516, Mahalaxmi, Dharwad JK 91 and G.Cot 100 were found to be more tolerant to salinity. Proline content, free radical scavengers and protein level remained high in tolerant varieties and may serve as important screening parameters for salinity tolerance.
- Water logging significantly reduced yield particularly in Asiatic cotton. The adverse effects are stunted growth, shedding of leaves and squares and lowered photosynthesis. High temperature and bright sunlight led to wilting of plants. Insecticide sprays affected plant defence system.
- The phenol and flavanol contents tend to decline while reducing sugars and amino acid content showed an initial increase with insecticide application.
- Gibberellic acid when given as foliar application during reproductive ontogeny showed a tendency for increase in square production while DAP 1 per cent foliar spray enhanced seed-cotton yield in NHH 44, MECH 12, 162 and 184 (Bt and non Bt).
- Continuous square removal at early stages by mechanical or chemical means

enhanced yield by way of increase in fruiting activity. Higher concentration of ethrel affected growth and yield. Maleic hydrazide application showed growth promoting trends.

- Seed gossypol content remained higher in *arboreum* lines. Seed possessed higher level of gossypol content as compared to other plant parts. It increased in the older-leaf, square, flower, boll and seed. Seed oil content in germplasm lines and advanced cultures varied from 15 to 26 per cent.

Coimbatore

- Ovules cultured initially on TM medium with IAA (1.0 $mg.L^{-1}$) +GA (1.0 $mg.L^{-1}$) + BA (1.0 $g.L^{-1}$) and later sub cultured on to medium containing IAA (2.0 $mg.L^{-1}$) + GA (0.0 $mg.L^{-1}$) + BA (0.5 $g.L^{-1}$) led to profused fibre growth. The fibre growth was found to be better under suspension culture than on semi-solid medium.
- Under irrigated conditions, all the genotypes that were laden with heavy boll number, photosynthesized comparatively at lesser rate (21.4 µ mol $C0_2.m^{-2}.s^{-1}$) compared to plants with medium number of bolls (> 8 bolls per plant) with photosynthetic rate of 23 mol CO, µ m^{-2}, S^{-1}. Similarly, plants that had poor boll set of less than 5 bolls per plant photosynthesized significantly at a higher rate of 24.7 µ mol CO_2, m^{-2}. 5.
- Studies indicated that cotton plants may suffer from poor photosynthesis and assimilation if the night temperature falls below 15°C .
- Photosynthetic rate and transpiration were drastically affected in reddened leaves due to jassid injury than physiological reddening in cotton.
- The data generated for prediction of regional level cotton yield by integrating remote sensing, geographic information system and crop models could simulate results accurately for 120 days after sowing.
- Bollworm tolerant genotypes viz., BRS 3, BRS 5, BRS 22, BRS 23 and HGIPS 542 yielded 40 -60 g/plant under unprotected conditions as compared to 50-95 g/plant under protected conditions inferring that the yield performance of unsprayed boll worm tolerant genotypes were comparable to the yield obtained in sprayed plots.

Agricultural Extension and Economics

Nagpur

- A panel study conducted on the socio-economic status of cotton over a period of three years revealed that cotton growers reporting their total income as farmers has not adequate enough to live on has increased from 62 per cent to 78 per cent. Current financial condition of a family was a very serious problem for 26 per cent cotton growers three years back. Now it is 46 per cent cotton growers. There is increase of 36 per cent farmers doing off-farm jobs to earn some extra money. Number of farmers working on others farm for wages have also increased from 37 per cent to 48 per cent. Womenfolk of farm families are now spending more hours working on farm. Three years back, 61 per cent of cotton growers were very concerned about returning the loan taken for agriculture. Now it is 70 per cent of farmers. Cotton growers reporting perceived quality of life as become somewhat worse has gone up from 56 to 60 per cent.
- A model tested for the adoption of IPM technology reveal that large portion of variance in adoption behavior of cotton growers can be explained by spatial distribution, availability of technology, marketing strategy, pricing and promotional communication.

- The cotton Frontline demonstrations have brought the significant changes in knowledge level of cotton growers, adoption percentage and also their yield levels as compared to non-FLD farmers.
- A survey of 43 Bt cotton cultivators in Nagpur and Wardha district revealed that MECH 184 Bt cotton (11.73 q/ha) gave significantly higher yield than ruling conventional hybrids (9.72 q/ha). There is significant saving over the plant protection cost. However, the full potential of Bt cotton could not be realized because of drought like situation and low incidence of bollworm.
- It has been revealed that delay in cash payment is an important determinant of cotton diversion from Monopoly Procurement Scheme than price realized.
- Data collected from northern states reveal that major constraints for yield loss are bollworm damage (55 %), non-availability of water on time (22 %) ,weed infestation (18%) and late sowing (15%). Small farms are found to be relatively more efficient in input utilization in cotton cultivation and large farms in wheat cultivation where bulk of the operations are mechanized. The overall mean output efficiency indicate that the technology realized was only 58.87 per cent of the frontier (potential) in the sample farm. Across the size groups, it ranged between 60.35% in small farms to 59.82 in case of big farms at the mean level.

Coimbatore

- The technological interventions implemented, resulted in an average yield increase of 30 per cent in cotton and 35 per cent in Maize. There was more than 80 per cent adoption and change in the attitude of farmers in using scientific technologies.

DG and DDGs interacting with the Director and Scientists in the field.

Dr. Panjab Singh, DG, releasing Institute Publication.

Ms Shashi Misra, Additional Secretary, DARE & Secretary, ICAR visiting Bio-control Laboratory.

Dr. S B Mahapatra, Secretary Textiles, Govt. of India interacting with the scientists in the field.

ICAR

Extension & Economics

Nagpur

A study on structure of agriculture and social dynamics of cotton production

(Hemchandra Gajbhiye).

Longitudinal data collected at two points in time from 107 cotton growers from Mangli, Mohagaon, Kawadas, and Adegaon villages in Hingna taluka of Nagpur district during the year 2000 and 2003 by panel method reveal that the farmers reporting their total income as not adequate enough to live on has increased from 62 per cent to 78 per cent during last three years. Farmers reporting their total income as just adequate enough to barely get by on has reduced to 19 per cent from 35 per cent during the same period. The data clearly indicates that total income of cotton growers has come down during the reported period. Current financial condition of a family was very serious problem for 26 per cent cotton growers three years back. Now it is 46 per cent farmers. Many of the farmers whose financial condition of a family was not a problem or a slight problem are reporting as a serious problem in current year.

Twenty one per cent cotton growers were doing off-farm job besides cultivating their own land in the year 2000. Now, 37 per cent cotton growers are engaged in off-farm job to make both the ends meet. As a result of declining income and increasing demand of money, the womenfolk of farm families have increased their number of hours working on farm besides doing their regular household chores. Seventy five per cent womenfolk were working for 4 to 8 hours every day on farm during the crop season in the year 2000. Now it is 81 per cent. Number of farmers working on others farm for wages have also increased from 37 to 48 per cent during these three years. Because of financial constraints majority of cotton growers take loan for agriculture. Three years back, 61 per cent of them were very concerned about returning the loan. Now it is 70 per cent farmers. Slightly and moderately concerned cotton growers have been pushed to very concerned category during these three years.

In respect of the changes in perceived quality of life, cotton growers reporting quality of life as somewhat worse has gone up from 56 to 60 per cent and those reporting as much worse has gone up to 24 per cent from 19 per cent during these three years.

A study on technology adoption behavior of cotton growers : structural perspective

(Hemchandra Gajbhiye).

This study was undertaken to understand the pattern of diffusion of some selected technologies related to cotton production through Market and Infrastructure perspective. Following model was tested for the explanation of adoption behavior of cotton growers in relation to Integrated Pest Management Technology.

$$Y = X_1 + X_2 + X_3 + X_4 + X_5 + e_i$$

Where Y = Technology adoption behavior; X_1 = Spatial distribution; X_2 = Availability of technology; X_3 = Marketing strategy; X_4 = Pricing; X_5 = Promotional communication.

When this model is tested with the data collected from 107 cotton growers from Mangli, Mohagaon, Kawadas and Adegaon villages in Hingna Taluka of Nagpur district, it is revealed that the model is significant (Multiple R = .69) and 53 per cent variation in technology adoption behavior related to IPM may be explained by this model. The model suggests that adoption behavior of IPM practices among cotton growers is a function of the physical distance of their village from propagator, availability and access to technology, marketing strategy adopted by the propagator, money required for purchasing of technological inputs, and resources spent on promotional communication by the propagator. To

popularize more of IPM technology, these variables should be paid attention to.

Impact of cotton front-line demonstrations on technological advancement of cotton growers (S. M. Wasnik, H. L. Gajbhiye & S.Usha Rani).

The data collection for all the 300 cotton growers (150 FLD participating and 150 non-FLD cotton growers) from the districts Nagpur, Sirsa and Coimbtore under CICR Nagpur, CICR Sirsa and CICR Coimbtore has been completed. The data for CICR Nagpur and CICR Sirsa for all the 200 sample farmers has been analyzed with respect to assessing the influence of cotton FLDs on various aspects (Table 12). The results of the investigations revealed that the cotton FLD did make a significant impact in building confidence of the growers in improved cotton cultivation practices on both FLD participating and non-participating farmers of rainfed Nagpur and irrigated Sirsa districts details are given below:

Impact on Knowledge enhancement

The mean overall knowledge was observed to 67.64 and 62.67% in case of FLD participating farmers, while that of non-FLD growers it was 53.82 and 47.67 per cent at Sirsa and Nagpur districts, respectively, which was 13.79 and 14.91 per cent increase of knowledge in participating farmers over that of fellow farmers. It was noteworthy to mention that not only FLD farmers but non-FLD fellow farmers also gained in knowledge of cotton technological practices.

Impact on extent of Adoption

Mean overall adoption was 57.33 and 56.42% in case of FLDs while 48.73 and 45.39% in case of non-FLD growers in Sirsa and Nagpur, respectively with overall increase of 8.6 and 11% on FLD growers in both the districts. The highest increase in level of adoption was observed in plant protection measures followed by intercultural operations, irrigation management, integrated nutrient management in Sirsa district while use of improved varieties and hybrids followed by plant protection, use of proper seed rate and maintaining plant population, interculture operations and integrated nutrient management in Nagpur district.

Impact on Yield Levels

The study further revealed that the cotton yield increased significantly due to implementation of cotton front-line demonstrations since the average yield was reported to be 9.5 and 16.0 q/ha in Nagpur and Sirsa, respectively, whereas it was 4.5 and 7.85 q/ha at fellow farmers fields. The influence of FLD with respect to yield levels was greater among FLD farmers since knowledge and adoption was higher but other farmers also gained through the programme as all the farmers in the villages both at Nagpur and Sirsa districts attained higher productivity level as compared to district average of 2.08 and 4.37q/ha, respectively, state average of 1.73 and 3.94 in Maharashtra and Haryana and national average yield of 2.66. Because of frequent visits to FLD farmers fields and discussion with them, fellow farmers got advantage of seeing the performance of demonstrations and attained higher productivity.

Consultancy patterns for seeking information by fellow farmers

As regards consultancy patterns of other farmers in improved cotton cultivation practices like seed rate, improved varieties/hybrids, FYM/compost applications, use of fertilizers and plant protection measures, the FLD farmers are found as primary source of information since it ranked first (weighted scores 248). This may be due to the fact that the other farmers noticed the worthiness of improved technologies demonstrated at FLD participating farmers fields, which provided opportunities to them for getting information while discussing results of front-line demonstrations.

Neighbours and friends stood second in rank and agro-fertilizers dealers ranked as third source for consultation. This implies that cotton Front-Line Demonstration approach has played a significant role in dissemination of sustainable cotton production technology effectively to other farmers also to a great extent.

Discontinuance of cotton technologies by FLD farmers

The data were collected from FLD participating farmers towards the technologies discontinued by them shows that some farmers discontinued the cultivation of cotton hybrids like PKV Hy 2 and Omshankar due to high requirements of inputs and unavailability of resources at proper time. Farmers had also stopped the use of neemseed extract, HNPV, pheromone traps and bio-agents in the villages both at Nagpur and Sirsa districts because of their non-availability.

Farmers Perception for best practices contributing to higher yield

The data collected from FLD cotton growers with respect to their perception of best practices contributing higher yields pointed out that about 73 % farmers perceived pest control through bio-pesticide (neem oil), HNPV and use of bio-agents as the most important cotton technological package that has contributed for higher cotton yield followed by maintaining proper plant population by gap filling/thinning as needed, intercultural operations and weed management in both Sirsa and Nagpur districts. The other cotton technological practices contributed for higher yields were combined application of organic, inorganic and biofertilizers, timely sowing of the crop and use of good quality seed of improved varieties/ hybrids. The technological practices contributing for higher yields were more or less the same in both Sirsa and Nagpur districts.

Table 12: Level of knowledge & Extent of adoption of cotton production practices under FLD & non-FLD participating cotton growers

Sr. No.	Cotton technology components	CICR, Sirsa				CICR, Nagpur			
		Knowledge(%)		Adoption(%)		Knowledge(%)		Adoption(%)	
		FLD	NON-FLD	FLD	NON-FLD	FLD	NON-FLD	FLD	NON-FLD
1	Deep ploughing	62.66	41.33	42.0	36.67	50.0	42.67	48.67	43.33
2	Sowing	68.0	57.33	60.0	50.67	62.67	47.33	54.67	44.0
3	Seed rate	66.67	60.67	48.0	42.67	58.67	44.67	56.67	42.67
4	Seed treatment	52.0	42.0	44.67	38.66	59.33	50.0	54.0	46.67
5	Spacing	62.0	52.67	54.67	47.33	60.0	45.33	56.0	48.0
6	Improved varieties/hybrids	72.67	62.0	71.33	64.0	68.0	44.0	59.33	39.33
7	Nutrient management	79.33	60.0	58.0	48.67	64.0	50.0	57.33	45.33
8	Interculrural operations	59.33	42.67	56.0	42.0	78.67	57.33	66.0	52.67
9	Irrigation management	78.67	58.0	70.0	57.33	49.33	38.67	48.0	44.0
10	Plant protection	81.33	62.0	65.33	51.33	81.33	62.0	65.33	51.33
11	Picking	61.67	53.33	60.67	56.67	57.33	43.33	54.66	42.0
	Overall	67.64	53.82	57.33	48.73	62.67	47.76	56.42	45.39
	t value	10.4884***		10.4883***		10.7682***		10.001***	

*** Significant at 0.001 level of probability

P1-94/1-ICR-E10/0430:

Economic analysis of cotton cultivation in India (P.Ramasundaram and H. L. Gajbhiye).

Data were collected from 180 cotton farms - 100 in Amravati district and 80 in the Sri Ganganagar district and analysed for performance and constraints for the current year. A survey of 43 Bt cotton cultivators in Nagpur and Wardha district was made. Besides effect of allowing private procurement along with monopoly was studied by collecting data from 63 cultivators in the bordering tehsils. Empirical estimation of field constraints with the temporal conflict between extended picking of cotton and delayed sowing of wheat as a test case was attempted with the panel data of 400 farms for three years. A schematic frame work of the conflict was modeled and it was found that the farmers' decision to prolong cotton picking and delay wheat sowing was rational considering the yield and price levels of both. The average delay in sowing of wheat was 15 days and the loss due to per day delay was 20 kg/ ha. The value of net loss @ of Rs.6.10 per kg was Rs.1220 /-. The estimated expected yield of cotton in last picking was 250 kg. The net addition @ Rs.1900/q was Rs. 3467.5 /ha. The net gain of added cotton over lost wheat yield was Rs.2247.5/ha.

The survey of 43 Bt cotton cultivators in Nagpur and Wardha districts revealed that MECH 184 Bt cotton (11.73 q/ha) gave significantly higher yield than ruling conventional hybrids (9.72 q/ha), while the performance of MECH 162 was not satisfactory vis-à-vis the conventional hybrid Ankur 651. Inclusion of MECH 162, brought down the difference to non-significant level. The crop season (2002-03) was characterized with initial drought that belied the high expectations. The major constraints were lack of follow-up by promoters, absence of refugia, incidence of wilt and high cost of seed. The technical information on the technology has not diffused to the desirable extent among cultivators and this offers much scope for further yield realization.

The data collected from 63 cotton cultivators in the bordering tehsils of Nagpur district analysed through dummy dependent regression revealed that cash payment is the important determinant of cotton diversion than prices realized. The state decision to allow private trade in cotton procurement has made no difference in the bordering tehsils except ligitimisation of the practice in vogue for years.

Coimbatore

Role of women in cotton based cropping systems of Tamil Nadu (S. Usha Rani and M. Sabesh).

Cotton area in and around Coimbatore district was surveyed and 50 farmwomen in Chinnaputhur village of Dharapuram taluk of Erode District and 50 farmwomen in Kallapuram village of Kinathukadavu taluk of Coimbatore district of Tamil Nadu were selected as respondents for the study. A well-structured interview schedule with variables, which are found to have relevancy with the investigation was constructed.

National Agricultural Technology Project

TAR-RFIVLP-15 : **Technology assessment and refinement of rainfed cotton based production system in Nagpur district (M.S.) through Institute Village Linkage Program** (Hemchandra Gajbhiye, M.K.Meshram, P. Ramasundaram, G.Majumdar, Gulbir Singh, S.S.Patil, A.S.Tayade and U.V.Galkate).

The IVLP project is being executed at two villages *viz* Telgaon and Tishti in Kalmeshwar

Taluka of Nagpur district. More than 300 farmers are involved in this program for implementing 25 technological interventions. These interventions include crop based, plant nutrient based, IPM based, horticulture based and animal based technologies. In the crop based interventions it was revealed that Bt cotton (MECH-184) gave 21 per cent higher yield and MECH-162 gave 11 per cent more yield than prevailing hybrids. Dry sowing of cotton during one week ahead of monsoon gives 10 per cent more yield over sowing after the arrival of monsoon. Desi cotton (AKA-7) has given 14 per cent more profit to cotton growers over farmers practice (LRA 5166). Under delayed arrival of monsoon conditions, ground-nut as intercrop in cotton has increased profitability by 17 per cent over sole cotton and 19 per cent over sole ground-nut crop. Pigeon-pea as strip crop in cotton, gave 14 per cent more profitability over sole cotton crop. A new hybrid cotton Mahabeej-2 developed by Maharashtra State Seed Corporation gave 5 per cent more yield over PKV-4. Use of balance dose of chemical fertilizers in cotton combined with bio-fertilizers has increased the yield up to 10 per cent. However, Integrated Nutrient Management approach in cotton has increased the yield up to 16 per cent over farmers practice. It was also observed that the yield of soybean has increased up to 23 per cent by appropriate plant population and Integrated Nutrient Management approach. During the year characterized by early withdrawal of monsoon, two applications of 2 per cent DAP as foliar spray, first at flowering and second at boll formation stage increases the cotton yield up to 6 per cent. Productivity of cotton is increased up to 17 per cent with the application of complete module of Integrated Pest Management. Pesticide Application Technology (PAT) developed by CICR may increase the profitability by 4 per cent. With the use of new approach towards Insecticide Resistance Management, the profitability in cotton production may be increased up to 21 per cent. Bacterial blight in cotton may be successfully managed by using the delinted seed and spraying the crop with copper oxychloride + streptocyclin. Grey mildew disease in cotton may be managed by spraying the crop with carbendazim. *Fusarium* wilt in pigeon-pea can be managed by using wilt resistant variety (ICPL-87119) and seed treatment with *Tricoderma viride*.

Under the horticultural interventions, a new commercial crop of marigold is introduced as intercrop in orange orchards under delayed arrival of monsoon, and it was found to give higher profitability over cotton or soybean as intercrop in orange orchards. A new tomato hybrid Abhinash-2 has given 27 per cent higher yield than popularly grown tomato variety. It was also observed that damping off in tomato nursery can be successfully controlled by use of raised-bed nursery and seed treatment with Thirum. The new high yielding variety of marigold (Golden Sierra) can give 20 per higher yield than usually grown varieties like Giant Suman and also fetches better price in market.

Under Animal based interventions, it was observed that de-worming of cattle with Morantal Citrate 1 bolus/100kg body weight of the animal has increased the productivity of milch animals by 19 per cent. Milk production can also be increased up to 14 per cent by supplementing the diet of dairy cattle with mineral mixture @ 50 gm/ animal/ day + Vitablend AD3 @ 25g/100 kg feed. With the introduction of Osmanabadi buck in local herds of goat, the twining percentage of goats have increased by 20 per cent. Body weight of kids by Osmanabadi bucks was also significantly higher than kids by local bucks. Lucerne as a new leguminous fodder crop was also introduced in both the villages and it was found that milk production has increased by 16 per cent.

PSR-24: **Socio-economic characterisation and analysis of cotton based cropping systems** (P. Ramasundaram, D. Blaise and M. Sabesh).

Data were collected from the 400 sample farmers for the third consecutive year (2001-02 crop season) and analysed. The model of technological progress as an aggregation of product of ratio of actual to potential yield and the corresponding weights determined as the value of individual crop in aggregate crop income of the farm holding price variations constant. The results indicated that at mean level Hisar and Muktsar districts farms have higher technological progress and across size groups small and medium register higher technology realization though the variation is minimal in large size groups.

The model on constraints quantification was finalized and loss percentages, probabilities and extent of affected area under identified constraints have been worked out. Boll worm damage topped in cotton with the yield loss ranging from 23 per cent in Bhatinda and 55.25 % in Sirsa and the probability was 0.75. Fifteen more constraints were quantified and ranked in order with probabilities. Non-availability of water on time (22%), weed infestation (18%) and late sowing (15%) were the major constraints in wheat. Farming efficiency in cotton-wheat system was estimated deploying frontier production function. The results indicated that there is a greater degree of association of the variables selected as reflected by high R^2. The non-significant coefficients of the major variables indicated the decreasing marginal returns set in the intensive cultivation of cotton-wheat system. High rate of output efficiency has been recorded in both the crops. But, in order to achieve this highest potential, the farmers tend to utilize the inputs at an inefficient level. There was a glaring over use of important resources considered in the study. The actual and frontier usage of inputs for both the crops has been worked out for size groups. The input use inefficiency was highest in Hisar and ranged from 62-73%. Small farms were relatively more efficient in input utilization in cotton cultivation and large farms in wheat cultivation where bulk of the operations is mechanized.

RCPS 1: **Agro-ecosystem Characterisation of Cotton Based Cropping System in relation to soil and constraints** (P. Ramasundaram and N. K. Perumal).

The overall mean output efficiency indicated that the technology realized was only 58.87 % of the frontier (potential) in the sample farms. Across the size groups, it ranged between 60.35% in small farms and 59.82% in case of big farms at the mean level. Over the districts, the output efficiency increased with farm size in case of Baroda district, decreased with farm size in case of Amravati and Yavatmal districts, and followed no trend in the rest. The mean overall input efficiency indicated that at present mean yield could as well have been realized only by the 28.28% of the current inputs used. In other words, 71.72 % of the input applied was not utilized in the output transformation. Across the size groups, the input efficiency decreased with farm size in Amravati, Yavatmal, Nanded and Baroda districts, while it increased with farm size in Jalgoan sample. Loss minimization technologies like resistance importance to ruling genotypes against major pest, particularly bollworms, like Bt cotton can enable augmentation of movement along the frontier in the low productive regions.

The regression results showed that potash was negative and that of plant protection was positive significantly affecting cotton production in Amravati sample. The coefficients revealed that holding all other inputs constant, the percent increase in potash use, may decrease the yield by 0.03 per cent while one more rupee spent on plant

protection may increase the yield by 0.02 per cent at mean level. The coefficent of farm size was significant and negative in case of Yavatmal district while that of nitrogen and phosphorous were positively significant. This showed that further increase in farm size, *ceteris paribus* will reduce the yield by 0.14 per cent and that small farms were more efficient than larger farms and the under use of N and P. Only plant protection and farmyard manure were positively significant variables affecting cotton production in Nanded sample. Plant protection was negatively significant indicating the excessive and indiscriminate use of pesticides in cotton production in Baroda district. On the contrary, in Surendrangar, it was positive indicating that *ceteris paribus* a one per cent increase in plant protection expenditure will contribute to production increase by 0.29 per cent.

Coimbatore

TAR 18: **Technology Assessment and Refinement of Irrigated Agro-Eco System for Coimbatore region (Tamil Nadu)** (S. Usha Rani).

To assess and refine the identified technologies, a total of 250 farmers in three hamlets were selected. Among the 250 farmers, 35 benefited in cotton cultivation, 50 in maize cultivation, 25 in vegetable cultivation and remaining benefited in other thematic areas. Apart from the 31 technological interventions, ten trainings were conducted for 500 farmers in the areas like hybrid seed development, bio diversity, farm implements maintenance, biopesticide production, mushroom production, integrated crop management for cotton, milch animals and goat and sheep management. Two trainings were conducted for farmwomen development in the areas of home science technology, food processing technology and entrepreneurship development.

Based on the results obtained in all the interventions implemented, 30 per cent yield increase in cotton and 35 percent increase in the maize crop were seen. Very successful implementation of milch animals, health camp, introduction of Amla (*Emblicus afficinalis*) fruit trees, nutrient management of more than 1500 coconut trees and introduction of new high yielding vegetable varieties all resulted in more than 80 per cent of overall adoption and change in the attitude of farmers in using their own local ideas to cultivation of cotton, other crops and allied activities.

Technology Mission on Cotton

MMG 1: **Technology intervention and socio-economic analysis in cotton based cropping system.**

Nagpur - (Hemchandra Gajbhiye, S. M. Wasnik, S. S. Patil and A. S.Tayade).

This study is initiated with a objective of assessing some of the cotton production technologies developed by all co-operating centers during last 20 years for their partial adoption or complete non-adoption by the client system and bring out some refinements or fine tuning for reintroduction of these technologies into production system. The project is operating in 14 co-operating centers with CICR, Nagpur as the Lead center.

Bt cotton (MECH-184Bt) gave 234 kg/ha higher yield per hectare and MECH-162Bt gave 127 kg more yield per hectare than prevailing hybrids

The new hybrid Mahabeej-2 has also given better performance over other hybrids. *Desi* cotton AKA-7 has recorded 11 per cent more profitability over LRA 5166.

Dry sowing of cotton one week ahead of arrival of monsoon was reported to be giving up to 15 per cent higher yields than monsoon sowing in rainfed conditions. Opening of ridges and furrows at 30 days after sowing

has increased the yield up to 20 per cent in rainfed situations. Optimal plant density has increased the cotton yield up to 25 per cent at several centers. If all the technologies under Integrated Pest Management are used in cotton, the production may go up to 40 per cent. Integrated approach to nutrient management which includes organic manures, green manures, balance use of fertilizers based on soil testing, use of bio-fertilizers and appropriate time of application seems to increase the yield up to 10 per cent with reduced spending on chemical fertilizers and higher profitability.

Coimbatore - (S. Usha Rani).

Based on the results obtained, it could be observed that by conducting the cotton production technological interventions through on farm trials, the farmers were able to get additional yield. The cost of cultivation for growing cotton crop either variety or hybrid by following the technological interventions and the farmers' practices showed that the farmers were able to get higher cost: benefit ratio for the technological intervention practices than their own practices. The highest cost benefit ratio of 1: 2.7 was obtained in the case of adoption of Bt cotton hybrids.

Impact of the Technology:

Farmers were convinced about all the seven interventions. IRM farmers realized harmful effect of using broad-spectrum insecticides at initial stages of pest management as well as use of tank mixtures. Moreover they also realized the benefit to delay first spray and use Endosulfan as first spray. The participatory farmers also reduced the use of pyrethroids and the trend of tank mixing synthetic pyrethroids in each spray was broken. All the IPM farmers and their community were influenced by the IPM techniques like Pheromone trap, Trichocard, NPV, Neem Seed Kernel Extract seed treatment and resistant/tolerant varieties/hybrids. Farmers are ready to use FYM and 2 percent DAP as foliar spray continue in their field because they have convinced about the soil health and hygiene.

Some of the non-participatory farmers also took interest in the interventions. Detopping of cotton crop became quite popular. The net profit gained by participatory farmers was much higher as compared to non-participatory farmers.

Nagpur

AP Cess Fund:

Identification and quantification of constraints, risks and policy impacts in cotton cultivation in India

(P. Ramasundaram and H. L. Gajbhiye).

Tehsil wise cotton productivity data were collected for Maharashtra state since 1980-81 and were analysed for instability. The yield instability ranged from 126.10% in Hadgaon tk, Pharbhani to 18.74 % in Palam, Pharbhani. The district level analysis is being done for all the cotton growing states.

The policies that affect cotton, cultivation, production, trade, marketing, processing and transport since independence has been compiled and documented. It was revealed that nearly 40 per cent of the policies that regulate the agricultural production is targeted on cotton alone, though most of it is being lifted, revealed, rescinded, liberalized since 1990-91 keeping in tune with the economic liberalization. Farm level risk indicators are being identified and risk coefficients are being computed using the survey data in northern and central zones.

MMG1 : Sirsa - (Surender Kumar)

SN	Technological Interventions	Year(s)	Mode VT/ OFT	No. of farmers covered	Treatments	Yield q/ha	%increase in yield over FP	Net return Rs./ha.	B:C ratio	Remarks
1	2	3	4	5	6	7	8	9	10	11
1	To determine the optimum spacing in hybrid/variety	2002-03	OFT	10	**T1**:**FP**. 67.5x30 cm (varieties) 90x45 (Hybrids)	16.38		18346	1:1.30	Satis-factory
					T2: (varieties: 60x60 cm) (Hybrids: 100x60cm)	16.87	7.6	19740	1:1.40	
2	Detopping in cotton crop.	2002-03	OFT	10	**T1**:**FP**: No detopping	15.36	5.65	16620	1:1.9	Satis-factory
					T2: Detopping at time of 100 DAS	15.78		17560	1:1.25	
3	IRM in cotton crop	2002-03	OFT	10	**T1**: **FP**: Mixing of non-recommended insecticides by the farmers	14.88		16220	1:1.12	Satis-factory
					T2: All IRM strategy	15.73	21	19640	1:1.66	
4	IPM in cotton crop	2002-03	VT	10	**T1**:**FP**: No use of any IPM Technique	13.62	23	14040	1:0.94	Satis-factory
					T2: All IPM strategy	15.00		17372	1:1.14	
5	INM in cotton crop	2002-03	VT	10	**T1**: FP: No use of 10 tonne of FYM & 2%DAP foliar spray	15.36		16712	1:1.16	Satis-factory
					T2: FYM &2% DAP foliar spray	16.19	5	17510	1:1.29	
6	Performance of hybrid Omshankar	2002-03	VT	10	**T1**: FP: H1098 and LH-1556	16.33		18184	1:1.24	Satis-factory
					T2: Hybrid Omshankar & LHH-144	18.09	17.91	21680	1:1.33	
7	Own hybrid seed production.	2002-03	VT	3	F1 Hybrid seed of AAH-1 &LHH-144	6.08	NA	122333	1:0.63	Satis-factory

Technology Assessed and Transferred

Nagpur

- Bt cotton has been introduced to reduce the excessive use of chemical pesticides against *Heliothis*. Two Hybrid Bt cottons MECH 184 and MECH 162 were assessed on farmers fields in Telgaon and Tishti villages of Nagpur district. It was observed that MECH 184 Bt has given 234 kg more seed cotton yield and MECH 162 Bt has given 181 kg more seed cotton yield per hectare over locally grown hybrids.
- Dry sowing of cotton one week in advance of onset of monsoon has given 9.73 per cent more yield of seed cotton as compared to monsoon sowing in IVLP villages.
- In a trail under IVLP a new *arboreum* cotton AKA 7 has given 14 per cent more profit than LRA 5166.
- One of the widely used intercropping system of cotton + soybeans get affected under delayed arrival of monsoon. Under such conditions ground-nut is a promising intercrop in cotton. This combination gave 17 per cent profitability above sole cotton and 19 per cent above sole ground-nut.
- Use of balance dose of chemical fertilizers in cotton combined with bio-fertilizers has increased the yield up to 10 per cent. However, Integrated approach to nutrient management which includes organic manures, green manures, balance use of fertilizers based on soil testing, use of bio-fertilizers and appropriate time of application seems to increase the yield up to 16 per cent .
- The complete package of IPM in cotton which includes chemical, biological and mechanical methods of managing pest complex was assessed at IVLP villages and it was revealed that profitability can be increased up to 26 per cent.

Sirsa

- The programme on dissemination of IRM was implemented in thirty villages in Haryana state and convinced the farmers about the harmful effects of using broad spectrum insecticides at initial stage of pest management as well as use of tank mixture. The total number of sprays in case of participatory farmers were less compared to non participatory farmers and net profit of participatory farmers was much higher.
- The average yield of seed cotton in IPM plots (17.8 Q/ha)was high compared to that of non IPM plots(16.2 Q/ha) under large scale (50 acre) demonstration in Panihari village in Sirsa district. The expenses on plant protection aspects in IPM plots was Rs.1865/- and that of non IPM was Rs.2947/- The cost benefit was more in IPM farmers (1: 3.15) than on IPM farmers (1:2.62).
- The integrated nutrient management in cotton crop technology was identified and 2% DAP as foliar spray during peak flowering and boll formation stages was found very effective for boll setting. In case of detopping, the practice was very effective at 100 DAS and IPM /IRM technology was found very useful in cotton. The hybrid seed production technique was found very profitable by farmers.

Education and Training

Training Received

NATIONAL

- Ms. S. Usha Rani, Scientist (Agril. Extension) attended the training programme on 'Rapid Relaxed and participatory Rural Appraisal at CRIDA, Hyderabad from 4th to 12th December, 2002.
- Dr. K.B. Hebbar, Sr. Scientist, Plant Physiology, received training on physiological and molecular basis of abiotic stress resistance in crop plants at WTC, IARI from 16-30 Dec., 2002.
- Dr. Phundan Singh, Head, Division of Crop Improvement, Dr. S.M. Wasnik, Sr. Scientist (Agril. Extension) and Dr. Mahendra Singh, attended computer training programme at NIIT, Nagpur from 22.5.2002 to 8.7.2002.
- Dr. T.R. Loknathan, Sr. Scientist (Plant breeding) attended 3rd trainers training programme from 13th February, 2003 to 5th March, 2003 at NBPGR, New Delhi.

Training Imparted

Nagpur

National Training Course on Integrated Cotton Production

A National Training Course on Integrated Cotton Production Technology was organised during Sep.18-25, 2002, sponsored by the Ministry of Agriculture, New Delhi, to update the knowledge, enhance the skills and sensitize the participants to the integrated approach eco-friendly to cotton production. The course was inaugurated by Dr. Sharad. Nimbalkar, Vice-Chancellor, Dr. Panjabrao Krishi Vidyapeeth, Akola. Dr. Nimbalkar emphasized that soil health should be maintained at any cost to have a sustainable development in agriculture. Valedictory Address was delivered by Sh. Balbir Singh Grewal, Member, CICR Management Committee. Sh. N.N.Thengre, Member CICR Management Committee, Dr. Mahindre, Director, Extension, Govt. of Maharashtra and Sh. N.B. Nagrale, Jt. Director, Agriculture, Govt. of Maharashtra were also present on the occasion and they have distributed the certificates to the participants. Dr .C. D. Mayee, Director, CICR chaired the proceedings. The Course was attended by 20 senior level officers including from eight states. Dr. Hemchandra Gajbhiye, Principal Scientist and Head, Extension Section was the Course Director.

Training Courses on Molecular Biology and Tissue culture

Five Training Courses on Molecular Biology and Tissue culture were organised for college students. In total 52 under-graduates and 39 post graduates students of the Universities of Amaravati, Nagpur and Parbhani were trained.

Sirsa

- A zonal training programme was conducted at CICR, Regional Station, Sirsa, on 16th July, 2002 to train the State and district co-ordinators, under the project TMC-MM-II-IRM. This meeting was chaired by Dr. Sheoraj, Head, Division of Crop Protection, CICR, Nagpur and attended by delegates from Rajasthan, Haryana, and Punjab, JDA (Cotton), Haryana, and Representatives from Private Companies, Aventis and Excel.
- A farmers training programme on IRM and IPM was conducted at CICR, Regional Station, Sirsa on 17-7-02, in collaboration with JDA (cotton) Haryana, and Excel Industries Ltd., Mumbai.Dr. B.S. Dahiya, Director of Research, CCS HAU, Hisar was the chief guest and Dr. Sheoraj, head, Crop Protection, CICR, Nagpur presided over.
- Training programme of field workers held at CICR RS Sirsa by District /State Coordinator on 20th and 25th July. The field workers were trained about survey, surveillance and scouting.

Award & Recognitions

Shri A. Kannan, Principal Scientist (Plant Pathology), CICR, Regional Station, Coimbatore has received the National Magnum Honour Award 2001 "Uttam Sanshodhan Karya" for his outstanding Research in cotton crop in Tamil Nadu at the hands of Shri Vadde Shobhanadriswara Rao, Hon'ble Minister of Agriculture, Govt. of Andhra Pradesh on 20th December, 2002 at Hyderabad. The Award was sponsored by Magnum Foundation, Nagpur.

Dr. Hemchandra Gajbhiye, Principal Scientist and Head, Extension Section at CICR, Nagpur has been awarded first prize in the Best Research Paper Read Competition in the National Seminar on Entrepreneurship Development in Agriculture, organized by the Maharashtra Society of Extension Education and Marathwada Agricultural University, Parbhani, during March 2-3, 2002. Dr. Gajbhiye has received the award consisting of a Certificate and memento at the hands of Shri Govindraoji Adik, Hon'ble Minister for Agriculture, Govt. of Maharashtra in the presence of Sh. Annasaheb M.K. Patil, Hon'ble Minister of State of Rural Development, Govt. of India and Dr. A.G. Sawant, Chairman, Agricultural Scientists Recruitment Board, New Delhi.

Dr. P. Ramasundarm, Sr. Scientist, Agril. Economics received an award consisting of cash prize and certificate for his article 'WTO and its Implication for Indian Agriculture' in a national contest conducted by Indine Institute of Public Administration, New Delhi on Oct. 25, 2002 during the general body meeting from his Excellency T. N. Chaturvedi, Governor of Karnataka and Vice President of Indian Institute of Public Administration

Dr. Kumudini Nautiyal, Assistant Director (O.L.) has been awarded Munshi Premchand Puraskar by the Maharashtra Rajya Hindi Sahitya Academy for her book '*Rajani Gandha Kee Mahak*' for the year 2002-03. The Honourable Chief Minister of Maharashtra, Shri Sushil Kumar Shinde gave her the award at a puraskar ceremony of the Maharashtra Rajya Hindi Sahitya Academy held on 4th November, 2003 at Sahydri Hall, Mumbai. This state level award carries Rs. 25,000/- and a citation.

Dr. Mahendra Singh Yadav, Technical Officer, has won a prize at the prestigious Dr. Homi Bhabha Vigyan Lekh Pratiyogita 2002, on science literature in Hindi jointly conducted by Hindi Vigyan Sahitya Parishad and Rajbhasha Karyanvayan Samiti of Bhabha Atomic Research Centre, Mumbai. Dr. Yadav bagged the prize for this article entitled " Transgenic Bt Cotton : a promising technology for increasing cotton production" presented at the competition.

Dr. Hemchandra Gajbhiye, Principal Scientist and Head of Extension Section, was honoured by the Department of Agriculture, Govt. of Maharashtra on December 23, 2002 at Nagpur for his outstanding contribution in the field of agricultural extension for the benefit of cotton growers in Maharashtra State.

The honour was bestowed on him in the form of "*Samman Patra*" at the hands of Ms. Sunita Gawande, President Zilla Parishad, Nagpur on the occasion of *Kisan Samman Diwas*.

Dr. Kumudini Nautiyal receiving Munshi Premchand Puraskar at the hands of Hon'ble Chief Minister of Maharashtra, Shri Sushilkumar Shinde.

Dr. H L Gajbhiye, receiving first prize at the hands of Shri Govindrao Adik, Minister of Agriculture, Govt. of Maharashtra.

Dr. P Ramasundaram, receiving award at the hands of His Excellency T.N.Chaturvedi, Hon'ble Governor of Karnataka.

Dr. Y. S Nerkar, Chairman, RAC addressing the scientists

ICAR

Linkages and Collaborations in India and abroad including externally funded projects

NATIONAL

Areas of Linkages	Institution
Fibre testing and quality evaluation	CIRCOT
Multilocation testing of promising cultures	AICCIP centers
Germplasm collection and maintenance	NBPGR
Seed technological research and breeder seed production	NSP
Evaluation of advanced cultures and germplasm for resistance to soil salinity	CSSRI (RS) Anand
Evaluation of suitable plant type for mechanical harvesting	CIAE, Bhopal
Development of Cry 1 A(a) gene construct	NBRI
Supply of gene construct and molecular evaluation of transgenic plan.	NRC Plant Biotechnology
DNA finger printing of cotton	NRC DNA Finger Printing
Testing of indigenous cotton bollworms pheromones	BARC

INTERNATIONAL

Areas of Linkages	Institution
Germplasm collection, conservation and documentation	IPGRI, Rome, Italy
Sustainable control of the cotton bollworm *Helicoverpa armigera* in small scale production system	Central Cotton Research Institute, Pakistan Narjing Agricultural University, China Rothamstead Agricultural Experimental Station, UK Natural Resources Institute, UK

All India Coordinated Cotton Improvement Project

Brief Report of Activities

Plant Breeding

- A total of 10 National Trials were conducted during 2002-03.
- In Br-02 (a) trial (IET) of irrigated *G.hirsutum* the first five entries, selected based on the seed cotton yield are LH.1960, H.1242, F.2009, GSHV.97/612, and CSH.7106.
- In the Preliminary conventional intra-hirsutum Hybrid trial, Br-05 (a)-1, the first five hybrids are ZCH.21405, Sandocot-708, VBCH.2204, DHH.355 and Nimbkar-215.
- In the Br-05 (a)-2 of irrigated MS based hirsutum hybrid trial, VICH.504, PSCHH.213, ARCHH.7010, Navkar-95 and Sandocot.175 were in the top five.
- In Br-15a H X B hybrid trial, RAHB.37, DHB.904, DHB.903, JKCHB.212 and RAHB.16 were the top five entries.
- In Br-22 a/b IET of *G.arboreum* entries, HD.424, LD.807, MDL.2582 and GAM.107 and DLSA.201 were the top five.
- In Br-25 trial for *G.arboreum* hybrids, the first five were BCAH.805, GSGDH. 7, JKDH.505, GSGDH.6 AND FMDH.3.
- In the *G.herbaceum* evaluation under Br-34, RAHS.101, GBhV.220, RBDV.17, DDhC.20, DDhC.22 came in the top five, local check being in third position.
- In rainfed *G.hirsutum* trial for varieties (Br-2b), the first five were ARB.757, GSV.99/305, NH.594, GBHV.153 and CCH.510-4.
- In the rainfed Preliminary conventional intra-hirsutum Hybrid trial, Br-05 (b)-1, the first five were ARB HH.351, DHH. 354, VBCH. 2204, BSSCH.489 and CH.1134.
- In the Br-05 (b)-2 of RAINFED MS based hirsutum hybrid trial, NRCH.976, VCHH.1037, Sancocot.395, ZCH.21409 and ARCHH.6940 reached the top five entries.

Agronomy, Physiology And Biochemistry

- Deep tillage once in two years followed by deep + conventional tillage produced significantly higher seed cotton yields under Ludhiana condition and was found optimum under Faridkot, Hisar and Sriganganagar.
- Integrated nutrient management with 50 % RD-NPK + FYM @ 10 t/ha + foliar spray of recommended nutrients at Faridkot, Hisar, Sriganganagar, Lam (Guntur) and Srivilliputur; RD-NPK + FYM @ 10 t/ha at Khandwa, Akola , Rahuri, Indore, Siruguppa and Coimbatore; RD-N + FYM @ 10 t/ha at Surat and RD-NP at Mathura were found optimum in sustaining higher cotton productivity.
- Combined application of nutrients viz. RD-NPK, DAP @ 2 %, KCl @ 1%, micronutrient spray @ 1 % and topping at 15th node at Srivilliputur, and without topping at Coimbatore maximized the seed cotton yield.
- Similar to N (but unlike of P) foliar application of K showed good response to seed cotton yield at Hisar whereas application of N in three splits (¼ + ½ + ¼ at sowing, 30 and 60 DAS respectively) maximized the cotton yield at Siruguppa.

- Incorporation of wheat residues sustained yields of both cotton and the succeeding wheat crop at Hisar while crop residues incorporation along with FYM @ 5 t/ha was the optimum at Lam (Guntur).
- Integrated weed management involving pendimathalin along with hoeing was found efficient in controlling weeds and getting higher cotton yield at Faridkot and Siruguppa.
- A new herbicide Galaxy (ready mix of clomazone 15 % + pendimathalin 30 %) along with hand weeding and twice hoeing was the best weed control package at Indore. Hand weeding followed by trifloxysulfuron @ 10 g/ha at Khandwa and Rahuri while hand weeding twice followed by Galaxy @ 2 l/ha (Pre-emergence) were the best at Coimbatore.
- Cotton-wheat followed by cotton-barley at Ludhiana and cotton-wheat followed by cottongram at Faridkot are the most sustainable cropping systems.
- Cotton sown on mid-April after harvest of December planted onion is the best sequential cropping system under Rahuri condition.
- Intercropping of cotton and potato at 1:1 as well as 3:1 row proportions and paired row system gave higher income and yield of cotton over sole cotton/potato at Dharwad.

Entomology

- Pink bollworm *Pectinophora gossypiella* was considerably high and caused damage to bolls and locules.
- The incidence of whitefly was very low in spite of prolonged dry weather.
- Jassid infestation caused considerable damage in central zone and cultures showed resistant reaction.
- New seed treatment chemicals such as thiamethoxam 600 FS, chlothianidine 600 FS were tested against sucking pests and they were found effective up to 50 days.
- Among the chemicals tested against bollworm Emamectin benzoate was found effective and remained on par with indoxacarb.
- In bio-pesticide trials, though the pesticide recorded less damage as compared to untreated check, they remained on par with endosulfan in reducing bollworm.
- In the chemical control of bollworm, there was increased incidence of mealy bug ranging from 26 to 61.2 per cent. The maximum infestation of mealy bug (61.2 % plants) was recorded in spinosad treatment.

Plant Pathology

- This year's experiment once again showed that early infection of CLCuV at 30 45 days could lead to more than 50 per cent loss in seed cotton yield.
- Several CLCuV resistant lines and hybrids have been identified.
- Several lines resistant to bacterial leaf blight, *alternaria* leaf spot and *myrothecium* leaf spot have been identified through screening.
- Seed treatment with Vitavax 200 FF 2 3.0ml/kg seed as well as soil amendment with neem cake gave good control of root rot.
- Seed treatment with talc powder formulation of *Pseudomonas fluorescens* Pf1 and CHAO strains @ 10g/kg followed by foliar spray @ 0.2% gave effective control of bacterial blight at Hisar.

Krishi Vigyan Kendra

One hundred and eight trainings were conducted for 1933 practicing farmers, 794 rural youth and 692 extension functionaries.

Training Achievements

S. No.	Discipline	No. of Courses	No. of Participants		
			Practising Farmers	Rural youth	Extension Functionaries
1	Agronomy	25	674	110	348
2	Horticulture	18	326	119	73
3	Veterinary Science	18	146	202	13
4	Extension	15	553	104	20
5	Home Science	16	137	214	-
6	Crop Protection	16	97	45	238
	Total	**108**	**1933**	**794**	**692**

Scientific Advisory Committee (SAC) Meeting

The sixth Scientific Advisory Committee Meeting of KVK held on dated 21.03.2003. Dr. S K Banerjee, Principal Scientist, CICR, Nagpur chaired the meeting. Dr. M K Hedge, Zonal Coordinator, Zone-IV, Hyderabad and officials from State Sericulture and State Fisheries department attended the meeting. Dr. S N Rokde, I/c KVK presented the progress report of KVK. Dr. Hedge visited different units i.e. Vermicompost, NADEP, Nutrition Garden, Fruit Cafetaria and Fruit Park, Evaporative Cool Chamber, Osmanabadi Goat unit, preservation unit, etc., established at KVK farm. He also visited different demonstrations in the adopted villages of KVK.

Front Line Demonstrations

Front Line Demonstration for pulses (pigeonpea variety AKT 8811) in Kharif and chickpea (HNPV) conducted included 20 farm families with 0.40 ha area each. An average increase of 30.68% in yield of pigeonpea and 62.36% of chickpea was recorded.

FLDs on Cotton (NHH 44) on 4.8 ha irrigated area and 3.6 ha rainfed area were conducted on 4 and 3 farmers fields respectively in adopted villages (Wakeshwar and Waranga). Despite more than 20 days dry spell in the month of July, 2002 and less rainfall, there was an average increase in yield to the tune of 16% and 20% under irrigated and rainfed conditions respectively over local check.

Two off campus FLDs on Okra (*Parabhani ranti* on 1 ha area have been conducted during *Kharif* and *Rabi* season in KVK adopted villages. In these demonstrations an average increase of 35.8% in fruit yield was noticed. The B:C ratio was 1:3.0 over local check. These progressive farmers have not used any chemical fertilizers.

Front Line Demonstration (FLDs) of KVK on *Helicoverpa armigera* Management in Chickpea (2002-03)

In Rabi season, three off campus FLDs Chickpea (Vijay) on of 2.4 ha area (irrigated) and 2.4 ha (Rainfed) have been conducted, that resulted in an average increase of 45.9%

and 30.8% in grain yield in irrigated and rainfed situation, respectively.

In Kharif crop season off campus FLDs on cotton on eight ha have been conducted.

Ten off campus FLDs on Integrated Nutrient Management (INM) Technology were conducted. Under these demonstrations an average increase of 14.6% in yield of seed cotton (cotton-hybrid) Ankur-651 was observed.

Another ten off campus FLDs on Integrated Pest Management (IPM), low cost pest management technology was demonstrated.

Promotion of *Desi* cotton hybrid through NATP-HCP demonstration

Five cotton hybrids PKV-4, CAHH-99, H-10, AKDH-7, G.Cot.MDH received from CICR were introduced in KVK adopted villages viz. Wakeshwar and Waranga. These demonstrations undertaken on two farmer's field on 1.20 ha area was visited by more than 100 farmers.

Promotion of bio-fertilizers through RBDC demonstrations

KVK, CICR has developed a strong linkage with Regional Biofertilizer Development Corporation Centre, Nagpur and jointly organised FLD on Biofertilizer in Soybean and Pigeonpea crops on the fields of 8 farmers in Wakeshwar, Waranga and Thisti Villages. It was observed that were was an increase in yield by 10.29 to 13.63% by using biofertilizers.

Other Demonstration

On farm demonstration units

Demonstration units of Goat, Mushroom, Vermi-compost, Bioagents, NADEP compost, Zero Energy Cool Chamber, Floriculture and Fruit Garden have already been started at KVK. The role and importance of these units was explained to visiting farmers, rural women, rural unemployed youth, extension functionaries and other visitors. Several trainees have been imparted skill oriented on campus trainings through these units.

On campus Crop demonstrations

Forty six crop demonstrations on cotton, chickpea, soybean, fodder crops viz. Lucerne, maize, jowar, vegetables and fruits were undertaken. The production and protection technologies of these crops were demonstrated on area ranging from 0.2 to 1 hectare. Large number of farmers from Nagpur district visited these demonstrations and were benefited.

Establishment of fruit garden.

Fruit garden of Orange and Sweet Orange on about 2.5 acre of land at KVK was established and 6 acre of land was covered by the fruit crops in KVK adopted villages.

Adaptive trials and client oriented trials

Five adaptive trials demonstrating innovative technologies on production and protection of crops and livestock were undertaken on the farmer's fields by providing critical inputs.

Extension Activities

Eight field days were organised during 2002 -03 wherein 2602 farmers have participated. Two *Kisan Goshthis* were arranged and 142 farmers participated in them. Seven radio talks and three television shows on various topics of agriculture, animal sciences and other allied subjects were given. A Total of four film shows on various topics of agriculture, animal science and other allied subjects were screened benefiting 215 farmers. Two on-campus trainings were arranged for animal treatment, vaccination and spraying for ectoparasitic control wherein 122 animals were treated and sprayed for ectoparasitic control while 67 animals were vaccinated.

Farmers Exposure Visit

A team of KVK organised an exposure visit to 50 farmers of Telgaon and Tishti villages distt. Nagpur to Dr. PDKV, Akola for 2 days

covering experimental fields on Drip Irrigation in Cotton, Oilseeds and Pulses and Sugarcane as well as Watershed, hybrid and varietal demonstration.

The team also visited Bhagora and Anbhora villages of Murtizapur Taluka to get acquainted with various IPM and INM activities implemented on farmer's fields and Vermicompost Units.

Agriculture diversification

Fruit plantation other than citrus has been promoted. Besides, Mushroom unit, Sericulture, Goat Unit, Dairy Unit establishment, floriculture, vermicompost unit were initiated. Goat, Floriculture, Vermicompost and Mushroom production activities have been well received by farmers of all the villages and they are now in demand.

Resource generation

Imparting the trainings and demonstrations to the farmers and Rs. 53227/- through the sale of 26 goats, fruits, flowers, vegetables, mushroom, spawns and preserved products etc. by KVK was generated.

Diagnostic Survey

Seventeen diagnostic surveys in adapted villages and other villages of Nagpur district were undertaken to suggest the remedies to overcome specific problems in crops, animals and mushroom production covering 27 hectare crops area, 134 animals and 5 units of mushroom.

Consultancy, Patents, Commercialization of Technology

Nagpur

The following genotypes/germplasm lines were registered with National Bureau of Plant Genetic Resources, New Delhi,

- A Cotton Leaf Curl Virus resistant genotype of G. *hirsutum* (CNH-123) belonging to race *latifolium* as INGR No. 02021
- A germplasm line (30838) of G. *arboreum* as INGR No. 02020. This germplasm line is immune to grey mildew.
- A newly developed GMS line LRA 5166 of G. *hirsutum* as INGR No. 02012

Coimbatore

Breeder seed production of the following varieties have been taken up and would be commercially sold to the Seed Producers as per the Government of India allotment.

No	Name of Variety/ Parent of Hybrid	Production Centre	Target 2002-03 (q)	
			Indent	Production
1	Savitha	CICR, Coimbatore		
	T7		0.38	0.60
	M12		0.21	0.45
2	LRA 5166	CICR, Nagpur		1.53
		JDA, Coimbatore		2.36
		CICR, Coimbatore		0.66
		TOTAL	2.99	4.55
3	ANJALI	CICR, Nagpur		0.50
		CSF, Sindhanoor		2.04
		CICR, Coimbatore		0.60
		TOTAL	2.07	3.14
4	MCU5 VT	SSF, Pongalur	1.36	3.30
5	SURABHI	CICR, Coimbatore	0.71	1.62
6	SUPRIYA	do	1.00	1.00 (exp)
7	SUVIN	do		0.50

Significant decisions of RAC, IMC, SRC Meetings

Research Advisory Committee (RAC)

The annual meeting of Institute's Research Advisory Committee was held on 2nd and 3rd June, 2002 at CICR, Nagpur under the Chairmanship of Dr. Y.S. Nerkar, Ex. VC, MPKV, Rahuri. The following members attended the meetings :

Dr. S.S. Narayanan, Dr. V.C. Patil, Dr. K.C. Jain, Dr. C.D. Mayee and Dr. M.R.K. Rao, Member Secretary.

The proceedings were approved by the ICAR. The following are some of the major recommendations.

- For registration of a variety/hybrid, DUS testing as per the guidelines of ICAR should be made mandatory.
- Components of precision farming be identified for good fibre quality alongwith higher productivity.
- Impact of major minor/micro nutrients on fibre quality be worked out.
- For efficient rain water harvesting, appropriate technologies be developed in collaboration with agricultural engineers for reducing/checking evaporative losses, so as to optimize storage of harvested rain water.
- The valuable material developed by CICR through introgression should serve as a base material for increasing productivity.
- Publications on the impact of extension activities and economic/risk analysis in the form of bulletins be brought out.
- Cytoplasmic genetic male sterile system has to be emphasized more in the development of hybrids. Broadening of CMS base for evolving productive CMS hybrids should be looked into.
- Development of superior quality *arboreum* lines comparable to *hirsutum* could strengthen the productivity and adoption pattern of *desi* cotton in the country. Exculsive *arboreum* cotton growing villages should be selected and feedback should be sought upon for improving boll weight and picking quality.
- Breeders of the Crop Improvement Division should also be involved in the transference of Bt genes to some important elite lines and also study the over all performance and fibre quality and may use them in superior hybrid development.
- Agr. Engineer may be encouraged to develop a battery operated spindle/ suction based picking unit with proper efficiency and trash free picking.
- CICR to get actively involved in genomics and protenomics research and collaborate in the global network of International Cotton Genome initiative workshop to be held in India next year.

Staff Research Council (SRC)

The Annual Staff Research Council meeting was held on April 27 and 28, 2002 at CICR, Nagpur under the Chairmanship of Dr. C.D. Mayee, Director to discuss the results of the work carried out during 2001-02. All the scientists from CICR, Nagpur presented achievements made in each project carried out during 2001-02. Progress of research in each project was critically reviewed and research programme for 2002-03 year was finalized after discussion. Two new project proposal were presented and approved after discussion.

Institute Management Committee (IMC)

Institute Management Committee meeting was held twice during 2002-03 on 18th June, 2002 and 3rd Feb. 03 at CICR, Regional Station Sirsa and Coimbatore respectively under the Chairmanship of Dr. C.D. Mayee. The proceedings of both the meetings were approved by the ICAR.

The following are the major recommendations:

- IMC approved to write off Rs. 53,500/- towards the loss incurred due to fire of dry Kadba fodder, one thatch shade and Red gram crop on 27.02.2000.
- The Committee expressed their satisfaction and agreed for continuation of farm development work.
- The committee approved the progress of budget of plan and Non-plan of 2002 2004 and expenditure upto January 15th, 2003.

ICAR Standing Committee for TMC Mini Mission I

The 4th meeting of ICAR Standing Committee for TMC Mini Mission I was held on July 31, 2002 at CICR, Nagpur under the Chairmanship of Hon'ble Dr. Panjab Singh, Secretary, DARE and Director General, ICAR, New Delhi. The meeting was attended by Dr. Mangala Rai, DDG (Crops), Dr. J.S. Samra, DDG (NRM), Dr. Anwar Alam, DDG (Engg.), Dr. S. Sreenivasan, Director, CIRCOT and the other nominated members from CCI, ICMF and State Agricultural Universites. The meeting was convened to discuss work done during 2001-02, finalization of the MM-I projects for Tenth Plan period and identification of significant technologies from MM-I trials.

Dr. Panjab Sigh, Chairing the meeting, welcomed the idea that the end users need to participate in the production process to get desirable quality raw material. He desired that there should be constant group meetings of the various Mini Missions to formulate action plan within and among various Mini Missions.

Dr. C.D. Mayee, Director, CICR and Member Secretary, Standing Committee, MM-I presented the progress carried out in 23 projects across 28 centers during 2001-02 and the significant work done in the target area of improvement of fiber quality, productivity and reduction in the cost of production. Issues like quality raw material supply, contract farming, denotification of obsolete cotton cultivars were discussed in great detail.

Participation of Scientists in Seminars/ Symposia/ Conferences/ Workshops/ Meetings

Sr. No.	Seminars/ Symposia/ Conferences/ Workshops/ Meetings.	Place & Date	Participant (s)
1.	Review meeting of IVLP	Coimbatore 02 April, 02.	S Usha Rani
2	Annual Workshop of IVLP	Hyderabad April 5-7, 2002	Dr. H Gajbhiye
3.	Zonal Workshop on ITK	Bhubaneshwar April 11, 2002	Dr. H Gajbhiye
4.	Annual workshop of NATP-PSR 26	CICR, RS, Sirsa, 10 April, 2002.	Dr. Sheo Raj Dr. N K Taneja
5.	Seminar on Drought and Water Resources	Nagpur, 16 April, 2002	Dr. S M Wasnik
6.	Scientific Advisory Panel Meeting of Irrigated Agro-Eco- System - NATP projects	NDRI, Karnal 16-17 April, 2002	S Usha Rani
7.	Annual Review Workshop for Technology Mission on Cotton - Mini Mission I	Nagpur 24 April, 2002	Dr. C D Mayee Dr. Sheo Raj Dr. P M Mukewar Dr. H L Gajbhiye Dr. S M Wasnik Dr. N K Taneja
8.	A Review meeting of NATP-MM project on "Development of Hybrid Crops - Cotton"	CICR, Nagpur 30th April, 2002	Dr. C D Mayee Dr. V Gotmare Dr. S Vennila Dr. N K Taneja Dr. S K Banerjee Dr. Suman Bala Singh
9.	Front Line demonstration meeting	CICR, Nagpur 29th May, 2002	Dr. P Singh
10.	DUS testing meeting	IARI, New Delhi 4th June, 2002	Dr. P Singh
11.	Biological Control of Lepidopteran pests 2002	PDBC, Bangalore, July 17-19, 2002.	Dr. N K Taneja
12.	DUS testing meeting	IARI, New Delhi 5-8 Aug.,2002	Dr. P Singh
13.	Monitoring and Evaluation Workshop of TAR-IVLP projects	Coimbatore 08 Aug., 02	S Usha Rani

14.	National Workshop on Technology assessment and Refinement through IVLP	Dharwad Sep.3-5, 2002	Dr. H Gajbhiye S Usha Rani
15.	Winter school on Management Development for Sustainable Agricultural Production	IARI, New Delhi 10 to 30 Sept., 2002	S Usha Rani
16.	Zonal Group Meeting - NATP Plant Bio-diversity	NRC for Citrus, 19-20 Sept., 2002	Dr. VVSingh Dr. Punit Mohan Dr. T R Loknathan
17.	Zonal Workshop on Training Planning	Nagpur Sep. 20-21, 2002	Dr. H Gajbhiye
18.	Workshop on biosafety issue related to genetically modified organism	Bhopal 27 Sept., 2002	Dr. A B Dongre
19.	Review meeting of NATP-MM Project on Development of Hybrid Crop - Cotton	CIFE, Mumjbai 30th Sept 6th Oct., 2002	Dr. T R Loknathan
20.	Training programme on Testing of Distinctness Uniformity and Stability for plant variety protection	IARI, New Delhi 4 to 10 Oct., 2002	Dr. K Rathinavel
21.	National level Review meeting of PSR projects of NATP Coastal Agro-ecosystem .	NRC Oilpalm, Pedavegi, (AP) 7-9, October, 2002.	Dr. N Gopalakrishnan
22.	Review meeting of NATP-MM Project on Development of Hybrid Crop - Cotton	CRIDA, Hyderabad 21-22nd Oct. 2002	Dr. Suman Bala Singh
23.	Symposium on Major Plant Diseases and their Management	Nagpur 29-30 October, 2002	Dr. C D Mayee Dr. P M Mukewar Dr, N K Taneja Sh. M K Meshram
24.	67th Annual Congress of IISS	JNKVV, Jabalpur 11-15 Nov., 2002	Dr. J V Singh Sh. M S Deshmukh
25.	2nd Meeting of Asian Cotton Research and Development Net Work	Tashkent Nov. 14-16, 2002	Dr. P Singh
26.	National Seminar on Genetically modified crop	Akola, 19 -20th Nov 2002	Dr. A B Dongre
27.	National Seminar on Prospects of GM Crops in India	Nagpur 23rd Nov.,2002	Dr. P Singh, Dr. V V Singh Dr. R K Deshmukh Dr. S B Singh Dr. T R Loknathan Dr. Punit Mohan Dr. D K Agarwal

			Dr. Vinita Gotmare Dr. O P Tuteja Dr. S K Verma
28.	International Agronomy Congress	New Delhi 26-30 Nov., 2002	Dr. K S Bhasker Dr. J V Singh Dr. D Blaise Er. G Majumdar
29.	Training programme on Rapid, Relaxed and Participatory Rural Appraisal to identify Farm Problems so as to prepare Need Based Research and Extension Action Plans.	CRIDA, Hyderabad 04 to 12 Dec, 2002.	S Usha Rani
30.	International seminar on communication and sustainable development in agriculture	Varanasi 7-9 January, 2003	Dr. S M Wasnik
31.	2nd International congress of Plant Physiology	IARI, New Delhi 8-12, January, 2003.	Dr. N K Perumal,
32.	Brain-Storming Session on Entomopathogenic nematodes	PDBC, Bangalore on Jan. 22-23, 2003	Dr. Nandini Gokte-Narkhedkar
33.	Cotton Breeder's meeting	CICR (R.S.) Coimbatore 3 Feb., 2003	Dr. P Singh, Dr. V V Singh
34.	Symposium on Trends in Immunology	Nagpur 6th Feb, 2003.	Dr. A B Dongre
35.	Mid-term Review Workshop onITK	Nagpur Feb. 6, 2003	Dr. H Gajbhiye
36.	National Seminar on Responding to Changes & Challenges : New Roles of Agricultural Extension	Nagpur Feb.7-9, 2003	Dr. H Gajbhiye Dr. S M Wasknik
37.	Meeting of Foundation for Agriculture and Rural Development and Environmental Security	Nagpur 10th Feb.,2003	Dr. P Singh
38.	Seminar on Cotton Productivity and Quality in Vidarbha	Nagpur Feb.10, 2003	Dr. M R K Rao Dr. H Gajbhiye
39.	6th Agricultural Science Congress on the theme Multi-Enterprise Systems for Viable Agriculture,	Bhopal 13-15 February, 2003	Dr. S M Wasnik
40.	Annual Workshop of TMC MMG-1	Nagpur Feb. 21, 2003	Dr. H Gajbhiye Dr. S M Wasnik
41	Zonal Group Meeting-cum-Orientation Training of NATP Plant Biodiversity Zone-IX	JNKVV, Jabalpur 26 Feb., 2003	Dr. V V Singh Dr. Punit Mohan

42.	Annual group meeting of NSP	Udaipur 2-4 March, 2003	Dr. P Singh Dr. K Rathinavel
43.	Annual Review Meeting of Project TMC-MMC Evaluation of Soil Site and Series Suitability for Cotton Based Cropping Systems in India'	Nagpur 7 March 2003	Dr. S M Wasnik
44.	World Cotton Research Conference	Cape Town, South Africa, 9-13, March, 2003	Dr. C D Mayee, Dr. S K Banerjee, Dr. K R Kranthi
45.	Workshop of the project, MME-4-Development of effective biocontrol agents and molecular techniques to improve antagonists.	PDBC, Bangalore 10th March 2003	B Dhara Jothi
46.	National Workshop for review of NATP-Coastal Agroecosystem projects PSR mode .	CTCRI, Thiruvananthapuram 17-18, March, 2003	Dr. N Gopalakrishnan
47.	TMC - MME I Project Review meeting and Programme finalization for future implementation	NCIPM New Delhi 20th March, 2003	Dr. T Surulivelu.
48.	Annual Workshop of IVLP	Kanpur Mar.21-22, 2003	Dr. H Gajbhiye
49.	Annual Group Meeting of TMC MMA-5	CICR, Nagpur 24 Mar., 2003	Dr. P Singh Dr. D K Agrawal Dr. T R Loknathan
50.	Annual Group Meeting of TMC MM1	CICR, Nagpur 25-26 March, 2003	Dr. P Singh, Dr. V V Singh, Dr. R K Deshmukh, Dr. S B Singh, Dr. T R Loknathan, Dr. Punit Mohan, Dr. D K Agarwal, Dr. V Santhy, Dr. Vinita Gotmare Dr. P M Mukewar Dr. H L Gajbhiye Dr. S M Wasnik
51.	Seminar on Role of Cost Efective Ginning in Production of Clean Cotton Bale and Scientific Processing of Cotton Seed	GTC, Nagpur March 28, 2003	Dr. P Singh Dr. V V Singh Dr. T R Loknathan Dr. D K Agarwal Dr. A B Dongre Dr. H L Gajbhiye Dr. S M Wasnik

Workshops/ Seminars/ Summer Institutes/ Farmer's Day Organised

Nagpur

Rashtriya Kapas Mela-2002

Rahstriya Kapas Mela (National Cotton Fair)-2002 was organized by CICR Nagpur on Dec.7, 2002. Sh. Nitin Gadkari, Leader of Opposition, Legislative Council, Maharashtra while delivering the inaugural address stressed on improving human resources in agriculture and said that it was possible within the government system if proper management is followed but that requires proper attitude, approach and vision. In his Address, Dr. Sharad Nimbalkar, Vice-Chancellor, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola told the farmers that it is for them to decide what they need from agriculture research institutes. They must be keen to avail the best technologies which require minimum input cost. Dr. A. G. Sawant, Chairman, Agriculture Recruitment Board, New Delhi, in his Presidential Address, stressed on switching to precision farming through proper management at every step.

Dr. C.D.Mayee, Director, CICR in his welcome Address informed about the technologies available with the Institute. He advocated introduction of Bt gene in cotton varieties, that would be more advantageous for farmers as they will be able to produce their own Bt seed.

Sixteen men and women farmers were feted for outstanding performance in cotton production. This national fair was attended by more than 1,500 farmers from all major cotton growing States of India. More than 25 companies put up their stall in the Exhibition arranged for the farmers and visitors.

Farmers Conclave on Bt Cotton

More than 150 farmers from all over Maharashtra and adjoining places in M.P. attended the conclave on Bt cotton organized at the Central Institute for Cotton Research, Nagpur on Apr.19, 2002. The farmers were sensitized on the concept of transgenic cotton and its production. Dr. C.D. Mayee, Director, CICR in his inaugural address pointed out that the Bt technology is very good but that could solve only *Heliothis* problem. He also stressed on introducing Bt gene in variety that would be more advantageous to farmers. Dr. Hemchandra Gajbhiye, Principal Scientist & Head Extension moderated farmer-scientist interaction.

Coimbatore

"Farmers' Day" was celebrated at Chinnaputhur village of Dharapuram Taluk, Erode district on 23rd December 2002 to commemorate the centenary celebration of Choudhary Charan Singh (Hon'ble Former Prime minister of India).

Sirsa

A Kisan Diwas was organised at CICR RS, Sirsa on 20-12-2002, to enlighten the farmers about the Bt cotton. Dr. C.D. Mayee presided over the function and demonstrated the Bt detection kit to farmers.

Shri Nitinji Gadkari, Leader of opposition, MLC, addressing the farmers at Rashtriya Kapas Mela.

View of the audience

Farmers visiting Krishi Vigyan Kendra.

Shri B S Grewal, Member, Management Committee, addressing participants of training course.

ICAR

Distinguished Visitors

Name & Designation	Organisation	Date
Nagpur		
Dr. S. S. Magar, Vice Chancellor	Dr. BS Konkan Krishi Vidyapeeth, Dapoli	12.04.2002
Dr. Y. S. Nerkar, Ex. Vice Chancellor, MPKV & Chairman, RAC, CICR	Mahatma Phule Krishi Vidyapeeth, Rahuri	22.04.2003
Dr. Amerika Singh, Director	NCIPM, New Delhi	22.04.2003
Dr. Panjab Singh, Secretary, DARE & Director General	Indian Council of Agricultural Research, New Delhi	31.07.2003
Dr. Mangala Rai, DDG(CS)	Indian Council of Agricultural Research, NewDelhi	31.07.2003
Dr. J. S. Samra, DDG (NRM)	Indian Council of Agricultural Research, New Delhi	31.07.2003
Dr. Anwar Alam, DDG (Eng.)	Indian Council of Agricultural Research, New Delhi	31.07.2003
Dr. S. Sreenivasan, Director	CIRCOT, Mumbai	31.07.2003
Ms. Shashi Misra, Addl. Secretary, DARE & Secretary, ICAR	Indian Council of Agricultural Research, New Delhi	22.08.2003
Dr. S. Nimbalkar, Vice Chancellor	Dr. PDKV, Akola	28.09.2003
Dr. Amerika Singh, Director	National Centre for Integrated Pest Management, New Delhi	29.10.2003
Dr. S. M. Paul Khurana, Director	Central Potato Research Institute, Shimla	29.10.2003
Dr. H. S. Sen, Director	Central Research Institute for Jute & Allied Fibres, Barrackpur	29.10.2003
Dr. Rip Landes, Sr. Economist	USDA, USA	22.11.2002
Dr. Thomas Vollrath, Sr.Economist	USDA, USA	22.11.2002
Dr. Stephen Mc Donald, Cotton Specialist	USDA, USA	22.11.2002
Shri Nitin Gadkari, Leader of opposition	Maharashtra Legislative Assembly, Mumbai	07.12.2002

Dr. A.G. Sawant, Chairman	ASRB, New Delhi	07.12.2002
Dr. Sharad Nimbalkar, Vice Chancellor	Dr. PDKV, Akola	07.12.2002
Dr. N. Arumugam, Director	Vasantrao Naik Institute of Agricultural Management Training	07.12.2002
Dr. S.B. Mahapatra, Secretary	Ministry of Textiles, Govt. of India, New Delhi	10.01.2003
Mr. Ashwini Kumar, IAS, Managing Director	MSSCL, Akola	18.01.2003
Dr. R. N. Singh, Director	NEERI, Nagpur	01.03.2003
Dr. V. Nossov, Coordinator	IPI, Russia	21.03.2003
Coimbatore		
Dr. M.K. Nair, Retd. Director	CPCRI, Kasaragod	26.07.2002
Dr. M.R. Sethuraj, Retd. Director	Rubber Board	26.07.2002
Dr. Mohan Naidu, Retd. Director	Sugarcane Breeding Institute, Coimbatore (Peer Review Team of NATP)	26.07.2002
Dr. S. Nagarajan, Director	Indian Agricultural Research Institute, New Delhi	06.12.2002
Dr. K.C. Jain, ADG (CC)	Indian Council of Agricultural Research, New Delhi	30.01.2003
Shri B.S. Grewal Shri N.N. Thengre	Members of CICR Management Committee	03.02.2003
Sirsa		
Dr. B.S. Dahiya, Director of Research	CCS HAU, Hisar	17.07.2002
Dr. Rakesh Mittal Dy. Director General (SG)	ICMR, New Delhi	28.08.2002
Dr. T.V. Ramanaiah, Scientist F	DBT, New Delhi	28.08.2002
Dr. R.K. Trivedi, Assistant Commissioner (Seeds)	DAC, Krishi Bhavan, New Delhi	28.08.2002
Dr. K.K. Garg, Additional Director	Ministry of Environment of Forests, Regional Office, Chandigarh.	28.08.2002
Shri Balbir Singh Grewal	Member of CICR Management Committee	20.12.2002

Personnel

Name of Officer/Scientist	Designation
CD Mayee	Director
TP Rajendran (Joined on 18.11.02)	Project Coordinator (Cotton) & Head
Plant Breeding -	
Nagpur	
Phundan Singh	Head Crop Improvement Divn
V V Singh	Principal Scientist
Mrs Suman Bala Singh	Senior Scientist
TR Loknathan	"
DK Agarwal	Scientist (Sr Scale)
Coimbatore	
KN Gururajan-	Principal Scientist
Sirsa	
SL Ahuja	Sr. Scientist
OP Tuteja	"
SK Verma	"
Genetics & Cytogenetics	
Nagpur	
SB Nandeshwar	Sr. Scientist
VN Waghmare	"
Mrs Vinita Gotmare	Scientist (Sr.Scale)
Coimbatore	
S Manickam	Scientist (Sr. Scale)
Mrs KPM Dhamayanthi	"
Seed Technology	
Nagpur	
RK Deshmukh	Pr. Scientist
Mrs PRV Kumari (on deputation)	Sr. Scientist
Mrs V Santhy	Scientist
Coimbatore	
K Rathinavel	Sr Scientist
Sirsa	
RA Meena	Sr Scientist
Economic Botany	
Nagpur	
Punit Mohan	Sr Scientist
Agronomy	
Nagpur	
KS Bhaskar	Pr. Scientist
Blaise	Sr. Scientist

AR Raju	Scientist
Coimbatore	
CS Praharaj	Sr. Scientist
Mrs P Nalayani	Scientist (Sr.Scale)
K Sankaranarayanan	"
Soil Science	
Nagpur	
Jagvir Singh	Sr. Scientist
Agril Engineering	
Nagpur	
G Majumdar	Scientist (Sr.Scale)
Plant Pathology	
Nagpur	
Sheoraj	Head, Crop Protection Division
MK Meshram	Pr. Scientist
PM Mukewar	"
NK Taneja	"
RC Ukey	Sr. Scientist
PK Chakrabarty (on post doctoral fellowship)	"
Coimbatore	
A Kannan	Pr. Scientist
P Chidambaram	"
Sirsa	
Dilip Monga	Sr. Scientist
Entomology	
Nagpur	
SK Banerjee	Pr. Scientist
TP Rajendran (Joined as PC on 18.11.2002)	"
TV Kathane (Vol. Retired on 31.01.2003)	Scientist (Sel. Grade)
KR Kranthi	Senior Scientist
Mrs S Kranthi	"
Mrs S Vennila	"
Coimbatore	
T Surulivelu	Pr. Scientist
K Natarajan	"
Mrs B Dhara Jothi	Sr. Scientist
Sirsa	
P. Jeyakumar	Scientist
Nematology	
Nagpur	
Mrs Nandini Narkhedkar	Sr. Scientist

Plant Physiology	
Nagpur	
MRK Rao	Head, Crop Production Division
NK Perumal	Pr. Scientist
KB Hebbar	Sr. Scientist
Coimbatore	
SESA Khader	Sr. Scientist
AH Prakash	Scientist (Sr. Scale)
Biochemistry	
Nagpur	
AB Dongre	Pr. Scientist
Mrs Mukta Chakrabarty	Scientist (Sel. Grade)
Coimbatore	
N Gopalakrishnan	Pr. Scientist
Biotechnology	
Nagpur	
G Balasubramani	Sr. Scientist
Mrs J Amudha	Scientist (Sr. Scale)
Agril Extension	
Nagpur	
HL Gajbhiye	Pr. Scientist
SM Wasnik	Sr. Scientist
Coimbatore	
Miss Usha Rani	Scientist
Agril Economics	
Nagpur	
P Ramasundaram	Sr. Scientist
Mrs Isabella Agarwal	Scientist (Sr.Scale)
Computer Appli.	
Coimbatore	
M Sabesh	Scientist
Agril Statistics	
Nagpur	
CD Ravindran - Transferred to CIRCOT on 29.06.2002	Sr. Scientist
Krishi Vigyan Kendra	
Nagpur	
SN Rokade	Sr. Scientist
Administrative Officer	
UC Prasad	
Finance & Accounts Officer	
Prashant Kumar	

Other Information

Infrastructure facilities developed:

Nagpur

- Created additional godown facilities near cold storage for storing experimental material related to male sterility project
- Created fencing facilities for DUS testing (about 6 hectares)
- Renovation of seed testing, germplasm, cytogenetic and male sterility laboratories and air-conditioning cytogenetic, germplasm and molecular laboratories

Sirsa

- Construction of approach road to the main station entrance
- Renovation of laboratories
- Erection of fencing on the back side of regional station boundary
- Construction of garages for the residential quarters
- Connection of overhead tank to office building and residential quarters
- Development of trainees hall and museum (nearing completion)

Video cassette on Cotton released

A video cassette on "Advances in cotton production technology' was released at the hands of Dr. Panjab Singh, Secretary, DARE and Director General, Indian Council of Agricultural Research on Jul.31, 2002. The video cassette is specially produced in Marathi for the benefit of cotton growers in Maharashtra.

Audio cassette on cotton released

Dr. Y.S.Nerkar, Director, Vasantdada Patil Sugar Institute, Pune and Chairman, Research Advisory Committee, CICR Nagpur released the audio cassettes on cotton production in Marathi on Apr.23, 2002.

National Science Day 2003

CICR celebrated 'National Science Day' on March 1,2003 on the theme 'DNA 50 years-IVF 25 years - A blue-print of life, as suggested by Department of Science and Technology. The programme was organized with a view to spread recent advances on biotechnological tools among students and other officials. Speaking on the occasion Dr. R. N. Singh, Director, NEERI and Chief guests narrated various discoveries in science, its evolution and its benefit to mankind. In his Presidential address Dr. Mayee, said that the judicious use of science has to percolate to common man so that 30-35% people below poverty line could be benefited by scientific achievements by prosperity of human beings.

To mark the event an Essay Competition on 'Role of Bio-technology in Agriculture Development' was organized in CICR campus on 24th February 2003 for the undergraduate students of Nagpur University.

Cotton Front-Line Demonstrations

The programme has been implemented under direct supervision of Dr. R. K. Deshmukh, Dr. M. K. Meshram and Dr. S. M. Wasnik at Masala village in Chikani circle of Warora Tahsil of the Chandrapur district. Agro-techniques viz row cropping/plant spacing, use of vermi-compost, foliar application of NPK, foliar application of organic spray like Kamdhenu and animal urine, application of fungicide for control of bacterial blight diseases, intercropping of mung, cow-pea, soybean and integrated nutrient management has been demonstrated at farmers field. On an average farmers harvested 4.44 q/ha cotton yield in variety LRK 516 (Anjali).

Exhibition KISAN-Indian Agricultural Trade Fair-2002

CICR participated in the National Exhibition Indian Agriculture Trade Fair 2002 KISAN organized by Deccan Exhibitors Pvt. Ltd during December 11-15,2002 at Govt. college of Engineering grounds, Shivaji nagar, Pune. CICR demonstrated effective environment friendly pest and disease management technologies and improved cotton cultivation. The other aspects like importance of quality seeds, improved crop management practices, intercropping systems, rainwater harvesting at watershed basis and biotechnological techniques were demonstrated through posters. Dr. S. M. Wasnik, Sr. Scientist (Extension) coordinated the CICR exhibition stall during the period.

Library

Additions

The Library procured 343 books, 75 scientific reports and bulletins 66 reprints on cotton and subscribed 35 Indian and 30 foreign journals and CD-ROM database.

Documentation Services

A. Bibliographic database on cotton

Library has developed computerized bibliographic database on cotton to provide comprehensive and update information on cotton. About 2035 bibliographic references along with abstracts have been stored in it. Documentation Service such as Current Awareness Service, SDI service, Specific subject search service have been provided by sorting out the database. Using the database also brings out 'Cotton Research Abstracts' a documentation bulletin.

B. Current Title Service

Library has provide Current Title Service by subscribing Current Contents with abstracts on disk from I.S.I. Philadelphia.

C. CD-ROM database Retrieval Service

Bibliographic information on cotton and other crops on various aspects are being retrieved and downloaded as per the users demand. The following CD-ROM databases were used to retrieve the information.

1.	CABCD	1972-2002
2.	CROPCD	1973-1998
3.	AGRICOLA	1975-2000
4.	AGRIS	1975-2001

D. Newspaper Clipping Service

Clippings on various aspects related to cotton from local and national newspapers have been compiled and made available for references.

E. Library Automation

Library Application Software has been procured and so far 450 books have been computerized and Barcodes assigned for the same.

WEATHER

Nagpur

Month	Temperature (°C)		Relative humidity (%)		Rainfall	No. of rainy days
	Max.	Min.	Max.	Min.	(mm)	
June 2002	36.7	26.5	69.0	46.6	354	13
July 2002	33.9	25.9	73.3	51.3	74	4
Aug. 2002	29.3	23.9	89.2	78.2	353	20
Sept. 2002	31.1	23.1	84.4	58.6	113	9
Oct. 2002	34.0	18.6	73.3	34.0	21	2
Nov. 2002	31.9	15.9	70.6	32.0	-	-
Dec. 2002	32.3	14.2	75.2	37.0	-	-
Jan. 2003	30.5	13.8	69.9	38.3	-	-
Feb. 2003	32.8	17.9	71.3	44.0	33	4

Coimbatore

Month	Temperature (°C)		Relative humidity (%)	Rainfall	No. of rainy days
	Max.	Min.	Max.	(mm)	
Aug. 2002	31.2	22.6	82	64	8
Sept. 2002	33.2	22.0	88	20	2
Oct. 2002	31.1	22.7	90	163	8
Nov. 2002	29.2	21.8	89	17	9
Dec. 2002	30.3	18.0	87	2	1
Jan. 2003	30.9	18.5	85	0	0
Feb. 2003	32.6	21.2	83	9	1
March-2003	34.4	22.1	86	119	4

Sirsa

Month	Temperature (°C)		Relative humidity (%)		Rainfall	Rainy days
	Max.	Min.	Max.	Min.	(mm)	
April 2002	42.8	-	49	23	-	-
May2002	45.8	-	45	27	40.4	2
June2002	43.6	-	48	35	29.5	3
July 2002	41.8	-	60	40	5.8	1
Aug. 2002	39.8	-	68	50	10.2	1
Sept. 2002	36.8	-	70	53	4.2	1
Oct. 2002	38.6	-	66	55	-	-
Nov. 2002	31.4	-	62	26	-	-
Dec. 2002	27.5	-	71	26	29.0	2

NATIONAL COTTON SCENARIO

State-wise area, production and productivity figures for the year of report and the preceding year are presented below:

State-wise cotton area, production and productivity

Zone/State	2001-2002			2002-2003		
	Area (Lakh ha)	Prod. (Lakh bales)	P (kg/ha)	Area (Lakh ha)	Prod. (Lakh bales)	P (kg/ha)
North Zone						
Punjab	5.10	9.00	300	4.25	8.00	320
Haryana	6.30	5.25	142	5.35	8.50	270
Rajasthan	5.10	5.75	192	3.35	4.50	228
Central Zone						
Gujarat	16.87	33.50	338	14.98	30.50	346
Madhya Pradesh	6.23	19.75	539	5.50	18.00	556
Maharashtra	30.41	33.50	187	27.99	24.00	146
South Zone						
Andhra Pradesh	10.02	27.50	467	9.00	20.00	378
Karnataka	5.97	8.00	228	3.62	06.00	282
Tamil Nadu	1.65	5.00	515	1.15	04.00	591
Others	0.86	0.75	148	0.53	01.00	321
Total						
Loose cotton consumed but not counted for in State-wise prod.		10.00	-		11.50	
Grand Total	**88.51**	**158.00**	**303**	**75.72**	**136.00**	**305**

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

Source : Office of the Textile Commissioner, Mumbai.

राजभाषा उन्नयन गतिविधियाँ

i. राजभाषा कार्यान्वयन समिति की तिमाही बैठकें डा. चारुदत्त मायी की अध्यक्षता में दि. 13.05.2002, 14.08.2002, 28.12.2002 व 07.05.2003 को आयोजित की गई।

ii. भारत सरकार, गृह मंत्रालय, राजभाषा विभाग के अंतर्गत नगर राजभाषा कार्यान्वयन समिति, नागपुर के तत्वावधान में आयोजित वर्ष 2001–2002 के लिए हिन्दी पत्रिका प्रकाशन एवं राजभाषा प्रचार–प्रसार में उत्कृष्ट योगदान के लिए संस्थान की पत्रिका श्वेत स्वर्णिमा को प्रोत्साहन पुरस्कार के रूप में प्रशस्तिपत्र प्रदान किया गया है। यह पुरस्कार 21 फरवरी 2003 को आयोजित पुरस्कार वितरण समारोह में महात्मा गाँधी अंतर्राष्ट्रीय विश्वविद्यालय, वर्धा के पूर्व प्रति उपकुलपति श्री असित सिन्हा के हस्ते प्रदान किया गया।

iii. संस्थान में 2 से 17 सितंबर 2002 तक हिन्दी पखवाड़ा का आयोजन किया गया जिसमें विविध प्रतियोगिताएँ व कार्यक्रम आयोजित किए गए। जिसका समापन हिन्दी दिवस के रूप में 17 सितंबर, 2002 को पुरस्कार व प्रमाणपत्र वितरण के साथ किया गया।

iv. संस्थान के क्षेत्रीय केन्द्र, कोयंबतूर में दि. 12 से 28 जनवरी, 2003 तक हिन्दी सप्ताह का आयोजन किया गया । जिसके अंतर्गत विविध प्रतियोगिताएँ व कार्यक्रम आयोजित किए गए, जिसका समापन दि. 4 फरवरी, 2003 को हिन्दी दिवस के रूप में पुरस्कार वितरण के साथ किया गया।

v. संस्थान के क्षेत्रीय केन्द्र, सिरसा में दि. 16 सितंबर, 2002 को हिन्दी दिवस का आयोजन किया गया, जिसमें विविध प्रतियोगिताएँ व कार्यक्रम आयोजित किए गए।

vi. केन्द्रीय कपास अनुसंधान संस्थान, नागपुर में दि. 23 जुलाई, 2002 को हिन्दी कार्यशाला का आयोजन किया गया। यह कार्यशाला विशेष रूप से प्रशासनिक कर्मचारियों के लिए रखी गई जिससे सरकारी कामकाज में हिन्दी का प्रयोग करते समय आने वाली समस्याओं का समाधान हो सके।

vii. संस्थान के क्षेत्रीय केन्द्र, सिरसा में दि. 19 जून, 2002 को हिन्दी कार्यशाला का आयोजन किया गया। यह कार्यशाला प्रशासनिक कर्मचारियों के लिए हिन्दी में सरकारी काम करने की झिझक को दूर करने के उद्देश्य से रखी गई।

viii. डा. कुमुदिनी नौटियाल, सहायक निदेशक (राजभाषा) ने राजभाषा विभाग, गृह मंत्रालय, भारत सरकार के केन्द्रीय हिन्दी प्रशिक्षण संस्थान, नई दिल्ली द्वारा दि. 08–12 अप्रैल 2002 तक आयोजित अभिमुखीकरण कार्यक्रम में भाग लिया।

ix. 'श्वेत स्वर्णिमा' (वार्षिक) व 'कपास समाचार' (तिमाही) का प्रकाशन किया गया।

कार्यकारी सारांश

फसल सुधार

नागपुर

- *जी. हिर्सुटम* के 625 बीजकोश (आनुवंशिक एवं भौगोलिक विविधता) संकलन, 400 उपयोगी संकलन, 1540 मूल संकलन, 580 विदेशी, 130 नये संकलन और 1200 वंशावलियाँ पुनर्उत्पादन के लिए उगाई गई और उनका आर्थिक व रेशे के गुणों के लिए मूल्यांकन किया गया।
- *जी. हिर्सुटम* व जी. अर्बोरियम की 100 वंशावलियों के दो समूहों के समन्वित परीक्षण (बी आर 01) के अंतर्गत नागपुर (बारानी), सिरसा व कोयंबतूर (सिंचित) में परीक्षण किया गया और प्रत्येक जाति की 10 श्रेष्ठ वंशावलियों को पहचाना गया।
- *जी. हिर्सुटम* की 930 व *जी. हर्बेशियम* की 530 वंशावलियों को शीतगृह में संग्रहित किया गया।
- अमरीकन कपास का कपास पत्ती मोडक रोग अवरोधी संवर्धन सी एन एच 123 और *जी. अर्बोरियम* का सलेटी धब्बा के लिए असंक्राम्य संवर्धन 30838 दोनों को एन बी पी जी आर में पंजीकृत किया गया। जिनका क्रमशः आई एन जी आर नं. 02021 व 02020 है।
- *जी. अर्बोरियम* के संवर्धन सी आई एन ए 316 को बी आर 22 से बी आर 24 में बढाया गया और एक नये संवर्धन सी आई एन ए 318 की राष्ट्रीय परीक्षण बी आर 22 ए व बी में सम्मिलित किया गया।
- *अर्बोरियम* किस्म ए के ए 8401 की गहरी मृदा व अधिक वर्षा, गहरी मृदा व कम वर्षा तथा उथली मृदा व कम वर्षा के अंतर्गत अच्छी पैदावार आँकी गई। अन्य किस्म जवाहर ताप्ती की मध्यम मृदा व कम वर्षा में अच्छी पैदावार आँकी गई।
- पाँच अंतः हिर्सुटम बी.टी. संकर (आर सी एच 2, आर सी एच 20, आर सी एच 134, आर सी एच 138व आर सी एच 144) तथा उनके गैर बी.टी. संकरों का मूल्यांकन किया गया। चैक की तुलना में बी.टी. संकरों की बेहतर पैदावार आँकी गई।
- एल आर ए 5166 का एक कुंतल तथा अँजली के 51 कि.ग्रा. प्रजनक बीज का उत्पादन किया गया।
- नर बंध्यता कार्यक्रम में 36 सी एम एस, 7 आर व 13 जी एम एस लाइनों का अनुरक्षण किया गया। चार जी एम एस संकर जैसे एन जी एम एस एच 11–03, एन जी एम एस एच 13–03, एन जी एम एस एच 1–03 व एन जी एम एस एच 7–03 आशाजनक पाये गये। एक जी एम एस संकर सी एन एच एच जी 2003 समन्वित परीक्षण (बी आर 05 सी बी 2) में प्रविष्ट किया गया। समन्वित परीक्षणों में सम्मिलित करने के लिए जी एम एस आधारित दो संकरों के संकर बीज का उत्पादन किया गया। एल आर ए 5166 की जी एम एस में परिवर्तित वंशावली को एन बी पी जी आर में आई एन जी आर नं. 02012 में पंजीकृत किया गया।
- मिजोरम, उड़ीसा व आंध्रप्रदेश में तीन अन्वेषण किए गये। संकलित 268 नमूनों में *जी. हिर्सुटम* के 80, *जी. अर्बोरियम* के 119, *जी. हर्बेशियम* के 41, *जी. बार्बेडेंस* के 25 व जिनकी पहचान नहीं हुई 3 हैं।
- के.क.अनु.सं., नागपुर में विकसित *जी. अर्बोरियम* के तीन उन्नत संवर्धन जैसे – सी आई एन एच 316, सी आई एन एच 323 बी व सी आई एन एच 329 के पंजीकरण का प्रस्ताव किया जा रहा है। इन संवर्धनों (कल्चर) में अधिक गूलर वजन, जल्दी तैयार होना, रेशे की मध्यम लंबाई, रेशे की अधिक मजबूती व लोक्यूल धारण क्षमता अधिक है।
- चार संकरण जैसे – पी 3 x एस पी 3892 (सी), एल एल 56 x एस पी 3892 (सी), एस पी 4626 x एस पी 3892 (सी वाई) तथा बदनावर x एस पी 3892 सी सी

सूखा सहिष्णु पाये गये। दो संवर्धन जैसे – डी एस टी 25 व डी एस टी 28 मृदा लवणता के लिए सहिष्णु पाये गये। दो नए संवर्धन जैसे सी एन एच 3003 व सी एन एच 3004 को समन्वित राष्ट्रीय परीक्षण (बी आर 02 ए व बी) में जाँच के लिए भेजा गया।

- *जी. हिर्सुटम* की 25 जननद्रव्य वंशावलियों में बीज तेल की मात्रा 15–24.9%, जी. *अर्बोरियम* की 16 जननद्रव्य वंशावलियों में 20.1 से 24.7%, *जी. हिर्सुटम* के 13 उन्नत संवर्धनों में 19.2–23% तथा जी. *अर्बोरियम* के चार संवर्धनों में 18.5–20.8% थी।
- झाड़ीनुमा की तुलना में बौने व सुगठित जीनप्ररूपों से कपास की समान या बेहतर पैदावार मिली। झाड़ीनुमा समूह में जी जे एच वी 163, जी जे एच बी 337, पी एच 802, सी एन एच 132 व के एच 117 बेहतर थे। सुगठित जीनप्ररूपों जैसे एन डी एच 1010, एन डी एच 1001, पूसा 802 व सी पी डी 745 ने बेहतर पैदावार दी।
- वातावरणीय परिस्थितियों में नौ महीने तक भंडारित करने पर पी के वी संकर 4 ने अधिकतम 80.8 % अंकुरण दिया। इसी तरह किस्मों में सुमंगला ने अधिकतम अंकुरण प्रतिशत 79.8% दिया।

कोयंबतूर

- उत्तरी क्षेत्र में किये गये समन्वित संकर परीक्षणों में संकर सी सी एच एच 10555 ने कपास की 23.9 कु./है. की औसत उपज दी तथा सामान्य संकर एल एच एच 144 की 22.0 कु./है. की तुलना में दूसरे स्थान पर रहा।
- अखिल भारतीय समन्वित कपास सुधार परियोजना (अ.भा.स.क.सु.प.) के परीक्षणों में संवर्धन सी सी एच 4 ने मध्य क्षेत्र (25.79 कु./है.) व दक्षिणी क्षेत्र (13.29 कु./है.) दोनों ही परीक्षणों में अधिकतम पैदावार दी। यह संवर्धन अल्टरनेरिया पत्ती धब्बा रोग के लिए भी अवरोधी पाया गया।
- संवर्धन सी सी एच 526612 ने कपास की 24.6 कु./है. की औसत पैदावार दी और समन्वित परीक्षणों में एम सी यू 12 (22.1 कु./है.) व सुमंगला (22.9 कु./है.) दोनों से अच्छा रहा।
- अंतर प्रजातीय संततियों (9 x 1) x 14 बी x 4)–3 की कपास की पैदावार 28.5 कु./है. (चैक किस्म सुमंगला 18.9 कु./है.), आई आर एच 1–9–131 की 29.0 कु./है. (चैक किस्म एल आर ए 5166, 15.8 कु./है.), 12–32 एच एस –(3) की 28.4 कु./है. (चैक किस्म एल आर ए 5166, 15.8 कु./है.), आई आर एच 1–10–(3) की 37.9 कु./है. (चैक किस्म एल आर ए 5166, 21.3 कु./है.) ने चैक किस्मों की तुलना में उल्लेखनीय रूप से अधिक पैदावार दी।
- प्राकृतिक परिस्थितियों में, चार वर्ष पुराने बीजों को हेलोजन आधारित फार्मुलेशनों से उपचारित करने पर बीज गुणता में सुधार देखा गया। क्लोरीन या आयोडीन के उपचार से बीज की अंकुर क्षमता में क्रमशः 11% व 9% का सुधार देखा गया।
- रेशारहित कपास के बीजों को पॉलीकोट की परत चढ़ाना, एक स्टार्च आधारित पानी में घुलने वाले पोलीमर से 1 कि.ग्रा. में 5 मि.ली. की दर से बीज कोटिंग करने से बिना कोटिंग के बीज की तुलना में अंकुरण में 5% तक की उल्लेखनीय वृद्धि हुई।

सिरसा

- उपज व गुणता मानदंडों के आधार पर किए गए परीक्षणों में संकर सी एस एच एच–198 सबसे अच्छा पाया गया। *जी. हिर्सुटम* के 175 सी एम एस संकरणों में से 128 संकरणों ने उर्वरता पुनः स्थापन प्रदर्शित किया। एक जी एम एस आधारित संकर सी एस एच एच जी 966 को अ.भा.स.क.सु.प. के राष्ट्रीय परीक्षणों में बहुस्थानिक परीक्षणों के लिए सम्मिलित किया गया।
- संकर सी आई एस ए एच 3 (एम एस आधारित) जिसके रेशे की लंबाई 24 मि.मी. से भी अधिक है इसका अ.भा.स.क.सु.प. के राष्ट्रीय परीक्षणों में अच्छा प्रदर्शन देखा गया। लंबी रूई की विभेदों और स्थानीय

किस्मों के संकरण से बनाये गये संकर जिसकी स्पान लंबाई 25 मि.मी. से अधिक है की पहचान की गयी । *जी. अर्बोरियम* के 25 मि.मी. अधिक स्पान लंबाई व 21 ग्रा/टेक्स मजबूती के कुछ संकरों को पहचाना गया।

- जब फसल को 120 x 90 सें.मी. में लगाया गया और बुवाई के 45 दिनों बाद 2% डी ए पी, 50 दिनों बाद 1% एम जी एस ओ4 का 60 दिनों बाद बोरोन 0.1%, 75 दिनों बाद 2% जेड एन एस ओ4 का 2% छिडकाव किया गया, किस्मों के बीज की उपज व गुणता में उल्लेखनीय वृद्धि देखी गई।
- संकरण कार्यक्रम के लिए उपज व गुणता की दृष्टि से 15 अगस्त से 25 सितबर का समय उपयुक्त पाया गया। जब मादा जनक के बीजों को बुवाई से पूर्व 6 घंटों के लिए के एच2 पी ओ4 (100 पी पी एम) में डुबोकर रखा गया तथा बुवाई के 60, 75 व 90 दिनों की अवस्था पर 1% एम जी एस ओ4 के घोल का छिडकाव किया गया तब संकरित गूलर विकास प्रतिशत, गूलर वजन, बीज/गूलर, बीज सूचकांक, बीज अंकुरण व ओज में सुधार देखा गया।

जैव प्रौद्योगिकी

नागपुर

- आर ए पी डी विश्लेषण से लगभग 100 जननद्रव्य वंशावलियों का विश्लेषण किया गया।
- 25 पृथक जननद्रव्य वंशावलियों (जी. हिर्सुटम) तथा 23 जँगली जातियों का ए व बी समूह के साथ 19 आई एस एस आर प्राइमर्स व 40 रेन्डम प्राइमर्स का उपयोग करते हुए विश्लेषण किया गया।
- सलेटी धब्बा अवरोधी व सुग्राह्य किस्मों में बहुरूपता स्थापित करने के लिए आर ए पी डी विश्लेषण किया गया।
- संकरों की अनुवांशिक शुद्धता की जाँच के लिए मॉलिकुलर डाइग्नोस्टिक टूल के विकास की दृष्टि से संकर के कुछ जनकों से यूनीक एम्प्लीफाइड बैंड्स का विगलन किया गया और अनुक्रम के लिए उसे क्लोन किया गया।
- एल आर ए 5166 व एल आर के 516 के अधिक संख्या में प्युटेटिव ट्रांसफार्म्ड पौधे जिसमें बी टी क्राई 1 एसी का समावेश है के प्ररोह अंग–विकास व भ्रूण कक्ष द्वारा पुनर्उत्पादित किए गए।
- पारजीनी पौधों में एलिसा जाँच के आधार पर जीन समाकरण व अभिव्यक्ति की पुष्टि हुई।
- आर जी 8 पौधों में क्राई 1 (ए) बी के द्वारा अधिक मात्रा में बी.टी. प्रोटीन की अभिव्यक्ति देखी गई।
- जँगली व खेतिहर द्विगुणित व चतुर्गुणित अंतर जातियों के बीच कुछ चयनित संकरण किए गए। जिनमें गूलर जमाव में उल्लेखनीय रूप से वृद्धि हुई।

फसल उत्पादन

नागपुर

- अधिकांश आकृतिक व कार्यिकीय मापदंडों के लिए विविधता देखी गई। आर डब्लू सी व अन्य आकृतिक मापदंडों की तुलना में पौधे के बायोमास व शुष्क भार का उपज के साथ अधिक व धनात्मक संबंध पाया गया। पत्ती क्षेत्रफल का बायोमास के साथ धनात्मक संबंध पाया गया।
- मौसम, मृदा व फसल आदानों (2002–03 खेत परीक्षण से) जैसे कपास उगाये जाने वाले विभिन्न सस्य जलवायु क्षेत्रों में बुवाई की तीन तिथियाँ तथा चार नत्रजन स्तर के आधार पर इन्फोक्रोप मॉडल को प्रमाणित किया गया।
- कपास के साथ अरहर की पट्टियों में अंतः फसल 8:2 व 6:2 कपास : अरहर, के रूप लगाना प्रमुखता से पाया गया। इस तरह अरहर की अंतः फसल पट्टियों में लगाने से किसानों को बगैर किसी अतिरिक्त खर्च के अपने परिवार की पोषकता की आवश्यकता की पूर्ति के साथ ही आर्थिक लाभ भी प्राप्त होता है।
- कपास के दोनों जीनप्ररूपों में रासायनिक उर्वरकों के साथ गोबर की खाद के उपयोग से कपास की उपज बेहतर आँकी गई। फसलकाल के दौरान आर्द्रता प्रतिबल

के कारण पोषक तत्वों के अनुप्रयोग का उपज में स्पष्ट अंतर नहीं देखा गया।

- मृदा में 90 x 60 सें.मी. की दूरी पर सूक्ष्म पोषक तत्वों के अनुप्रयोग की तुलना में 60 x 60 सें.मी. पर देने से शुष्क पदार्थ की उपज बेहतर हुई। मृदा में अनुमोदित उर्वरक के साथ सूक्ष्म पोषक तत्वों के अनुप्रयोग से फसल के तैयार होने की अवस्था के समय ना., फा. व पोटाश की उपलब्धता में वृद्धि हुई।
- 50% एफ सी से तुलना करने पर विभिन्न नमी प्रवृत्तियों पर नाइट्रोजन खनिजीकरण के आँकड़ों से उद्घाटित हुआ कि उर्वरक की अनुमोदित मात्रा जिसमें 5 टन फार्म यार्ड खाद तथा आई एन एम 75% एफ सी (नमी प्रवृत्ति) ने शुष्क पदार्थ, कपास की पैदावार में वृद्धि, ना., फा. व जिंक उद्ग्रहण और ना. के एन ओ 3 – एन के रूप में खनिजीकरण में बेहतर प्रभाव पाया गया।
- भूमि विन्यास का प्रभाव, नमी संरक्षण तकनीक जैसे मेंढ़ व नाली पद्धति अपनाने से बारानी परिस्थितियों की मध्यम गहरी मृदा में लाभदायक प्रभाव मिला और इससे मृदा में 3–4% नमी में वृद्धि हुई। आई एन एम उपचार में हरी खाद जैसे लोबिया, मूंग या सनई की अंतः फसल लगाकर पलवार के रूप में प्रयोग करने से किसानों की पद्धति की तुलना में उथली मृदा में 4–6% व मध्यम गहरी मृदा में 3–5% नमी प्रतिशत, नाइट्रोजन की उपलब्धता व जैविक कार्बन के बनने में वृद्धि हुई।
- जुताई पद्धतियों में (टी 1 : पारंपरिक जुताई, टी 2 : कम जुताई व टी 3 : कम जुताई–2), टी 1 सबसे अच्छा विकल्प पाया गया। कपास जीन प्ररूपों की जुताई पद्धतियों के प्रति अनुक्रिया में भिन्नता नहीं देखी गई। 60 कि.ग्रा. ना./है. की तुलना में 75 कि.ग्रा. ना./है. अनुप्रयोग करने से कपास की उपज में उल्लेखनीय वृद्धि देखी गयी।
- आठ वर्ष पूर्ण होने पर मृदा में पोषक तत्वों के स्तर का मूल्यांकन किया गया। सामान्यतः, आँकड़ों के अनुसार पोषक तत्वों में मृदा की गहराई के साथ उनके स्तर में ह्रास (0–0.1, 0.1–0.2, 0.2–0.3, 0.3–0.6 व 0.6–0.9) देखा गया। आधुनिक उर्वरीकरण पद्धति की तुलना में जैविक पद्धति में जैविक कार्बन व पोषक तत्वों का बनना उल्लेखनीय रहा केवल लौहा व मैगनीशियम को छोड़कर। अधिकांश संचय ऊपरी सतह 0–0.3 मी. पर पाया गया। संष्लेशित की तुलना में जैविक प्लाट में कपास की पैदावार थोड़ा अधिक पायी गयी।
- जैविक सामग्री के साथ फास्फोरस का संयोजन के रूप में उपयोग करने से फास्फोरस की उपलब्धता अधिक पायी गयी।
- सूक्ष्म पोषक तत्वों के लिए किए गये मृदा के विश्लेषण से पता लगा कि नागपुर जिले में जिंक की कमी पायी गई जबकि यवतमाल व हिंगोली में 30% फार्म नमूनों में जिंक की कमी देखी गई। लोहा, मेग्नीज व तांबा की मात्रा क्रांतिक सीमा से ऊपर पायी गई।
- 14 किसानों के खेतों में परीक्षण किए गए। किसानों द्वारा अपनाई जा रही पद्धति की तुलना में सर्वश्रेष्ठ प्रबधन पद्धति जैसे हरी खाद + चौड़ी क्यारी + उर्वरक की अनुमोदित मात्रा + सीमित पोषक तत्व में बेहतर पौध वृद्धि (पौध ऊँचाई, शुष्क पदार्थ), अधिक संख्या में खुले हुए गूलर तथा उल्लेखनीय रूप से अधिक पैदावार पायी गई।
- बैल चलित 2 पंक्ति का कॉटन प्लांटर जिसका पहले विकास किया गया था और आशाजनक पाया गया था का गाँव संपर्क कार्यक्रम के अंतर्गत फिर से जाँच की गई। इस प्लांटर से मैनुअल डिबीलिंग तरीके की तुलना में थोड़ा अधिक पैदावार से लाभ का अनुपात अधिक पाया गया।
- सिरसा में सिंचित परिस्थितियों के अंतर्गत कपास – गेहूँ पद्धति में *ए. क्रोकोकम* ताप सहिष्णु विभेद एच टी–54 (i) ने पूरे मौसम में बेहतर प्रदर्शन किया, इसमें 65% उर्वरकों की अनुमोदित मात्रा की अपेक्षा कपास की पैदावार 16% अधिक पायी गयी जो सांख्यिकीय रूप से 100% उर्वरक की अनुमोदित मात्रा के समान थी।
- 75% उर्वरकों की अनुमोदित मात्रा के उपयोग के साथ एजोस्प्रिलम + पी एस बी के बीज उपचार करने से उपज और

बायोमास में उल्लेखनीय सुधार देखा गया। उपलब्ध पोषक तत्वों के साथ बायोमास के उत्पादन व रूपांतरण के लिए 50 व 75% उर्वरकों की अनुमोदित मात्रा के उपचारों द्वारा मृदा नमी अधिक दक्षता से उपयोग की गई जो दोनों वर्षों में कपास की पैदावार के स्तर के रूप में सामने आयी।

- बायो इनोक्यूलेंट्स जैसे एजोस्प्रिलम विभेदों द्वारा बीज उपचार से कपास की उपज में 235–391 कि.ग्रा./है. की उल्लेखनीय वृद्धि हुई।
- एक जगह पर दो पौधे लगाने से कपास की पैदावार अधिकतम (18.75 कु./है.) प्राप्त हुई इसके बाद एक जगह पर तीन पौधे लगाने से 17.58 कु./है. की पैदावार मिली और एक जगह पर एक पौधा लगाने से 13. 66 कु./है. की सबसे कम पैदावार मिली।

कोयंबतूर

- 75 x 60 सें.मी. के अंतराल और उर्वरकों के अनुमोदित स्तर के 125 % का उपयोग और भिंडी को अंतः फसल के रूप लगाना बी टी संकर कपास के लिए सबसे अच्छा पाया गया। यह बुवाई देरी से करने की परिस्थिति के लिए भी अच्छा था।
- मृदा में लौह तत्व (50 कि.ग्रा./है. की दर से एफ ई एस ओ4) के उपयोग से ओटाई प्रतिशत उल्लेखनीय रूप से अधिक पाया गया। बोरेक्स के 5 कि.ग्रा./है. की दर के उपयोग से रेशे की 2.5% स्पान लंबाई उल्लेखनीय रूप से बढ़ी। गौण व सूक्ष्म पोषक तत्वों के उपयोग द्वारा माइक्रोनियर, रेशे की मजबूती व दीर्घीकरण उल्लेखनीय रूप से प्रभावित नहीं हुए।
- किसी भी एग्रोकेमिकल्स ने राइजोस्फीयर में फास्फोबैक्टीरिया की वृद्धि को अवरुद्ध नहीं किया। हालांकि कार्बेंडाजिम के अलावा अन्य दूसरे सभी एग्रोकेमिकल्स ने एजोस्पायरिलम की वृद्धि को रोका।
- कपास की सुरभि किस्म की 0.8 ई टी सी व 1.2 ई टी सी पर समान अधिक उपज थी। गर्मियों में बूँद–बूँद सिंचाई से उपज 28.9 से 61.5% तक बढ़ी। जल उपयोग क्षमता ड्रिप सिंचाई परिस्थिति में 8.8 से 15.8 कि.ग्रा./है. सें.मी. थी जबकि पूर सिंचाई में यह केवल 4 कि.ग्रा./है. सें.मी. थी।
- शीतकाल में, ड्रिप सिंचाई से 1.0 ई टी सी पर सिंचाई करने से सविता की कपास की उपज बढ़ी तथा यह 0.8 ई टी सी के समान थी लेकिन 0.6 ई टी सी व पारंपरिक सिंचाई से बेहतर पाई गई। ड्रिप सिंचाई द्वारा 1.0 ई टी सी सिंचाई करने पर पारंपरिक सिंचाई की तुलना में लगभग 3 कुतल उपज अधिक हुई। शीत ऋतु में ड्रिप सिंचाई के कारण जल उपयोग क्षमता पारंपरिक सिंचाई की 12.8 कि.ग्रा./है. सें. मी. की तुलना में 56.7 से 62.9 कि.ग्रा./है. सें.मी. पायी गई।
- कपास की एकल फसल की तुलना में कपास–ज्वार फसल पद्धति अपनाने से कपास व ज्वार की क्रमशः 79.2 व 4.3 कु./ है. की उपज हुई। (10 वर्षों के आँकड़ों के आधार पर) इसका कारण पौधों की अधिक वृद्धि व विकास, बेहतर उपज गुण व जड़ बायोमास तथा खरपतवारों की कम संख्या और इसका कम वजन रहा।
- गोबर की खाद 15 टन/है. के साथ फास्फोरस व पोटाश 19 व 37 कि.ग्रा./है. का संयोजन वार्षिक रूप से देने से कपास व ज्वार दोनों की उत्पादकता स्तर को बनाए रखा जा सका इसके बाद गोबर की खाद 5 टन/है. के साथ ना.फा.पो. क्रमशः 30, 13 व 25 कि.ग्रा./है. देने से उत्पादकता का स्तर संस्तुत प्रक्रियाओं के समान रहा।
- कोयंबतूर क्षेत्र की काली मटियार दुमट मिट्टी (थोड़ी क्षारीय) में लगातार कपास व ज्वार या ज्वार की खेती करने से फास्फोरस व पोटाश की उपलब्धता कम हुई, यद्यपि जैविक कार्बन व उपलब्ध नाइट्रोजन इस मिट्टी में थोड़ा अधिक था।

फसल संरक्षण

नागपुर

- 234 एफ1 संकरणों में से एफ2 के 79, एफ3 के 36, एफ1 के 43, एफ2 के 10 व एफ3 के 5 एकल पौध वरणों ने चूषक कीटों व बालवर्म के प्रति सहिष्णुता प्रदर्शित

की तथा साथ ही इसके रेशे की गुणता भी अच्छी थी।

- रेगमस स्पी. की मिरिड बग जिसे सामान्यतः टारनिश्ड प्लांट बग कहते हैं और इसे कपास का गौण कीट समझा जाता है यह बहुत अधिक मात्रा में बढ रहा है और इससे नुकसान देखा गया।
- नाशीकीटों की पहचान करने, उनकी संख्या या नुकसान का पता लगाने, आर्थिक नुकसान सीमा के आधार पर कीट नियंत्रण सलाहकारों जैसे प्रसार कार्यकर्ताओं द्वारा कीटनाशीय नियंत्रण उपायों की जानकारी देने के लिए भारतीय कपास नाशीकीट प्रबंधन पर कॉट आई पी एम नामक एक एक्सपर्ट सिस्टम का विकास किया गया।
- समयानुसार कीडों के व्यवहार (जीवन प्रक्रिया) का अध्ययन करने के लिए लाइट व फेरोमोन ट्रेप द्वारा एक टाइम सार्टिंग यंत्र का विकास किया गया है।
- अनुपचारित पौधों की तुलना में इमिडाक्लोप्रिड से बीज उपचार करने पर इंटरनोडल दीर्घीकरण में 42% की वृद्धि हुई, कली लगने के पहले तीन सप्ताहों में कलियों की अधिक संख्या और गूलरों के भार में 26% की वृद्धि देखी गई।
- किस्मों के संदर्भ में सी. क्लोरिडी से हे. *आर्मीजेरा* की विभेदक परजीवीकरण के परिणाम स्वरूप फसल फिनोलाजी में भिन्नता के कारण परपोषी एवं परजीव्याभ की संख्या के मध्य विभेदक समकालिक स्थापित हुआ।
- नाशीकीटों से होने वाला नुकसान जिससे बचा जा सकता था एल आर ए 5166 में 28.93% तथा एन एच एच 44 में 32.02% पाया गया।
- बालवर्म के नियंत्रण और कपास की उपज बढाने के लिए नये मालिक्यूल्स की तुलना में स्पिनोसेड व इमेमेक्सिन बेंजोएट (11 ग्रा. सक्रिय तत्व/है.) का उपचार बेहतर पाया गया।
- बहु बीमारी प्रतिरोधी संवर्धन जैसे सी एन एच 911, सी एन एच 2713 व सी एन एच 4736 ने एल आर के 516 की तुलना में काफी अच्छी पैदावार दी। रेशे की लंबाई के आधार पर 4 संकरण संयोजनों से 95 पौधों का वरण किया गया।
- वर्ष 2001–2002 के फसलकाल में क्यारी में कपास के लिए किए गए विश्लेषणों से उद्घाटित हुआ कि रोगजनक संक्रमण 8 फफूँदों तथा जीवाणु झुलसा रोगजनक एक्स ए. एम. मालवासिएरम के कारण हुआ।
- काँचघर परिस्थितियों में छाँटी गई 197 *जी. हिर्सुटम* जर्मप्लाज्म वंशावलियों में जीवाणु झुलसा रोग के लिए 6 अवरोधी, 17 मध्यम अवरोधी, 71 मध्यम सुग्राह्य व 103 सुग्राह्य पायी गई। जीवाणु झुलसा के लिए अवरोधी विभिन्न संकरणों में से 187 एकल पौधों के वरण तैयार किए गए।
- गमले की परिस्थिति में पत्तियों के फफूँद रोग के लिए छाँटी गई 134 *जी. हिर्सुटम* जर्मप्लाज्म वंशावलियों में से सभी वंशावलियाँ अल्टरनेरिया पत्ती धब्बा के लिए सुग्राह्य थी, 20 वंशावलियों ने सलेटी धब्बा के लिए अवरोधी प्रतिक्रिया प्रदर्शित की तथा 25 मायरोथीसियम पत्ती धब्बा रोग के लिए अवरोधी पायी गयी।
- मिश्रित सूक्ष्म प्रतिरोधी व रसायन पर्णिल रोगों के नियंत्रण के लिए समान प्रभावी थे।
- रेनीफार्म नेमेटोड के लिए पेस्टूरिया की उपस्थिति की बारंबारता 3–5% जबकि अवरोधी नेमेटोड के लिए यह 6–8% पायी गई।
- कपास पत्ती मोडक रोग के विषाणु के कोट प्रोटीन जीन के एम्प्लीफिकेशन के लिए प्राइमर के अभिकल्पन व संश्लेषण द्वारा कपास पत्ती मोडक विषाणु के लिए पी सी आर/डी एन ए प्रोब आधारित जाँच का विकास किया गया। एम्प्लीफाइड उत्पाद की क्लोनिंग द्वारा विषाणु जीनोम के एम्प्लीफिकेशन को प्रमाणित किया गया। कपास के पौधों में विषाणुओं का पता लगाने के लिए यह अत्यधिक संवेदनशील विधि है। कपास जननद्रव्य में अवरोधी पौधों की पहचान के लिए मालिकुलर मार्कर (ओ पी ए–10) का विकास किया गया। सफेद मक्खी की संख्या के विभेदकों की पहचान के लिए ओ पी ए 5 का मॉलिकुलर मार्कर के रूप में उपयोग किया जा सकता है। *जी. हिर्सुटम* के चौंतीस

जीनप्ररूप कपास पत्ती मोड़क रोग के लिए अवरोधी तथा सफेद मक्खी के लिए सहिष्णु पाये गये।

- सलेटी धब्बा रोगजनक का सफलतापूर्वक स्वस्थ पत्ती ऊतक के निवेशन की पद्धति द्वारा सवर्धन किया गया। नया सिथेटिक मीडिया अकेले या इनके संयोजनों में आर. एरिओला की वृद्धि के लिए बेहतर था। तीन फाइलोप्लेन विषाणु एक्स ए.पी.वी. माल्वासिएरम को रोकने में आशाजनक देखा गया।
- 44 स्थानों से एकत्रित नमूनों से *एच. आर्मीजेरा* विभेद के लिए कीटनाशक अवरोधता की निगरानी की गई। प्रयोगशाला वरण द्वारा कीट अवरोधी विभेद विकसित किए गए और संकरण द्वारा अनुवांशिकी का पता लगाया गया। पाइरेथ्राइड, आर्गेनोफास्फेट, कार्बामेट्स तथा क्राई 1 ए सी के लिए अवरोधता प्रदान करने वाले विकल्पी को प्रतीप संकरण (बी सी 6) द्वारा सुग्राह्य विभेदों में अंतर्निहित किया गया। बी सी 5 संतति को स्वनिषेचन करके होमोजाइगस लगभग आइसोजेनिक वंशावलियों का विकास किया गया। इन वंशावलियों के उपयोग से संकरण अवरोधता का अध्ययन किया गया। खेत में कीटनाशकों के प्रति अवरोधी विकल्पी की बारंबारता के अनुमान के लिए एफ2 संतति की जाँच की गई। अवरोधता से सम्बद्ध आर ए पी डी व एस सी ए आर मारकर्स के विकास के लिए मालिकुलर अध्ययन का उपयोग किया गया। अवरोधता का पता लगाने के लिए दो किट विकसित किए गए।
- *एच. आर्मीजेरा* में क्राई 1 ए सी की अवरोधता की आनुवंशिकी का अध्ययन प्रतीप संकरण द्वारा किया गया। क्राई 1 ए सी एक्सप्रेशन में टेम्पारेल व स्पेटियल विविधता को समझने के लिए पूरे मौसम काल में पारजीनी पौधों में क्राई 1 ए सी के प्रदर्शन का मूल्यांकन किया गया। खेत में क्राई 1 ए सी के अवरोधी विकल्प की बारंबारता का अनुमान लगाने के लिए एफ2 की जाँच की गई।
- ट्राईजोफास की सहयोगी के रूप में भूमिका को समझने के लिए इसकी विभिन्न मात्राओं में डेल्टामेथ्रिन के साथ जाँच की गई। डेल्टामेथ्रिन व ट्राईजोफास के साथ बायोएसे द्वारा पायरेथ्राइड अवरोधता के लिए दो *एच. आर्मीजेरा* विभेदों की इस्ट्रेज व ऑक्सीडेज़ के साथ की जाँच की गई। ईस्टरेज से सम्बद्ध पायरेथ्राइड अवरोधता के जैव रसायन एस्से द्वारा उद्घाटित हुआ कि ट्राइजोफास इस्टरेज़ का एक सशक्त अवरोधक है और यह इस्टरेज़ अवरोधक से सहक्रिया में सम्मिलित हो सकता है।
- आई आर एम विस्तार परियोजनाओं के संयोजकों के लिए क्षेत्रवार ट्रेनिंग कार्यक्रम आयोजित किए गए। सूखे के मौसम के बावजूद, परियोजना के प्रसार से कीटनाशकों के उपयोग में 30–65% की कमी देखी गई और उपज में 0–15% की वृद्धि देखी गई।
- *एच. आर्मीजेरा* के दो विभेदों का परपोषी पर जीवनयापन के आधार पर श्रेणीकरण किया गया। इन्हें कपास प्रजाति और गैर कपास प्रजाति के रूप में पहचाना गया। दोनों प्रजातियों के लिए माइटोकोन्ड्रियल सी ओ1 रीज़न को क्रमवत किया गया। कार्नूटल स्पाइन्स की शारीरिक संरचना की भिन्नता के आधार पर, परपोषी पर खाने की प्राथमिकता, एलिलोकेमिकल्स की अनुक्रिया व आर ए पी डी – पी सी आर फाइलोजेनेटिक विश्लेषण से यह निष्कर्ष निकाला गया कि दोनों प्रजातियाँ अनुवांशिकीय आधार पर भिन्न थी।
- उत्तर, मध्य व दक्षिणी भागों के 20 स्थानों के खेतों से एकत्रित किए गए *एच. आर्मीजेरा* व *ई. विटेला* के विभेदों पर आधारीय विषाक्तता का अध्ययन किया गया। धब्बेदार बालवर्म के लिए एक नये बायोएसे सिस्टम का मानकीकरण किया गया। धब्बेदार सूंडी के प्रति क्राई 1 ए सी की एल डी 50 मानक 0.01 से 0.284 ug/ग्रा. थी। विजयवाड़ा या अदिलाबाद की तुलना में खम्माम, नलगोंडा व वारंगल की संख्या में क्राई 1 ए सी के लिए अधिक सुग्राह्यता थी। दक्षिणी क्षेत्र में धब्बेदार बालवर्म की 0.024–0.036 ug/ग्रा. खुराक की तुलना में मध्य भारत में एल डी 50 मानक कम आँकी गई।

कोयंबतूर

- विभिन्न बालवर्मों से *जी. हिर्सुटम* किस्मों में 63% तथा अंतः हिर्सुटम संकरों में 71% तक कपास की उपज में नुकसान देखा गया।
- बुवाई के 20 व 25 दिनों बाद नीम की खली + नीम का तेल + मिटटी चढाने से तने घुन के प्रकोप का प्रतिशत न्यूनतम क्रमशः 12.79 तथा 12.95 आँका गया और जो क्लोरिपाइरिफास 0.05%, नीम की खली, बुवाई के 30 व 40 दिनों बाद नीम की खली + नीम के तेल + मिटटी चढाने के बराबर था और पी. एफिनिस के प्रबंधन के लिए सामान्य की तुलना में बेहतर पाया गया।
- इमामेक्टिन बेंजोएट ग्रेडंड मात्रा के स्तर 8, 9.25 व 11 ग्रा. सक्रिय तत्व प्रति हैक्टर बालवर्म काम्प्लेक्स के लिए प्रभावी पाये गये और गूलर नुकसान को कम करने तथा कपास की उपज बढाने में इंडोक्साकार्ब व स्पिनोसेड के समान पाये गये।
- स्थान विशिष्ट आई पी एम व आई आर एम रणनीतियों के सफलतापूर्वक क्रियान्वयन के परिणामस्वरूप कीटनाशकों के छिड़काव की संख्या व फसल संरक्षण खर्च में कमी आई। कीटनाशकों के छिडकाव में कमी से पारिस्थितिकी में प्राकृतिक शत्रुओं की संख्या में वृद्धि के साथ ही कपास की अतिरिक्त उपज एवं अंतः फसलों से अतिरिक्त आय भी प्राप्त हुई।
- *जी. अर्बोरियम* की नई जर्मप्लाज्म वंशावलियों को सलेटी धब्बा के लिए छांटा गया और फिर रामुलेरिया एरिओला से कृत्रिम निवेशन किया गया इसमें ए के ए 61 व ए के ए 62 दो वंशावलियाँ असंक्राम्य देखी गई और 12 वंशावलियाँ जैसे ए के ए 12, ए के ए 13–1, ए के ए 13–2, ए के ए 28, डी एच 149, ए के एच 496–1, ए के एच 580, ए के एच 590, 7307 एस सी 136, 78/एल ए 1, ए के 5 व ए के 590–1 अवरोधी पायी गई।
- *जी. हिर्सुटम, जी, बार्बेडेंस, जी. अर्बोरियम* व *जी. हर्बेसियम* का *आर. एरिओला* के विभिन्न एकलों के साथ निवेशन करने पर उनकी परपोषी पौध को प्रकोपित करने की क्षमता में स्पष्ट अंतर देखा गया।
- अल्टरनेरिया पत्ती धब्बा के प्रबंधन में जैवकारक *ट्राइकोडर्मा विरिड, टी. विरेंस* व *टी. विरिड* तथा *सूडोमोनास, फ्लूरेसेंस* फफूंदनाशक प्रोपिकोनाजोल के समान प्रभावी पाये गये।

सिरसा

- कीटनाशकों के साथ नीम के बीज का अर्क (5%) का समावेशन से नाशीकीटों व खर्चे को कम करने में सहायक पाया गया इसका उपज पर कोई विशेष प्रभाव नहीं देखा गया। यद्यपि किसानों द्वारा की जाने वाली छिडकाव पद्धति में उपज अधिक थी। केन्द्र के परीक्षणों में आई पी एम मोड्यूल (1:1.70) की तुलना में अनुपात कम (1:1.49) पाया गया। लाभ : लागत सिरसा जिले के पनिहारी गाँव में आई पी एम तकनीकों का बड़े पैमाने (50 एकड) पर प्रदर्शन के अंतर्गत गैर आई पी एम किसानों (16.2 कु./है.) की तुलना में आई पी एम अपनाने वाले किसानों के खेतों की औसत उपज (17.8 कु./है.) रही। गैर आई पी एम किसानों की (1:2.62) तुलना में आई पी एम अपनाने वाले किसानों का लागत : लाभ का प्रतिशत अधिक (1:3.15) रहा।
- सफेद मक्खी, गुलाबी बालवर्म नुकसान व अल्टरनेरिया पत्ती धब्बा प्रकोप के लिए ऐतिहासिक कीट मौसम आँकड़ों से समाश्रयण समीकरण का विकास किया गया। इमिडेक्लोप्रिड से बीज उपचार तथा नीम आयोजन व कीटनाशक जैसे ट्राईजोफास व डिफेन्थुरोन का पर्णिल छिड़काव सफेद मक्खी व पत्ती मोडक रोग प्रबंध के लिए प्रभावी था।
- आर ए पी डी तकनीक के उपयोग से *राइजेक्टोनिया सोलानी* के बारह एकलों और *आर. बटाटिकोला* के पंद्रह एकलों का विभेदन किया गया। मेट्रिक्स व डेंडोग्राफ की सहायता से प्राइमर ओ पी एन – 02 द्वारा एम्पलीफाइड बेंड्स का विश्लेषण किया गया और *आर. सोलानी* एकलों को चार समूहों में श्रेणीकृत किया गया। इसी तरह *आर. बटाटिकोला* में प्राइमर ओ पी एन – 04 द्वारा एम्पलीफिकेशन किया गया तथा एकलों को तीन भिन्न समूहों में वर्गीकृत किया गया।

पादप कार्यिकी व जैव रसायन

नागपुर

- सापेक्षतः अधिक सूखा सहिष्णु जीनप्ररूप पहचाने गये। *जी. अर्बोरियम* व *जी. हर्बेशियम* जीन प्ररूपों में कम पत्ती जल क्षमता, अधिक जड–तना अनुपात तथा अधिक नाइट्रेट रिडक्टेज एक्टिविटी होती है। *हर्बेसियम* वंशावलियों में वाष्पोत्सर्जन पत्ती शीतलन व उपज स्थायित्व देखा गया। *जी. हिर्सुटम* जीनप्ररूपों में अधिक रंध्रीय अवरोधता, पत्ती जल क्षमता तथा शुष्क पदार्थ उत्पादन प्रदर्शित हुआ।
- लवण सहिष्णुता के संबंध में, 10 ई सी लवणता स्तर तक अधिकांश जीन प्ररूपों की उपज स्थिर रही इससे अधिक होने पर उपज में कमी देखी गई। पी के वी 081, एल आर के 516, महालक्ष्मी, धारवाड जे के 91 व जी. काट 100 लवणता के लिए अधिक सहिष्णु थे। सहिष्णु किस्मों में प्रोलीन की मात्रा, फ्रीरेडीकल स्केवेजंर तथा प्रोटीन का स्तर अधिक था ये लवण सहिष्णुता की जाँच के लिए महत्वपूर्ण मापदंड हैं।
- विशेषकर एशियाई कपास में जलमग्नता से उपज में उल्लेखनीय कमी देखी गई । इसके विपरीत प्रभाव से वृद्धि में रुकावट आई, पत्तियाँ व कलियाँ झडीं और प्रकाश संश्लेषण में कमी देखी गई। अधिक तापमान व सूर्य के तेज प्रकाश से पौध गलन हुआ। कीटनाशकों के छिडकाव से पौध सुरक्षा पद्धति प्रभावित हुई।
- कीटनाशकों के अनुप्रयोग से रिडयूसिंग सुगर व अमिनो एसिड की मात्रा में प्रारंभिक वृद्धि हुई फिनॉल व फ्लेवनाल की मात्रा में कमी देखी गई।
- जब जननीय विकास के समय जिबरेलिक एसिड का उपयोग पर्णिल छिडकाव के रूप में किया गया तो कलियाँ बनने में वृद्धि हुई और डी ए पी के 1 प्रतिशत पर्णिल छिड़काव से एन एच एच 44, एम ई सी एच 12, 162 व 184 (बी टी व गैर बी टी) की कपास की उपज में वृद्धि हुई।
- कलियाँ लगने की प्रारंभिक अवस्था के समय यांत्रिक या रसायनिक तरीकों से लगातार कलियों को हटा देने से फलन प्रक्रिया में वृद्धि से उपज में बढोत्तरी हुई। ईथ्रेल की अधिक सांद्रता का वृद्धि व उपज में विपरीत प्रभाव पडा। मेलिक हाइड्रेजाइड के उपयोग से विकास में वृद्धि प्रदर्शित हुई।
- अर्बोरियम वंशावलियों में बीज गॉसीपाल की मात्रा अधिक रही। पौध के अन्य भागों की अपेक्षा बीज में गॉसीपाल की मात्रा अधिक थी। गॉसीपाल की मात्रा में पुरानी पत्ती, कली, फूल, गूलर, बीज में क्रमिक बढोत्तरी हुई। जर्मप्लाज्म वंशावलियों व उन्नत संवर्धनों में बीज तेल की मात्रा 15 से 26 प्रतिशत देखी गई।

कोयंबतूर

- प्रारंभ में बीजाडों को आई ए ए (1.0 मि.ग्रा. /ली.–1) + जी ए (1.0 मि.ग्रा./ली. –1) + बी ए (1.0 ग्रा./ली.–1) के साथ टी एम मीडियम में सवंर्धित करने और उसके बाद आई ए ए (2.0 मि.ग्रा./ली.–1) + जी ए (0.0 मि.ग्रा./ली.–1) + बी ए (0.5 ग्रा. /ली–1) वाले मीडियम में सवंर्धित करने से रेशे की अत्यधिक वृद्धि हुई। रेशे की वृद्धि अर्ध ठोस मीडियम की तुलना में प्रलंबन संवर्धन में बेहतर पायी गयी।
- सिंचित परिस्थितियों में, जिन जीनप्ररूपों में अधिक गूलर लगे थे उनमें मध्यम संख्या के गूलर वाले पौधों (8 गूलर प्रति पौध) की प्रकाश संश्लेषण दर 23 मोल सी ओ2 μ एम,–2 एस–1 की तुलना में अधिक गूलर वाले सभी जीनप्ररूपों में प्रकाश संश्लेषित दर कम (21.4 μ mol Co2 m-2 एस ^{1}) थी। उसी तरह जिन पौधों में गूलरों की संख्या 5 गूलर प्रति पौध से कम थी उनमें प्रकाश संश्लेषण दर अधिक (24.7 μ mol Co2 m-2 एस.$^{-1}$) थी।
- अध्ययनों से प्रकट हुआ कि यदि रात्रि का तापमान 15^{0} सें.ग्रे. से नीचे जाता है तो कपास के पौधे प्रकाश संश्लेषण व स्वांगीकरण से प्रभावित हो सकते हैं।
- कपास में कार्यिकीय रूप से लाल पत्ती होने की अपेक्षा जैसिड से प्रकोपित लाल पत्तियों में प्रकाश संश्लेषण दर व वाष्पोत्सर्जन का अत्यधिक प्रभाव पडा।
- रिमोट सेंसिंग, भौगोलिक सूचना पद्धति व

फसल मॉडेल के समाकलन से फसल की बुवाई के 120 दिनों बाद के आँकड़ों से क्षेत्रीय स्तर पर कपास की उपज का अनुमान लगाया जा सकता है।

- बालवर्म सहिष्णु जीन प्ररूपों जैसे बी आर एस 3, बी आर एस 5, बी आर एस 22, बी आर एस 23 व एच जी आई पी एस 542 ने संरक्षण परिस्थितियों में 50–95 ग्रा./पौध की उपज की तुलना में गैर संरक्षण परिस्थितियों 40–60 ग्रा./पौध उपज दी इससे यह स्पष्ट होता है कि बगैर छिडकाव के बालवर्म सहिष्णु जीन प्ररूप की पैदावार छिडकाव वाले प्लाट्स के समान थीं।

कृषि प्रसार व अर्थशास्त्र

नागपुर

- पिछले तीन वर्षों में कपास के सामाजिक एवं आर्थिकीय अध्ययनों से उद्घाटित हुआ कि कपास उगाने वाले किसान के रूप में प्राप्त आय जीवन यापन के लिए पर्याप्त नहीं है। इसमें 62 से 78% की वृद्धि हुई। तीन वर्ष पहले 26 प्रतिशत कपास उत्पादकों के परिवारों की आर्थिक स्थिति बहुत गंभीर थी। अब ऐसे 46 प्रतिशत कपास उत्पादक हैं। खेती के अलावा अन्य कामों से अतिरिक्त धन कमाने वाले किसानों में 36 प्रतिशत की वृद्धि हुई है। दूसरों के खेतों में मजदूरी करने वाले किसानों में भी 37 से 48% की वृद्धि हुई है। किसान परिवारों की महिलाएँ भी अब खेती के कार्यों में अधिक समय दे रही हैं। तीन वर्ष पहले 61 प्रतिशत कपास उत्पादक ऐसे थे जिन्होंने कृषि हेतु ऋण लिया था और उसे लौटाने के लिए चिंतित थे अब 70 प्रतिशत किसान ऐसे हैं। कपास उगाने वाले किसान जिनका जीवन स्तर खराब था ऐसे किसान पहले 56% थे जो अब 60% हो गये।
- आई पी एम तकनीक अपनाने के संबंध में एक मॉडल की जाँच से पता चला कि कपास उत्पादकों में इस तकनीक को अपनाने में स्थानिक वितरण, तकनीक की उपलब्धता, विपणन रणनीति, कीमत तय करना व संपर्क प्रसार में भिन्नता थी।
- बगैर गाँव संपर्क कार्यक्रम वाले किसानों की तुलना में कपास के अग्रिम पंक्ति प्रदर्शनों से कपास के किसानों के ज्ञान–स्तर, तकनीकी अपनाने के प्रतिशत तथा उपज स्तर में उल्लेखनीय परिवर्तन देखा गया।
- नागपुर व वर्धा जिलों में 43 बी टी कपास उत्पादकों पर किए गए सर्वेक्षण से पता चला कि एम ई सी एच 184 बी टी कपास ने पारंपरिक संकर की उपज (9.72 कु./है) की तुलना में उल्लेखनीय रूप से अधिक (11.73 कु./है.) उपज दी। पौध संरक्षण खर्च में उल्लेखनीय बचत की गई। यद्यपि सूखे व बालवर्म के कम प्रकोप के कारण बी टी कपास की पूर्ण क्षमता को नहीं देखा जा सका।
- कपास एकाधिकार योजना को बहुत कम प्रतिसाद मिलने से पता चला कि कपास के मूल्य के मुकाबले पैसा मिलने में देरी एक महत्वपूर्ण कारण था।
- उत्तरी राज्यों से एकत्रित किए गए आँकड़ों से पता चला कि उपज में कमी की मुख्य बाधायें बालवर्म नुकसान (55%), समय पर जल की अनुपलब्धता (22%), खरपतवार से नुकसान (18%) तथा देर में बुवाई (15%) हैं। छोटे किसान कपास की खेती के लिए आदानों के उपयोग में अपेक्षतया अधिक दक्ष थे और बड़े किसानों ने गेहूँ की खेती के लिए आदानों का उपयोग किया जबकि अधिकांश सस्य क्रियाओं को मशीनों द्वारा किया गया। कुल प्राप्त परिणामों से स्पष्ट होता है कि नमूना फार्मों में प्रौद्योगिकी का क्रियान्वयन केवल 58.87 प्रतिशत रहा। फार्म के आकारों के अनुसार छोटे फार्मों में यह 60.35% था जबकि बड़े फार्मों में औसत स्तर 59.82% था।

कोयंबतूर

- प्रौद्योगिकियों के क्रियान्वयन के परिणामस्वरूप कपास की उपज में 30% व मक्का में 35% की वृद्धि देखी गई। किसानों में वैज्ञानिक प्रौद्योगिकियों को अपनाने और उनके दृष्टिकोण में 80% से अधिक का बदलाव देखा गया।

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Nematode infested seed and planting material: Denematization and salvaging techniques	Technical Bulletin No. 20	Gokte-Narkhedkar Nandini Mukewar PM Mayee CD
Genetic Improvement of Cotton Seed Oil	Technical Bulletin No. 21	Agarwal DK Singh P Mayee CD Kate Nita.
Transgenic Bt. Cotton	Technical Bulletin No. 22.	Mayee CD Singh P Dongre AB Rao M.R.K. Sheo Raj
Technology Transfer in Cotton	Technical Bulletin No. 23	Wasnik SM Mayee CD Singh P.
Male Sterility in Cotton	Technical Bulletin No. 24	Singh SB Singh P Mayee CD

List of approved on-going projects

Institute Projects

CICR, Nagpur

Crop Improvement

1. Collection, conservation, evaluation, documentation and utilization of genetic resources of cultivated species of *Gossypium*.
2. Genetical and anatomical studies on drought tolerance in cotton *G.hirsutum*.
3. Conservation of wild species of *Gossypium* and introgressive hybridization for the improvement of cultivated cottons.
4. Breeding for high yielding and long staple genotypes of *arboreum* cotton with high fibre strength .
5. Breeding cotton genotypes suitable for cultivation in shallow soils.
6. Studies of genetic enhancement of upland cotton.
7. Improvement of seed yield and its quality in cotton hybrids and varieties.

Biotechnology

8. Evaluation of cotton germplasm through molecular techniques.
9. Development of tissue culture protocol for use in breeding and genetic transformation.

Crop Production

10. Studies on use of harvested rain water for recycling at critical stages of rainfed cotton for augmenting its production in vertisols
11. Studies on long term effect of nutrient management practices on the productivity, nutrient balance and sustainability of cotton based cropping systems.
12. Tillage and crop residue effects on soil, nutrient and cotton crop behaviour.
13. Development of bullock drawn seed drill cum planter for cotton sowing in vertisols.
14. Studies on water use efficiency of harvested rainwater, through drip irrigation and fertigation.

Crop Protection

15. Screening of cotton germplasm against key pests to find out morphological and biochemical basis of resistance.
16. Biochemical basis of induction of defense related proteins in cotton against the gram pod borer *Helicoverpa armigera*.
17. Interaction effects of cultivars, agrotechniques, insect pests and entomophages in cotton ecosystem.
18. Estimation of losses due to major pests of cotton.
19. Studies on multiple disease resistance in upland cotton.
20. Studies on seed transmitted pathogenic infections and other seed microflora of cotton.
21. Studies on evolution of races of *Xanthomonas axonopodis* pv. *malvacearum* (*Xam*) and utilization of UVS in identification of resistant sources .
22. Evaluation of cotton germplasm against Alternaria and Myrothecium leaf spot diseases.
23. Effect of mix-micro-antagonist on control of cotton foliar diseases.
24. Studies on plant parasitic nematodes associated with cotton.

Plant Physiology and Biochemistry

25. Physiological evaluation of cotton germplasm under rainfed conditions.
26. Physiological studies on abiotic stress with particular reference to heat and drought in cotton.
27. Physiological and biochemical basis of salinity tolerance in cotton plants.
28. Physiological and Biochemical adaptation of cotton plant to waterlogging tolerance in cotton.
29. Source-sink alteration with reference to flower induction as a tool to improve physiological efficiency and productivity in cotton.

Extension & Economics

30. A study on structure of agriculture and social dynamics of cotton production .
31. A study on technology adoption behaviour of cotton growers : Structural perspective.
32. Impact of cotton front-line demonstrations on technological advancement of cotton growers.
33. Economic analysis of cotton cultivation in India.

Regional Station, Coimbatore

34. Development of high yielding intra *hirsutum* hybrids.
35. Breeding *G.hirsutum* cotton varieties with new plant types - Development of medium staple varieties.
36. Development of extra long staple high spinning hybrids of interspecific origin with wider adaptability.
37. Development of high yielding and high spinning extra long staple cotton.
38. Maintenance and evaluation of cotton germplasm.
39. Inter-specific and inter-racial hybridization and gene transfer in *Gossypium*.
40. Development and utilization of cytoplasmic and genetic male sterility for hybrid cotton seed production and fertility restoration in cotton.
41. Studies on viability, vigour and longevity of cotton seeds.
42. Studies on the long term effect of nutrient management practices on the productivity, nutrient balance, soil physico-chemcial properties and sustainable of cotton based cropping system.
43. Exploring suitable agro-techniques for Bt cotton hybrid.
44. Studies on population dynamics of cotton pests and their enemies in the cotton ecosystem.
45. Studies on the host plant relationship and development of resistant/tolerant varieties to insect pests of cotton.
46. Studies on the role and effect of insecticides in cotton ecosystem.
47. Studies on bioecology and management of cotton stem weevil *Pempherulus affinis* Faust.
48. Studies on the epidemiology and management of fungal foliar diseases of cotton.
49. Studies on soil borne diseases of cotton.
50. Studies on bacterial blight of cotton.
51. Physiology of fibre growth and development.
52. Identification and utilization of adaptive responses to abiotic stress in cultivated species of cotton.
53. Studies on the response of elevated carbon di-oxide on physiology and productivity.
54. Callus induction and growth measure or apparent stress tolerance to screen cotton genotypes for drought / tolerance.
55. Studies on biochemical mechanisms of resistance to bollworm of cotton.
56. Studies on development biochemistry of

cotton pest/ disease interaction.

57. Source sink alteration with reference to flower induction as a tool to improve physiological efficiency and productivity in cotton.

58. Role of women in cotton based cropping system of Tamil Nadu.

Regional Station, Sirsa

59 Evaluation of parents in *Gossypium hirsutum* for heterotic potential and useful heterosis for replacement of existing cultivars under north Indian conditions.

60. Development of varieties and hybrids (MS based) of medium staple length in *Gossypium arboreum L.*

61. Development of male sterility based hybrids of *G.hirsutum* for north India.

62. Studies on seed technological aspects of hybrids and varietal seed production under north zone.

63. Evaluation and refinement of IPM module for irrigated cotton in north zone.

64. Studies on cotton leaf curl virus disease and development of resistant varieties and hybrids for its management.

65. Collection, conservation, evaluation and maintenance of genetic resources

Externally Funded Projects

1. Development of sensitive molecular diagnostic tools for rapid detection and differentiation of races of *Xanthomonas axonopodis* pv. *malvacearum.*

2. Sustainable control of the cotton bollworm *Helicoverpa armigera* in small scale production systems.

AP Cess Fund

1. Use of entomopathogenic nematodes for biological control of insect pests of cotton.
2. Identification and quantification of constraints, risk and policy impacts in cotton cultivation.
3. Studies on the effect of insecticide on cotton plants and their interactions with American Bollworm *Helicoverpa ormigera* (Hubner) and its parasitoid *Campoletus chlorideae* Uchida

National Agricultural Technology Project (NATP)

Mission Mode

CP-MM I : Development of Hybrid Crop-Cotton

MM III 17 : Development of weather based forewarning systems for crop pests and diseases - cotton.

PB MM: Survey/ exploration, collection, evaluation, characterisation, conservation and utilisation of global collection of *Gossypium* species for sustained production and productivity.

Bt transgenic: Bt. Transgenic for insect resistance - Cotton, Pigeonpea and Rice.

II. Irrigated Agro-Ecosystem

PSR 4: Studies on efficacy of bioinoculants in cotton-wheat based production system

PSR 24 : Socio economic analysis and characterisation of cotton-based cropping systems

PSR 33 : Evaluation of tillage, residue and nutrient management practices for cotton-wheat system

PSR 26: Control of leaf curl viral disease in cotton and development of protocol for mass multiplication of predators, parasites and insect pathogens

PSR 27: Evaluation and identification of

suitable pest tolerant compact cottons amenable to mechanical harvesting

PSR 36: Adoption and refinement of cotton picker and cleaning system

IVLP TAR 18 : Technology assessment and refinement (TAR) of irrigated Agro Ecosystem for Coimbatore Region TN

III. Rainfed Cotton Production System (RCPS)

RCPS-1 Agro economic characterisation and constraint analysis of rainfed cotton based production systems in relation to soil, rainfall and socio economic factors

RCPS-2 Optimising nutrient supply in relation to moisture availability for enhanced productivity and stability of rainfed cotton based production system

RCPS-3 Assessment of Gossypol content in cotton Germplasm

RCPS-4 Delineating the efficient productive zones for Cotton production system using GIS based crop models

RCPS-5 Rainwater conservation, harvesting and recycling/ recharging techniques for enhanced productivity of cotton based cropping system

RCPS-7 Promotion of productive high quality *G. arboreum* cotton to meet the needs of marginal cultivators of rainfed ecosystem vis-à-vis textile industry

RCPS-8 Characterisation and identification of productive and high quality cotton species/ genotypes including *G. herbaceum* for different rainfed agro-ecological situations adopting suitable approaches through farmers participatory programmes

RCPS-9 Develop and evaluate production technology for the indigenous cotton of NE Region

RCPS-10 Development of Bt. transgenic diploid cotton

RCPS-11 Impact of tillage, land treatment and organic residue management on soil health, drainage and crop productivity of rainfed cotton based system

IVLP- TAR 15 Technology assessment and refinement of rainfed cotton based production system in Nagpur district through institute village linkage programme under rainfed Agro Eco-system.

IV. Agro Ecosystem (Coastal)

PSR-16 Exploitation of *G. herbaceum* cotton for improving agricultural output and economy of the coastal agro ecosystem

V. Competitive Grant Programme

CGP-I Induction of para nodules in cotton with N_2 (nitrogen) fixing bacterium *Azorhizobium caulinodans*.

Technology Mission on Cotton (TMC)

Proj. Code	Project Name	Centre
MMA-1	Identification and development of promising genotypes from introgressed materials	N C S
MMA-2	Identification and development of diploid cotton with high yield and fibre quality suitable for high speed spinning	N C S
MMA-3	Characterisation of plant ideotypes suitable for different agroclimatic zones	N C S
MMA-4	Improvement of medium long and extra long staple fibre quality suitable for high speed spinning	N C S
MMA-5	Quantitative and qualitative improvement of cotton seed oil	N C S
MMA-6	Overcoming incompatibility barriers in interspecific hybridisation	N C
MMB-1	Maintenance of genetic purity of released varieties and parents of hybrids	N C S
MMB-2	Molecular characterisation of released varieties and parents of hybrids	N
MMB-3	Pre and post harvest management techniques for the improvement of seed quality	N C S
MMC-1	Nutrient dynamics in cotton and establishment of critical limits of macro and micro nutrients	N
MMC-2	Evaluation of bioinoculants including VAM & PSB for eco-friendly and economical nutrient management	N C
MMC-3	Evaluation of soil site and series suitability for cotton based cropping system	N
MMD-1	Methodologies for production of regional level cotton yield by incorporating remote sensing, GIS and crop models	N C
MMD-2	Mechanisation of tillage, planting, interculture and plant protection operations in cotton cultivation	N
MMD-3	Development of precision farming techniques for higher productivity	C
MME-1	Evaluation of location specific IPM modules for eco-friendly and sustainable cotton production	N C S
MME-2	Development of pest and disease forecasting system	N C S
MME-3	Diagnostic tools for differentiation of biotypes/races in pathogens and insect pests	N C S
MME-4	Development of efficient strains of biocontrol agents through molecular techniques	N C
MMG-1	Technology evaluation, assessment and refinement	N C S
MMH-1	National Cotton Informatics and Documentation System	N C
MMH-2	Monitoring and Coordination Cell	N

N- Nagpur C - Coimbatore S - Sirsa