

# **Bt COTTON EVALUATION REPORT**

MRC. 6160 Bt	MRC. 6322 Bt	MRC. 6703 Bt	RCH. 2 Bt	RCH. 20 Bt
RCH. 344 Bt	RCH. 362 Bt	RCH. 368 Bt	MRC.6918 Bt	MRC.6928 Bt

TRANSGENIC COTTON HYBRIDS WITH  
DELTA ENDOTOXIN Cry1A(c)  
Bollgard I GENE

## **SOUTH ZONE**

*Submitted to*  
**INDIAN COUNCIL OF AGRICULTURAL RESEARCH**

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# Executive Summary

The All India Coordinated Cotton Improvement Project (AICCIP) undertook the evaluation of twelve cotton hybrids possessing the Cry 1A(c) gene, expressing delta- endotoxin, an insecticidal protein from the spores of the soil bacterium, *Bacillus thuringiensis var. kurstakii* for the management of cotton bollworms, based on the ICAR letter No. 2(8)/2003-C.C.I. dated 25.4.2003 in the South Zone AICCIP centres. Eight Bt hybrids, viz., RCH.2, RCH.20, RCH.344, RCH.344, RCH.362, RCH.368, MRC.6160, MRC.6322 and MRC.6703 under H x H hybrids as well as two H x B hybrids, viz., MRC.6918 AND MRC.6928 were evaluated in Breeding (protected against sap sucking insects at ETL) and Entomology (without any plant protection for insect pests and diseases) evaluations. RCH.2, RCH.20 Bt hybrids have gone into the second year of testing during this season. The trials were laid out in accordance with the protocol and following standard package of practices of cotton cultivation, of respective centres, where the evaluations were undertaken. The untreated, acid de-linted seeds of the relevant test hybrids and their non-Bt hybrids were provided by M/S Rasi Seeds Pvt. Ltd., Athur and M/S Maharashtra Hybrid Company (MAHYCO) Seeds Pvt. Ltd., Jalna.

The breeding evaluation concentrated on various observations on plant biometric characters such as number of branch on first sympodium, number of sympodia per plant, nodes per first sympodium, mean length of sympodia, number of fruiting points per sympodium, number of green bolls per plant at harvest, number of burst bolls per plant at harvest, mean boll weight, seed index, Lint index, mean seed cotton yield per

plant and per plot and final yield of seed cotton yield per hectare in addition to the fibre length, strength and micronaire of the test hybrids. The Entomology evaluations aimed at the response of the Bt hybrids towards the three prevalent species of bollworms in the zone as well as to sap sucking pests. The seed cotton yield was the ultimate measure of the performance of these hybrids under these two evaluation criteria.

### Evaluation of H x H hybrids:

A comparison of the seed cotton yield of both protected and non-protected plots showed through the following table that RCH.2Bt and RCH.362Bt hybrids had consistent superiority over other Bt hybrids. Under protected conditions, the performance of MRC.6703Bt and RCH.368Bt in terms of better seed cotton yield was distinct. The conclusion from this year's data is that although under drought conditions, the south zone evaluations showed that Bt hybrids are superior to all other test hybrids. The superiority of yield in the Bt hybrids such as RCH.2, RCH.362 and MRC.6703, even under unprotected condition is distinct.

From the first year of testing most of Bt hybrids as well as repetitions of RCH 2Bt and RCH 20Bt hybrids from last year, it is seen that seed cotton yield of both protected and non-protected plots showed that RCH.2Bt and RCH.362Bt hybrids had consistent superiority over other Bt hybrids.

The conclusion from this year's data is that, although under drought conditions, the south zone evaluations showed that Bt hybrids are superior to all other test hybrids. All Bt test hybrids recorded higher yield over check Bt hybrid as well as than check hybrids and non-Bt counterparts. RCH.2Bt consistently performed in south zone over the last two years for seed cotton yield. The seed cotton yield of various test

entries, under protected conditions, showed that RCH.2Bt (1935 g/ha) followed by RCH.368Bt (1803 kg/ha) and RCH.362Bt (1783 kg/ha) occupied the first three slots.

The seed cotton yield data under unprotected showed that there is distinct difference of Bt hybrids in yielding 25-30% more than check hybrids. There is obvious superiority of all Bt hybrids over the checks. RCH.362Bt (1583 kg/ha) gave the highest yield, followed by RCH.2Bt (1520.75 kg/ha) and MRC.6703Bt seed cotton (1487 kg/ha).

Under rainfed condition of Nandyal, the fibre property data shows that RCH.368Bt recorded the best strength : length ratio of 0.90 followed by MRC.6160Bt and MRC.6322Bt. RCH.344 non-Bt also recorded 0.94 as this ratio. The local check hybrid had similar data as that of the best Bt hybrids. The fibre property recorded in the irrigated trial at Dharwad, although affected by a general drought, showed similar results as that of Nandyal. The Bt hybrids showed above 0.8 ratio of strength to length, RCH.368Bt being the highest (0.85). Amongst the others, MRC.6160 non-Bt hybrid recorded 0.86. The check hybrid also had 0.82.

The percent open boll damage was virtually fifty percent of that in non-Bt hybrids as well as in check hybrids. The highest percent was in MRC.6322Bt (20.88%) followed by RCH.362Bt (16.92%).

The sap-sucking pests were similar in pattern of infestation in unprotected and protected plots. Due to drought conditions, the general population of jassids was low; however, their numbers on three leaves per plant did show a significant difference between various entries.

Based on the data of Coimbatore center, under sprayed conditions of Breeding plots, the per cent increase in net returns is recorded in MRC.6160Bt followed by RCH.2Bt hybrids over corresponding non-Bt hybrids as well as over Bt check hybrid. RCH.20 recorded better returns on investment over MECH.162 Bt. The unprotected plots at the same location gave high net returns in the case of RCH.2Bt. RCH.20Bt,

RCH.344Bt, RCH.362Bt, RCH.368Bt and MR.6160Bt over both corresponding non-Bt hybrids as well as over check Bt hybrid during this season.

Due to inclement weather conditions, there was no disease outbreak in the test hybrids during this season in any of the centers, except in Dharwad, where report of Grey mildew disease at moderate levels was observed on most of the test hybrids. No significant variations in disease reaction to Grey mildew was seen in any of the Bt hybrids in comparison to check hybrids as well as their corresponding non-Bt hybrids.

### Evaluation of H x B hybrids:

There was no difference in Lint index while in Seed index, MRC.6926 Bt hybrid recorded the highest value of 12.4 g, it is significant to note that the highest GOT was obtained in DCB.105 (33.7%). In H x B hybrids, this is significant character that has to be looked at for better lint yield. The average Ginning outturn percentage was seen to be high in MRC.6703Bt followed by RCH.344Bt (table below). All other Bt hybrids showed similar range as in the case Bt check hybrid, the lowest being in RCH.20Bt.

Although seed cotton yield was lower than expected, as south zone states were known for, due to prevailing drought, the Bt hybrids were better than their non-Bt counterparts as well as with check hybrids. The highest yield in Breeding plots under protection against sucking pests at ETL was in MRC.6918Bt (1628 kg/ha). DHB.105 gave 1618 kg/ha seed cotton yield and was similar to MRC.6928Bt hybrids in this respect.

The unprotected plots recorded superior seed cotton yield over all the others. MRC.6928Bt recorded **1842** kg mean seed cotton yield in the south zone, while MRC.6918Bt recorded 1731 kg/ha. The drought has affected the cotton yield profusely, especially for H x B hybrids.

The data for various fibre property parameters data at Dharwad and Vaigai Dam shows that the staple length of MRC.6918Bt ( $t/l=0.83$ ) was superior over MRC.6928Bt. At Vaigai dam, there was no entry that had recorded  $t/l$  value above 0.80, the CIRCOT norm as per requirement of textile industry. A characteristic influence due to drought was seen in this location on fibre property. However, strength : length ration never crossed 0.72 and 0.75 in the zone. This could be an influence of the prevailing peculiar climatic features.

There is no increase in net returns over other hybrids for Bt hybrids this year since there was reduction in production under protected conditions. Under unsprayed conditions, the net seemed to be better. MRC. 6928Bt gave 51.5% increase in net returns over its corresponding non-Bt hybrid. The MRC. 6918Bt hybrid was also similarly better in having higher net returns over its non-Bt counterpart.

## **Introduction**

The South Zone, comprising of Andhra Pradesh, Karnataka and Tamil Nadu, is characterized by areas having assured rainfall, dryland areas of Dharwad and command areas of various irrigation projects of these states. In Tamil Nadu, three seasons are prevalent with winter crop and summer area followed by rice fallows. Cotton farmers prefer both hybrids and varieties in this area. Long and extra-long staple varieties are grown extensively. Due to uncertain climatic and edaphic factors, reduction in cost of cultivation is the primary requirement for the growers. Intense bollworm pressure and extensive increase in expenditure to effectively suppress them from cotton crop have caused the cotton growers to struggle to make both ends meet.

During 2003-04, the deficient monsoon rains caused drought at various ranges in Dharwad and Nandyal, while flooding conditions in the early part of the season followed by extensive period of drought at Guntur prevented the sowing operations. Erratic rainfall did affect the testing results and the various parameters of evaluation were influenced due to this. However, a realistic picture about the performance of all the test hybrids is given below.

The All India Coordinated Cotton Improvement Project (AICCIP) undertook the evaluation of eight cotton hybrids possessing the Cry 1 A(c) gene expressing delta- endotoxin, an insecticidal protein from the spores of the soil bacterium, *Bacillus thuringiensis* var. *kurstakii* for the management of cotton bollworms, based on the ICAR letter No. 2(8)/2003-C.C.I. dated 25.4.2003 in the North Zone AICCIP centres. The trials were laid out in accordance with the under-mentioned protocol and following standard package of practices of cotton cultivation, followed at



respective centres, where the evaluations were undertaken. The untreated, acid de-linted seeds of the relevant test hybrid were provided by M/S Rasi Seeds Pvt. Ltd., Athur and M/S Maharashtra Hybrid Seed Company (MAHYCO) seeds Pvt. Ltd., Jalna. The results of these evaluations are provided with relevance to Bt and Non-Bt hybrids of these seed companies in addition to Bt check hybrid as well as local checks (hybrids & variety), as the case may be.

The Monitoring team of this zone inspected the trials of all the centers and provided their report that is given as ANNEXURE-I herein.

**Centres involved:**

University of Agricultural Sciences, Cotton Research Station, Dharwad  
 University of Agricultural Sciences, Cotton Research Station, Siruguppa  
 Acharya NG Ranga Andhra Pradesh Agricultural University, RARS,  
 Nandyal

Central Institute for Cotton Research, Regional Station, Coimbatore

Test hybrid entries:

The following eight Bt hybrids were tested in this study in the above centres. There was also a Bt hybrid check in addition to zonal checks and local check hybrids.

H x H Bt hybrids with Bt Cry 1A (c) gene (Bollgard I)

CENTRAL ZONE AICCIP CENTRES:

Dharwad, Siruguppa, Nandyal, Vaigai Dam, Coimbatore

M/S Rasi Seeds Pvt. Ltd.	RCH.2 Bt RCH.138 Bt RCH.144 Bt RCH. 118 Bt RCH. 3354 Bt RCH. 368Bt
M/S Maharashtra Hybrid Seeds Co. (MAHYCO) Ltd.	MRC. 6160 Bt MRC. 6322 Bt MRC. 6703 Bt
NHH.44 (ZC), MECH.162 Bt (Bt check)	

**Bollgard I : H x H Entries - Coding details**

Sr.No.	Code	Name
1	2360	RCH.344 Bt
2	2361	RCH. 362 Bt
3	2362	RCH. 368 Bt
4	2363	MRC. 6160 Bt
5	2364	MRC. 6322 Bt
6	2365	MRC. 6703 Bt
7	2366	RCH.2 Bt
8	2367	RCH.20Bt
9	2368	LAHH.5/DHH.11/SAVITA (Local checks)
10	2369	BUNNY (Zonal check)
11	2370	MECH.162 Bt (Bt check)
12	2371	RCH.344
13	2372	RCH. 362
14	2373	RCH. 368
15	2374	MRC. 6160
16	2375	MRC. 6322
17	2376	MRC. 6703
18	2377	RCH.2
19	2378	RCH.20

**BREEDING TRIAL**

DESIGN-RBD - No. of treatments :19, 2 REPLICATIONS – 6 ROWS X 6 metre rows

Plots	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
R1	60	72	66	77	75	69	76	63	68	71	74	62	64	73	61	65	70	78	67
R2	78	68	72	70	60	67	73	77	71	65	69	75	63	62	64	66	74	76	61

**PLANT PROTECTION TRIAL**

DESIGN-RBD - No. of treatments :19, 2 REPLICATIONS – 6 ROWS X 6 metre rows

Plots	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
R1	60	72	66	77	75	69	76	63	68	71	74	62	64	73	61	65	70	78	67
R2	78	68	72	70	60	67	73	77	71	65	69	75	63	62	64	66	74	76	61

# RESULTS OF EVALUATIONS

The Breeding and Plant Protection evaluations of Ankur-09Bt, Ankur-651Bt, Ankur-2534Bt, MRC.6301Bt, MRC.6304Bt, MRC.6160Bt, RCH.2Bt, RCH.118Bt, RCH.138Bt, RCH.144Bt, RCH.335Bt & RCH.359Bt were undertaken along with their non-Bt counterparts and Bt check hybrid (MECH.162 Bt) and zonal check hybrid, NHH.44 at the designated five AICCIP centers, viz., Surat, Khandwa, Nanded, Akola and Nagpur.

## Intra-hirsutum Bt hybrids

### Breeding evaluation

**(Protected from sap sucking pests at ETL)**

#### **Important dates**

Events	Dharwad	Nandyal	Coimbatore	Siruguppa
<b>Sowing</b>	30.06.2003	07.07.2003	22/25.08.03	08.08.03
<b>Germinaton</b>	07.07.03	12.07.2003	25/28.8.03	14.08.03
<b>Harvesting</b>	January,2004	January,2004	February, 2004	January,2004

The breeding evaluation concentrated on various observations on plant biometric characters such as number of branch on first sympodium, number of sympodia per plant, nodes per first sympodium, mean length of sympodia, number of fruiting points per sympodium, number of green bolls per plant at harvest, number of burst bolls per plant at harvest, mean boll weight, seed index, Lint index, mean seed cotton yield per plant and per plot and final yield of seed cotton yield per hectare in addition to the fibre length, strength and micronaire of the test hybrids.

## Plant Breeding evaluations

The Bollgard I gene containing Bt test hybrids were evaluated for various aspects of breeding parameters. The per cent germination, as given below, was found to be very good, being more than 95% in Bt and non-Bt hybrids.

### Germination percentage

Genotype	DHARWAD	COIMBATORE	NANDYAL	Mean
MRC. 6160	87.8	100.0	92.8	93.5
MRC. 6160 Bt	94.7	100.0	96.2	97.0
MRC. 6322	96.9	99.0	92.5	96.1
MRC. 6322 Bt	94.7	97.0	94.3	95.3
MRC. 6703	91.7	100.0	96.3	96.0
MRC. 6703 Bt	93.9	100.0	91.0	95.0
RCH.2	85.6	98.0	93.5	92.4
RCH. 2 Bt	93.9	99.0	95.0	96.0
RCH. 20	96.9	99.0	91.0	95.6
RCH. 20 Bt	93.2	100.0	95.8	96.3
RCH. 344	93.9	98.0	93.4	95.1
RCH. 344 Bt	96.2	100.0	94.3	96.8
RCH. 362	97.7	98.0	97.3	97.7
RCH. 362 Bt	89.8	100.0	94.8	94.9
RCH. 368	94.7	99.0	96.2	96.6
RCH. 368 Bt	91.7	99.0	94.9	95.2
BUNNY (ZC)	93.9	98.0	94.0	95.3
LC (HYBRID)	95.4	71.0	91.0	85.8
MECH. 162 Bt (CC)	97.7	100.0	94.3	97.3

The average plant height recorded amongst Bt hybrids shows that the shortest type was RCH.344Bt (72.4 cm) and the tallest was RCH.20Bt (85.9 cm) as much as hat in check Bt hybrid, as can be seen below.

### Plant Height

Mean plant height (cm)

Genotype	DHARWAD	SIRUGUPPA	COIMBATORE	Mean
MRC. 6160	60.2	92.0	76.2	76.1
MRC. 6160 Bt	71.2	102.0	66.5	79.9
MRC. 6322	69.3	103.0	65.8	79.4
MRC. 6322 Bt	67.5	84.0	62.9	71.5
MRC. 6703	64.7	103.0	65.8	77.8
MRC. 6703 Bt	71.0	101.0	56.6	76.2
RCH.2	65.0	111.0	68.3	81.4

RCH. 2 Bt	67.5	90.0	66.7	74.7
RCH. 20	71.8	113.0	97.2	94.0
RCH. 20 Bt	73.0	118.0	66.6	85.9
RCH. 344	71.4	131.0	87.7	96.7
RCH. 344 Bt	73.3	80.0	63.9	72.4
RCH. 362	89.3	97.0	74.8	87.0
RCH. 362 Bt	78.1	98.0	72.0	82.7
RCH. 368	82.8	117.0	83.6	94.5
RCH. 368 Bt	82.3	107.0	76.0	88.4
BUNNY (ZC)	71.9	95.0	69.8	78.9
LC (HYBRID)	81.2	120.0	83.1	94.8
MECH. 162 Bt (CC)	75.9	120.0	61.4	85.8
CD @ 5%	NS	NS	18.1	
CV %	10.9	13.8	11.9	

## Monopodia

The number of monopodia in Bt test hybrids ranged from 0.4 to 2.0 while local check hybrid recorded 2.2 and other checks were below 0.9.

### Number of monopodia in test hybrids

Genotype	DHARWAD	COIMBATORE	Mean
MRC. 6160	1.8	1.4	1.6
MRC. 6160 Bt	1.4	1.8	1.6
MRC. 6322	1.5	1.3	1.4
MRC. 6322 Bt	2.1	1.9	2.0
MRC. 6703	1.7	0.8	1.3
MRC. 6703 Bt	1.3	0.2	0.7
RCH.2	2.2	1.7	1.9
RCH. 2 Bt	2.1	1.5	1.8
RCH. 20	1.3	1.9	1.6
RCH. 20 Bt	2.1	1.8	2.0
RCH. 344	1.6	1.6	1.6
RCH. 344 Bt	1.9	1.6	1.7
RCH. 362	0.8	1.3	1.1
RCH. 362 Bt	0.6	0.3	0.4
RCH. 368	0.8	1.2	1.0
RCH. 368 Bt	0.5	0.4	0.5
BUNNY (ZC)	1.1	0.8	0.9
LC (HYBRID)	2.8	1.7	2.2
MECH. 162 Bt (CC)	0.7	1.2	0.9
CD @ 5%	0.6	1.0	
CV %	16.3	-	

## Number of Sympodia

It is observed the average number of sympodial branches ranged between 15.1 to 17.4 between all hybrids without any variation between Bt or non-Bt types.

## 2.5% Span Length (mm)

2.5% Span Length (mm) test hybrids

Genotype	DHARWAD	COIMBATORE	Mean
MRC. 6160	14.2	17.8	16.0
MRC. 6160 Bt	15.4	17.0	16.2
MRC. 6322	17.1	16.4	16.8
MRC. 6322 Bt	15.2	15.8	15.5
MRC. 6703	15.3	16.0	15.7
MRC. 6703 Bt	15.9	16.0	16.0
RCH.2	14.9	16.7	15.8
RCH. 2 Bt	15.2	16.2	15.7
RCH. 20	16.3	18.4	17.4
RCH. 20 Bt	14.7	17.4	16.1
RCH. 344	14.8	17.5	16.2
RCH. 344 Bt	16.0	17.2	16.6
RCH. 362	15.8	17.7	16.7
RCH. 362 Bt	15.5	16.2	15.8
RCH. 368	12.9	16.9	14.9
RCH. 368 Bt	14.9	17.7	16.3
BUNNY (ZC)	15.6	14.5	15.1
LC (HYBRID)	16.8	17.5	17.2
MECH. 162 Bt (CC)	14.7	17.5	16.1
CD @ 5%	NS	3.3	Mean
CV %	12.6	29.1	16.0

## Length of Sympodia

The average sympodial length varied between 22.6 cm in RCH.368Bt to 36.9 cm in RCH.2Bt. The following table gives the variation in this regard between test hybrids.

Average length (cm) of Sympodia in test entries

Genotype	DHARWAD	NANDYAL	Mean
MRC. 6160	15.1	49.2	32.2
MRC. 6160 Bt	23.1	30.6	26.9
MRC. 6322	26.6	34.6	30.6
MRC. 6322 Bt	25.2	31.0	28.1
MRC. 6703	29.8	64.8	47.3
MRC. 6703 Bt	22.1	39.4	30.8
RCH.2	37.5	43.2	40.4
RCH. 2 Bt	25.2	48.6	36.9
RCH. 20	29.4	50.4	39.9
RCH. 20 Bt	20.2	30.0	25.1
RCH. 344	35.4	52.0	43.7
RCH. 344 Bt	22.2	27.6	24.9
RCH. 362	39.0	32.8	35.9
RCH. 362 Bt	26.7	46.0	36.4
RCH. 368	25.9	39.8	32.9
RCH. 368 Bt	19.3	25.8	22.6
BUNNY (ZC)	29.9	44.2	37.1
LC (HYBRID)	26.9	54.6	40.8
MECH. 162 Bt (CC)	25.7	31.8	28.8
CD @ 5%	10.1	-	
CV %	18.4	-	

Number of bolls/plant

The average number of bolls per plant in all Bt hybrids was consistently above 21. the highest boll number was recorded in RCH.2Bt, as seen from the following table.

Average number of bolls per plant

Genotype	DHARWAD	SIRUGUPPA	COIMBATORE	NANDYAL	Mean
MRC. 6160	14.6	21.8	34.5	8.2	19.8
MRC. 6160 Bt	19.9	30.2	30.5	11.8	23.1
MRC. 6322	17.0	28.1	33.5	8.9	21.9
MRC. 6322 Bt	22.7	27.2	31.0	11.2	23.0
MRC. 6703	22.0	24.2	30.0	12.9	22.3
MRC. 6703 Bt	21.7	34.2	32.5	16.8	26.3
RCH.2	20.5	22.7	40.0	10.9	23.5
RCH. 2 Bt	22.7	29.9	42.5	11.8	26.7
RCH. 20	14.0	20.7	31.5	9.9	19.0
RCH. 20 Bt	25.4	35.0	37.5	14.9	28.2
RCH. 344	10.7	16.4	39.5	16.6	20.8
RCH. 344 Bt	22.2	22.9	31.0	10.5	21.7

RCH. 362	18.9	17.9	45.0	8.6	22.6
RCH. 362 Bt	27.3	31.6	29.5	12.8	25.3
RCH. 368	20.3	22.1	43.5	10.4	24.1
RCH. 368 Bt	23.5	21.2	32.5	12.7	22.5
BUNNY (ZC)	15.0	23.0	31.0	9.5	19.6
LC (HYBRID)	19.5	27.5	46.5	13.3	26.7
MECH. 162 Bt (CC)	17.9	25.6	34.0	9.7	21.8
CD @ 5%	7.5	10.1	11.2	-	
CV %	17.8	19.0	-	-	

## Boll weight

### Average boll weight (g)

Genotype	DHARWAD	SIRUGUPPA	COIMBATORE	NANDYAL	Mean
MRC. 6160	5.1	4.6	5.0	4.0	4.7
MRC. 6160 Bt	5.5	5.0	5.2	4.6	5.1
MRC. 6322	5.2	4.3	5.0	5.2	4.9
MRC. 6322 Bt	5.5	5.1	4.9	5.3	5.2
MRC. 6703	4.7	4.6	4.3	3.3	4.2
MRC. 6703 Bt	5.1	4.9	4.3	5.7	5.0
RCH.2	4.8	4.9	4.8	4.0	4.6
RCH. 2 Bt	5.3	4.7	4.9	4.8	4.9
RCH. 20	5.6	4.0	5.8	4.4	5.0
RCH. 20 Bt	5.4	5.2	5.3	4.2	5.0
RCH. 344	5.7	5.1	6.2	4.4	5.4
RCH. 344 Bt	5.9	4.6	5.3	4.6	5.1
RCH. 362	4.9	5.4	5.0	4.7	5.0
RCH. 362 Bt	5.9	5.6	5.5	4.5	5.4
RCH. 368	4.7	4.9	5.3	3.5	4.6
RCH. 368 Bt	6.0	5.6	5.6	4.3	5.4
BUNNY (ZC)	5.1	5.0	4.7	4.0	4.7
LC (HYBRID)	5.5	4.9	4.9	4.8	5.0
MECH. 162 Bt (CC)	5.7	5.1	5.2	4.1	5.0
CD @ 5%	1.8	NS	0.4	-	
CV %	6.4	9.3	-	-	

The above table shows that there was no significant variation between centers for this parameter in Bt and non-Bt hybrids.

## Seed cotton yield

The seed cotton yield of various test entries showed that RCH.2Bt (1935 g/ha) followed by RCH.368Bt (1803 kg/ha) and RCH.362Bt (1783 kg/ha) occupied



the first three slots. All Bt test hybrids recorded higher yield over check Bt hybrid as well as than check hybrids and non-Bt counterparts. RCH.2Bt consistently performed in south zone over the last two years for seed cotton yield.

#### Seed cotton yield (kg/ha)

Genotype	DHARWAD	SIRU GUPPA	COIMBA TORE	NANDYAL	Mean
MRC. 6160	775	1102	1163	321	840
MRC. 6160 Bt	1582	1844	1617	1627	1668
MRC. 6322	1173	1145	1262	570	1038
MRC. 6322 Bt	1685	1753	1214	1778	1608
MRC. 6703	976	940	1114	1113	1036
MRC. 6703 Bt	1613	1790	1185	2282	1718
RCH.2	959	858	1655	478	988
RCH. 2 Bt	2152	1696	2181	1712	<b>1935</b>
RCH. 20	936	809	1633	591	992
RCH. 20 Bt	2038	1381	1996	1575	1748
RCH. 344	635	810	2218	1177	1210
RCH. 344 Bt	2148	1580	1762	1437	1732
RCH. 362	1459	991	2042	594	1272
RCH. 362 Bt	1933	2238	1523	1438	<b>1783</b>
RCH. 368	893	833	2113	578	1104
RCH. 368 Bt	1759	1829	1975	1650	<b>1803</b>
BUNNY (ZC)	1057	918	1169	891	1009
LC (HYBRID)	1175	1191	1264	1686	1329
MECH. 162 Bt (CC)	1848	1552	1282	1213	1474
CD @ 5%	460	536	709	287	
CV %	10.2	19.2	21.0	11.0	

The zonal average of lint index and seed index, as seen from the following tables did not vary much between hybrids.

#### Lint Index

##### Lint Index (g)

Genotype	DHARWAD	SIRUGUPPA	COIMBATORE	NANDYAL	Mean
MRC. 6160	5.8	5.2	6.3	5.0	5.6
MRC. 6160 Bt	6.6	5.9	6.5	5.0	6.0
MRC. 6322	6.2	5.4	6.7	7.0	6.3
MRC. 6322 Bt	7.4	6.0	6.3	6.0	6.4
MRC. 6703	6.2	6.0	6.2	6.0	6.1

MRC. 6703 Bt	6.9	6.0	6.3	8.0	6.8
RCH.2	5.9	5.6	6.9	5.0	5.9
RCH. 2 Bt	6.6	5.6	7.2	6.0	6.4
RCH. 20	7.6	6.3	7.1	7.0	7.0
RCH. 20 Bt	6.8	6.1	6.0	5.0	6.0
RCH. 344	7.4	5.9	8.0	6.0	6.8
RCH. 344 Bt	7.8	7.6	7.4	6.0	7.2
RCH. 362	6.4	5.7	6.7	6.0	6.2
RCH. 362 Bt	7.4	6.8	7.0	6.0	6.8
RCH. 368	6.7	5.9	7.1	5.0	6.2
RCH. 368 Bt	7.9	7.1	7.5	6.0	7.1
BUNNY (ZC)	6.4	4.7	6.3	4.0	5.4
LC (HYBRID)	6.6	4.7	6.2	6.0	5.9
MECH. 162 Bt (CC)	7.5	6.2	6.4	5.0	6.3
CD @ 5%	0.6	0.9	0.7	-	
CV %	5.8	7.0	15.5	-	

## Seed index

The mean seed index values as given below shows that most of entries including Bt hybrids had no variation in this regard. The check hybrids as well non-Bt hybrids also shared similar values.

### Seed index (g)

Genotype	DHARWAD	SIRUGUPPA	COIMBATORE	NANDYAL	Mean
MRC. 6160	10.6	10.1	10.7	10.0	10.4
MRC. 6160 Bt	11.2	11.0	11.1	9.0	10.6
MRC. 6322	11.1	9.9	11.5	10.0	10.6
MRC. 6322 Bt	12.5	11.9	11.0	13.0	12.1
MRC. 6703	10.0	10.6	10.2	13.0	11.0
MRC. 6703 Bt	11.3	10.0	9.8	11.0	10.5
RCH.2	11.0	12.2	12.6	10.0	11.5
RCH. 2 Bt	11.6	10.4	12.0	8.0	10.5
RCH. 20	14.3	12.9	14.1	10.0	12.8
RCH. 20 Bt	13.2	11.3	14.4	10.0	12.2
RCH. 344	12.7	12.6	12.6	11.0	12.2
RCH. 344 Bt	12.3	12.5	11.3	8.0	11.0
RCH. 362	9.8	10.3	10.6	13.0	10.9
RCH. 362 Bt	11.0	11.4	10.6	12.0	11.3
RCH. 368	10.3	11.5	11.4	11.0	11.1
RCH. 368 Bt	12.1	11.8	11.6	11.0	11.6
BUNNY (ZC)	11.2	10.3	11.1	8.0	10.2
LC (HYBRID)	9.9	8.6	10.7	10.0	9.8
MECH. 162 Bt (CC)	10.6	9.9	9.6	11.0	10.3
CD @ 5%	1.3	1.8	1.4	-	
CV %	5.6	7.8	18.2	-	

## Ginning outturn

The average Ginning outturn percentage was seen to be high in MRC.6703Bt followed by RCH.344Bt (table below). All other Bt hybrids showed similar range as in the case Bt check hybrid, the lowest being in RCH.20Bt.

Ginning outturn (%)

Genotype	DHARWAD	SIRUGUPPA	COIMBATORE	NANDYAL	Mean
MRC. 6160	35.2	34.2	37.0	33.3	34.9
MRC. 6160 Bt	36.9	34.7	37.0	35.7	36.1
MRC. 6322	35.8	35.1	36.5	41.2	37.1
MRC. 6322 Bt	37.3	33.5	36.0	31.6	34.6
MRC. 6703	38.1	36.0	38.0	31.6	35.9
MRC. 6703 Bt	37.8	37.4	39.5	42.1	<b>39.2</b>
RCH.2	35.1	31.4	35.0	33.3	33.7
RCH. 2 Bt	36.3	35.0	37.5	42.9	37.9
RCH. 20	34.7	32.9	33.5	41.2	35.6
RCH. 20 Bt	34.0	35.1	34.0	33.3	34.1
RCH. 344	36.7	32.2	39.0	35.3	35.8
RCH. 344 Bt	38.8	37.6	39.5	42.9	<b>39.7</b>
RCH. 362	39.3	35.5	38.5	31.6	36.2
RCH. 362 Bt	40.1	37.6	39.5	33.3	37.6
RCH. 368	39.4	33.9	38.5	31.3	35.8
RCH. 368 Bt	39.4	37.4	39.5	35.3	37.9
BUNNY (ZC)	36.4	31.8	36.0	33.3	34.4
LC (HYBRID)	39.9	31.8	36.0	37.5	36.3
MECH. 162 Bt (CC)	41.5	38.3	40.5	31.3	37.9
CD @ 5%	1.1	NS	1.9		
CV %	1.8	6.3	7.4		

## Fibre property parameters

Under rainfed condition of Nandyal, the fibre property data shows that RCH.368Bt recorded the best strength: length ratio of 0.90 followed by MRC.6160Bt and MRC.6322Bt. RCH.344 non-Bt also recorded 0.94 as this ratio. The local check hybrid had similar data as that of the best Bt hybrids.

Nandyal center

Genotype	2.5% SL Length (l) mm	Bundle Strength Tenacity (g/tex) at 3.2 mm gauge (t)	T/l ratio	Fineness Micronaire 10 <sup>-6</sup> g/in	Uniformity Ratio (%)
RCH.344 Bt	28.4	21.7	0.76	4.2	48.5
RCH. 362 Bt	28.8	21.3	0.74	3.7	45.2
RCH. 368 Bt	<b>25.1</b>	<b>22.7</b>	<b>0.90</b>	<b>3.9</b>	<b>48.9</b>
MRC. 6160 Bt	25.0	20.2	0.81	3.9	52.2
MRC. 6322 Bt	24.3	20.4	0.83	3.1	46.6
MRC. 6703 Bt	25.4	17.0	0.66	3.3	48.7
RCH.2 Bt	27.8	19.1	0.68	4.0	49.1
RCH.20Bt	29.3	19.0	0.64	3.7	44.3
LAHH.5/DHH.11/SAVITA (Local checks)	<b>27.6</b>	<b>23.9</b>	<b>0.86</b>	<b>3.6</b>	<b>48.8</b>
BUNNY (Zonal check)	26.8	20.8	0.78	4.0	46.7
MECH.162 Bt (Bt check)	25.2	18.0	0.71	3.8	43.7
RCH.344	<b>23.5</b>	<b>22.2</b>	<b>0.94</b>	<b>4.2</b>	<b>48.8</b>
RCH. 362	24.6	16.0	0.65	4.4	48.0
RCH. 368	27.6	19.8	0.71	3.4	47.2
MRC. 6160	28.3	23.9	0.84	3.1	45.2
MRC. 6322	25.3	22.2	0.87	3.7	49.9
MRC. 6703	25.1	23.1	0.92	2.7	47.2
RCH.2	27.7	21.6	0.78	3.6	49.2
RCH.20	30.2	20.3	0.87	4.0	45.9

Dharwad center

The fibre property recorded in the irrigated trial at Dharwad, although affected by a general drought, showed similar results as that of Nandyal. The Bt hybrids showed above 0.8 ratio of strength to length, RCH.368Bt being the highest (0.85). Amongst the others, MRC.6160 non Bt hybrid recorded 0.86. The check hybrid also had 0.82.

Genotype	2.5% SL Length (l) mm	Bundle Strength Tenacity (g/tex) at 3.2 mm gauge (t)	T/l ratio	Fineness Micronaire 10 <sup>-6</sup> g/in	Uniformity Ratio (%)
RCH.344 Bt	30.2	24.6	0.81	4.9	49
RCH. 362 Bt	28.5	24.0	0.84	4.7	48
<b>RCH. 368 Bt</b>	<b>28.4</b>	<b>24.1</b>	<b>0.85</b>	<b>3.9</b>	<b>51</b>
MRC. 6160 Bt	27.3	22.9	0.83	4.3	49
MRC. 6322 Bt	28.5	23.0	0.81	3.6	49
MRC. 6703 Bt	27.2	22.1	0.81	4.2	50

RCH.2 Bt	27.6	23.2	0.84	4.3	50
RCH.20Bt	31.6	23.4	0.75	3.6	50
LAHH.5/DHH.11/SAVITA (Local checks)	<b>26.6</b>	<b>21.9</b>	<b>0.82</b>	<b>4.3</b>	<b>51</b>
BUNNY (Zonal check)	30.2	22.9	0.76	3.7	47
MECH.162 Bt (Bt check)	26.7	20.4	0.76	4.5	46
RCH.344	30.7	24.2	0.79	4.3	47
RCH. 362	28.9	23.7	0.82	4.7	49
RCH. 368	28.8	23.5	0.82	4.2	50
<b>MRC. 6160</b>	<b>27.1</b>	<b>23.2</b>	<b>0.86</b>	<b>3.5</b>	<b>51</b>
MRC. 6322	27.8	22.3	0.80	3.7	50
MRC. 6703	26.7	21.3	0.80	4.1	50
RCH.2	28.5	22.6	0.79	4.0	49
RCH.20	32.2	24.3	0.75	3.8	48



PLANT PROTECTION EVALUATION

# Plant protection evaluations

During 2003 - 04 winter cotton season eight Bt cotton hybrids viz., RCH 2, RCH 20, RCH 344, RCH 362, RCH 368, MRC 6160, MRC 6322 and MRC 6703 were evaluated against cotton pests with special reference to bollworms along with their non-Bt counterparts and check hybrids viz., MECH 162 Bt, Savita and Bunny. Detailed observations on bollworms incidence, damage to fruiting bodies along with the incidence of sap sucking insects pests and seed cotton yield were carried out.

## Dharwad

The eggs of Spotted bollworm and American bollworm was observed in the plots between 25-29 days after sowing. However, the second instar larvae of these pests were prominently seen only after 80-100 days after sowing, as is given below.

### PEST PHENOLOGY DETAILS

Genotype	First egg seen (DAS)		First 2 <sup>nd</sup> instar larva seen (DAS)	
	SBW	ABW	SBW	ABW
RCH.344 Bt	26	39	100	100
RCH. 362	27	41	80	100
RCH.2 Bt	29	41	100	100
RCH.2	26	42	80	100
MRC. 6322	27	42	90	110
BUNNY (Zonal check)	25	43	80	100
MRC. 6703	28	41	80	100
MRC. 6160 Bt	29	42	100	110
LAHH.5/DHH.11/SAVITA (Local checks)	24	38	90	110
RCH.344	26	40	80	100
MRC. 6160	27	41	100	100
RCH. 368 Bt	28	39	100	100
MRC. 6322 Bt	28	41	100	100
RCH. 368	25	43	100	100
RCH. 362 Bt	27	41	90	110
MRC. 6703 Bt	25	42	80	100
MECH.162 Bt (Bt check)	28	40	80	100
RCH.20	27	38	90	110
RCH.20Bt	29	41	100	100

DAS: Days after sowing

SBW = SPOTTED/SPINY BOLLWORM, ABW=AMERICAN BOLLWORM, PBW = PINK BOLLWORM

The per cent square damage under protected conditions was lower in all entries when compared to the same under unprotected conditions. However, there was significant reduction in square damage in Bt hybrids over on-Bt and check hybrids. The lowest square damage was seen this zone MRC.6160Bt, RCH.362Bt and RCH.2Bt and Siruguppa centre recorded more damage than Coimbatore centre.

#### Peak Percent SQUARE DAMAGE in Protected Breeding Plots

Genotype	Coimbatore 96 DAS	Siruguppa 55 DAS	MEAN
RCH.344 Bt	2.7	8.6	6.48
RCH. 362 Bt	2.6	4.8	2.47
RCH. 368 Bt	5.2	9.4	4.87
MRC. 6160 Bt	3.3	3.5	2.27
MRC. 6322 Bt	9.0	4.7	4.57
MRC. 6703 Bt	2.6	7.0	3.20
RCH.2 Bt	2.1	6.6	2.90
RCH.20Bt	3.5	11.7	5.07
LAHH.1/DHH.11/Savita (Local checks)	7.7	14.8	7.50
BUNNY (Zonal check)	8.7	23.3	10.67
MECH.162 Bt (Bt check)	4.0	16.7	6.9
RCH.344	7.9	25.2	11.03
RCH. 362	8.7	27.6	12.1
RCH. 368	8.1	23.9	10.67
MRC. 6160	5.6	27.9	11.17
MRC. 6322	9.0	10.7	6.57
MRC. 6703	10.6	20.4	10.33
RCH.2	6.4	14.7	7.03
RCH.20	11.1	23.1	11.4

The per cent open boll damage is given below. RCH.362Bt and MRC.6322Bt had the highest damage amongst Bt hybrids in as much as in check hybrids as well as higher than MEH.162Bt. The rest of Bt hybrids were at par with this Bt check hybrid.

#### OPEN BOLL DAMAGE in Protected Breeding Plots

Genotype	Coimbatore	Siruguppa	MEAN
RCH.344 Bt	3.9 (7.5)	10.9	5.74
RCH. 362 Bt	6.4 (14.7)	12.3	11.81
RCH. 368 Bt	9.2 (17.7)	11.2	6.73
MRC. 6160 Bt	4.1 (11.7)	10.6	5.35
MRC. 6322 Bt	9.2 (17.7)	11.8	15.04
MRC. 6703 Bt	12.0 (20.3)	13.6	8.27



RCH.2 Bt	7.5 (13.3)	12.8	7.56
RCH.20Bt	5.8 (13.9)	15.3	7.38
LAHH.1/DHH.11/Savita (Local checks)	26.2 (30.8)	19.6	16.64
BUNNY (Zonal check)	29.4 (32.8)	12.5	18.84
MECH.162 Bt (Bt check)	11.3 (19.6)	21.1	9.26
RCH.344	29.9 (33.1)	28.3	20.24
RCH. 362	21.5 (27.6)	22.4	14.08
RCH. 368	22.2 (28.1)	17.9	18.09
MRC. 6160	36.3 (37.0)	22.9	17.46
MRC. 6322	31.4 (34.1)	17.2	20.60
MRC. 6703	25.8 (30.5)	15.6	16.41
RCH.2	32.0 (34.4)	23.3	18.96
RCH.20	48.0 (43.9)	16.5	19.06
CD (P=0.05)	10.81	-	
CV %	20.58	-	

The per cent Open locule damage was the lowest in all Bt hybrids. MRC.6160Bt, RCH.344Bt, RCH.20Bt and RCH.2Bt recorded the lowest per cent locule damage. Maximum damage of 26.3% was recorded in RCH.20 hybrid.

#### Percent Open locule damage in Protected Plots

Genotype	Coimbatore
RCH.344 Bt	3.9 (11.4)
RCH. 362 Bt	5.5 (13.6)
RCH. 368 Bt	5.3 (13.3)
MRC. 6160 Bt	2.2 (8.5)
MRC. 6322 Bt	4.0 (11.5)
MRC. 6703 Bt	6.6 (14.9)
RCH.2 Bt	3.7 (11.1)
RCH.20Bt	2.9 (9.8)
LAHH.1/DHH.11/Savita (Local checks)	15.4 (23.1)
BUNNY (Zonal check)	16.1 (23.7)
MECH.162 Bt (Bt check)	7.5 (15.9)
RCH.344	16.8 (24.2)
RCH. 362	11.5 (19.8)
RCH. 368	11.2 (19.6)
MRC. 6160	20.1 (26.6)
MRC. 6322	18.2 (25.3)
MRC. 6703	13.4 (21.5)
RCH.2	19.4 (26.1)
RCH.20	26.3 (30.9)
CD (P=0.05)	7.73
CV %	20.18

similar evaluations were undertaken under unprotected conditions. It was found that the square damage in MRC.6322Bt and RCH.362Bt had higher square damage than Bt check hybrid. However, the lowest square damage was

recorded in MRC.6160Bt (4.1%) and MRC.6703Bt (5.3%). Damage to squares was noticed to be more in Dharwad and Siruguppa in all entries over that in Coimbatore trial.

## Evaluation in unprotected Entomology plots

### Peak Percent SQUARE DAMAGE

Genotype	Dharwad 77 DAS	Coimbatore 96 DAS	Siruguppa 55 DAS	MEAN
RCH.344 Bt	8.15	4.0	9.6	7.25
RCH. 362 Bt	28.55	0.0	7.2	11.92
RCH. 368 Bt	8.62	3.9	11.6	8.04
MRC. 6160 Bt	6.70	3.4	2.2	4.10
MRC. 6322 Bt	39.15	1.9	5.1	15.38
MRC. 6703 Bt	7.50	0.0	8.4	5.30
RCH.2 Bt	9.95	1.4	7.2	6.18
RCH.20Bt	8.40	1.6	10.2	6.73
LAHH.1/DHH.11/Savita (Local checks)	20.75	7.5	17.3	15.18
BUNNY (Zonal check)	33.45	0.0	22.7	18.72
MECH.162 Bt (Bt check)	7.50	2.3	24.7	11.50
RCH.344	22.75	0.0	23.9	15.55
RCH. 362	12.4	8.9	24.5	15.27
RCH. 368	35.50	10.6	25.2	23.77
MRC. 6160	10.65	10.8	28.4	16.62
MRC. 6322	33.80	8.5	13.6	18.63
MRC. 6703	24.25	14.1	24.0	20.78
RCH.2	20.55	2.0	15.2	12.58
RCH.20	11.75	3.5	23.0	12.75

The percent open boll damage, as given below, was virtually fifty percent of that in non-Bt hybrids as well as in check hybrids. The highest per cent was in MRC.6322Bt (20.88%) followed by RCH.362Bt (16.92%).

### Per cent OPEN BOLL DAMAGE

Genotype	Dharwad	Coimbatore	Siruguppa	MEAN
RCH.344 Bt	8.15	11.4 (19.7)	11.8	10.45
RCH. 362 Bt	28.55	8.6 (17.1)	13.6	16.92
RCH. 368 Bt	6.50	24.4 (29.6)	14.1	15.00
MRC. 6160 Bt	6.70	15.1 (22.9)	8.8	10.20
MRC. 6322 Bt	39.15	9.6 (18.0)	13.9	20.88
MRC. 6703 Bt	7.50	9.7 (18.1)	16.3	11.17
RCH.2 Bt	9.95	14.9 (22.7)	11.4	12.08
RCH.20Bt	8.40	9.9 (18.3)	18.8	12.37
LAHH.1/DHH.11/Savita (Local checks)	20.75	40.3 (39.4)	20.1	27.05
BUNNY (Zonal check)	33.45	39.8 (39.1)	24.8	32.68

MECH.162 Bt (Bt check)	4.65	16.0 (23.6)	28.6	16.42
RCH.344	22.75	34.6 (36.0)	14.0	23.78
RCH. 362	12.40	33.6 (33.6)	19.4	21.8
RCH. 368	35.50	32.8 (34.9)	13.8	27.37
MRC. 6160	10.65	50.7 (45.4)	19.6	26.98
MRC. 6322	33.80	34.1 (35.7)	18.7	28.87
MRC. 6703	24.25	25.5 (30.3)	16.4	22.05
RCH.2	20.55	40.0 (39.2)	20.8	27.12
RCH.20	11.75	41.1 (39.9)	18.1	23.65
CD (P=0.05)	-	8.68	-	
CV %	-	13.91	-	

The per cent open locule damage under unprotected conditions did follow similar trend as in the case of the data given for Bt hybrids under protected conditions, given above. MRC.6703Bt had numerically higher damage than MECH.162Bt, which is the check hybrid. Other Bt hybrids had distinctly lower damage than their non-Bt counterparts, Bt check hybrid as well as other check hybrids.

#### Percent Open locule damage

Genotype	Dharwad	Nandyal	Coimbatore	MEAN
RCH.344 Bt	4.70	15.8	5.8 (13.9)	8.77
RCH. 362 Bt	2.90	5.0	3.5 (13.9)	3.80
RCH. 368 Bt	7.98	10.8	12.4 (13.9)	10.39
MRC. 6160 Bt	6.12	13.3	8.0 (13.9)	9.14
MRC. 6322 Bt	3.08	10.8	6.1 (13.9)	6.66
MRC. 6703 Bt	4.81	21.7	3.4 (13.9)	9.97
RCH.2 Bt	5.27	6.7	7.6 (13.9)	6.52
RCH.20Bt	3.39	11.7	5.9 (13.9)	6.99
LAHH.1/DHH.11/Savita (Local checks)	19.85	23.3	22.8 (13.9)	21.98
BUNNY (Zonal check)	30.58	10.0	22.2 (13.9)	20.93
MECH.162 Bt (Bt check)	5.29	11.7	8.2 (13.9)	8.39
RCH.344	22.75	26.7	14.4 (13.9)	21.28
RCH. 362	17.55	12.5	18.6 (13.9)	16.22
RCH. 368	21.39	17.5	20.1 (13.9)	19.66
MRC. 6160	23.03	9.16	21.7 (13.9)	17.96
MRC. 6322	22.16	5.8	19.5 (13.9)	15.82
MRC. 6703	19.75	20.8	13.1 (13.9)	17.88
RCH.2	26.91	31.7	20.0 (13.9)	26.20
RCH.20	24.70	16.7	28.0 (13.9)	23.13
CD (P=0.05)	-	-	5.59	-
CV %	-	-	12.69	-

#### SAP SUCKING PESTS

The aphids were found to infest the crop in all plots by 15<sup>th</sup> July cross the threshold, while thrips were observed by 30<sup>th</sup> August. Jassids were found to cross threshold in various plots by 13<sup>th</sup> October. No whitefly was seen through

out the crop season. There was no difference between Bt and non-Bt hybrids with regard to the infestation of any of the sap-sucking pests in this center.

#### SIRUGUPPA

The sap sucking pests were similar in pattern of infestation in unprotected and protected plots, as can be seen from the table below. Due to drought conditions, the general population of jassids was low; however, their numbers on three leaves per plant did show a significant difference between various entries.

Mean jassid population per plant (on three leaves)

Genotype	ENTOMOLOGY (UNPROTECTED)		BREEDING (PROTECTED)	
	DAYS AFTER SOWING		DAYS AFTER SOWING	
	35	45	35	45
RCH.344 Bt	8.2	5.9	6.6	6.0
RCH. 362 Bt	14.3	20.0	13.0	17.8
RCH. 368 Bt	9.0	12.5	8.5	13.3
MRC. 6160 Bt	11.2	16.0	9.4	14.0
MRC. 6322 Bt	5.0	3.2	5.1	3.9
MRC. 6703 Bt	2.4	4.5	3.8	4.4
RCH.2 Bt	7.6	8.5	9.0	8.0
RCH.20Bt	9.6	8.1	9.3	9.0
LAHH.1/DHH.11/Savita (Local checks)	8.4	13.2	4.2	12.6
BUNNY (Zonal check)	11.8	9.7	10.5	8.8
MECH.162 Bt (Bt check)	6.8	18.3	7.1	16.9
RCH.344	3.7	9.6	3.8	8.7
RCH. 362	3.2	2.8	4.2	3.6
RCH. 368	5.2	20	3.7	3.7
MRC. 6160	5.7	2.5	6.9	4.7
MRC. 6322	12.4	12.2	13.4	12.0
MRC. 6703	2.6	30	3.9	5.2
RCH.2	4.6	2.4	3.1	4.3
RCH.20	7.6	11.3	6.1	13.5

The seed cotton yield data under unprotected condition can be seen in the following table. The distinct difference of Bt hybrids in yielding 25-30% more than check hybrids is clear. After looking into data of above parameters, there is obvious superiority of all Bt hybrids over the checks. RCH.362Bt (1583

kg/ha) gave the highest yield, followed by RCH.2Bt (1520.75 kg/ha) and MRC.6703Bt seed cotton (1487 kg/ha).

Seed cotton yield (kg/ha) - **unprotected plots**

Genotype	Dharwad	Nandyal	Coimbatore	Siruguppa	Mean
RCH.2 Bt	2365	966	1891	861	<b>1520.75</b>
RCH.20Bt	1339	988	1739	915	1245.25
RCH.344 Bt	2287	559	1986	724	1389.00
RCH. 362 Bt	2065	989	1631	1647	<b>1583.00</b>
RCH. 368 Bt	2184	462	1998	784	1357.00
MRC. 6160 Bt	1935	901	1797	745	1344.50
MRC. 6322 Bt	2303	1038	1460	858	1414.75
MRC. 6703 Bt	2396	1066	1452	1034	<b>1487.00</b>
LAHH.1/DHH.11/Savita (Local checks)	1426	645	740	315	781.50
BUNNY (Zonal check)	2307	765	1093	699	1216.00
MECH.162 Bt (Bt check)	1321	494	1668	664	1036.75
RCH.2	1339	1070	1062	147	904.50
RCH.20	1109	764	679	179	682.75
RCH.344	1214	1183	866	131	848.50
RCH. 362	1415	1192	1193	290	1022.50
RCH. 368	1375	854	1272	338	959.75
MRC. 6160	1285	745	1219	269	879.50
MRC. 6322	1373	1378	1485	431	1166.75
MRC. 6703	1330	389	1440	472	907.75
CD (P=0.05)	322	209.92	737	590	
CV %	9.12	35.58	12.69	26.7	

A comparison of the seed cotton yield of both protected and non-protected plots showed through the following table that RCH.2Bt and RCH.362Bt hybrids had consistent superiority over other Bt hybrids. Under protected conditions, the performance of MRC.6703Bt and RCH.368Bt in terms of better seed cotton yield was distinct. The conclusion from this year's data is that although under drought conditions, the south zone evaluations showed that Bt hybrids are superior to all other test hybrids. The superiority of yield in the Bt hybrids such as RCH.2, RCH.362 and MRC.6703, even under unprotected condition is distinct.

Comparative seed cotton yield (kg/ha)

Genotype	Mean seed cotton yield	
	Unprotected	Protected
RCH. 2 Bt	<b>1520.75</b>	<b>1935</b>
RCH. 20 Bt	1245.25	1748

RCH. 344 Bt	1389.00	1732
RCH. 362 Bt	<b>1583.00</b>	<b>1783</b>
RCH. 368 Bt	1357.00	<b>1803</b>
MRC.6160 Bt	1344.50	1668
MRC. 6322 Bt	1414.75	1608
MRC. 6703 Bt	<b>1487.00</b>	<b>1718</b>
BUNNY (ZC)	781.50	1009
LC (HYBRID)	1216.00	1329
MECH. 162 Bt (CC)	1036.75	1474
RCH.2	904.50	988
RCH. 20	682.75	992
RCH. 344	848.50	1210
RCH. 362	1022.50	1272
RCH. 368	959.75	1104
MRC.6160	879.50	840
MRC. 6322	1166.75	1038
MRC. 6703	907.75	1036

Based on the data of Coimbatore center in the following data of Coimbatore, under sprayed conditions of Breeding plots, the per cent increase in net returns is recorded in MRC.6160Bt followed by RCH.2Bt hybrids over corresponding non-Bt hybrids as well as over Bt check hybrid. RCH.20 recorded better returns on investment over MECH.162 Bt.

#### Yield and Economics under sprayed condition

Entries	Yield kg/ha	Gross Returns Rs./ha	No. of spray		PP Cost Rs./ha	Net Returns Rs./ha	Percent Increase	
			SP	BW			*	**
RCH 2 Bt	2181	56706	4	0	6200	50506	<b>43.5</b>	107.8
RCH 2	1655	43030	4	3	7825	35205		
RCH 20 Bt	1996	51896	4	1	7575	44321	33.3	82.4
RCH 20	1633	42458	4	4	9200	33258		
RCH 344 Bt	1762	45812	4	0	6200	39612	-	
RCH 344	2218	57668	4	5	10575	47093		
RCH 362 Bt	1523	39598	4	1	7575	32023	-	
RCH 362	2042	53092	4	4	9200	43892		
RCH 368 Bt	1975	51350	4	2	8950	42400	-	
RCH 368	2113	54938	4	4	9200	45738		
MRC. 6160 Bt	1617	42042	4	2	8950	33092	<b>57.3</b>	62.9
MRC. 6160	1163	30238	4	4	9200	21038		
MRC. 6322 Bt	1214	31564	4	1	7575	23989	1.6	-
MRC. 6322	1262	32812	4	4	9200	23612		

MRC. 6703 Bt	1185	30810	4	0	6200	24610	24.5	1.3
MRC. 6703	1114	28964	4	4	9200	19764		
Savita	1264	32864	4	4	9200	23664		
Bunny	1169	30394	4	5	10575	19819		
MECH 162 Bt	1282	33332	4	2	8950	24302		

Sucking pest protection cost for 4 sprays Rs. 3700/ha and for bollworms @ Rs. 1375/ha / spray. Additional seed cost for Bt hybrids assumed as Rs. 2500 /ha. Returns worked out @ Rs. 26 / kg of seed cotton.

\* Over corresponding non- Bt, \*\* Over MECH 162 Bt

The data given below from Coimbatore trials show that the unprotected plots gave high net returns in the case of RCH.2Bt, RCH.20Bt, RCH.344Bt, RCH.362Bt, RCH.368Bt and MR.6160Bt over both corresponding non-Bt hybrids as well as over check Bt hybrid during this season.

#### Yield and Economics under unsprayed condition

Entries	Yield kg/ha	Gross Returns Rs./ha	PP Cost Rs./ha	Net Returns Rs./ha	Percent Increase	
					*	**
RCH 2 Bt	1891	49166	6200	42966	79.7	115.6
RCH 2	1062	27612	3700	23912		
RCH 20 Bt	1739	45214	6200	39014	179.6	5.0
RCH 20	679	17654	3700	13954		
RCH 344 Bt	1986	51636	6200	45436	141.5	22.2
RCH 344	866	22514	3700	18816		
RCH 362 Bt	1631	42406	6200	36206	32.5	21.7
RCH 362	1193	31018	3700	27318		
RCH 368 Bt	1998	51428	6200	45228	54.0	9.0
RCH 368	1272	33072	3700	29372		
MRC. 6160 Bt	1797	46722	6200	40522	44.8	
MRC. 6160	1217	31694	3700	27994		
MRC. 6322 Bt	1460	37960	6200	31760	-	
MRC. 6322	1485	38610	3700	34910		
MRC. 6703 Bt	1452	37752	6200	31552	-	
MRC. 6703	1440	37440	3700	33740		
Savita	740	19240	3700	15540		
Bunny	1093	28418	3700	24718		
MECH 162 Bt	1668	43368	6200	37168		

Sucking pests protection cost for 4 sprays Rs. 3700/ha. Additional seed cost for Bt hybrids assumed as Rs. 2500 /ha. Returns worked out @ Rs. 26 / kg of seed cotton.

\* Over corresponding non- Bt ; \*\* Over MECH 162 Bt

## Reaction against diseases

Due to inclement weather conditions, there was no disease outbreak in the test hybrids during this season in any of the centers, except in Dharwad, where report of Grey mildew disease at moderate levels was observed on most of the test hybrids. No significant variations in disease reaction to Grey mildew was seen in any of the Bt hybrids in comparison to check hybrids as well as their corresponding non-Bt hybrids.



***INTERSPECIFIC (H x B) Bt HYBRIDS  
EVALUATION***

## INTERSPECIFIC Bt HYBRID EVALUATION

In South Zone, the AICCIP also conducted an evaluation trial for two **interspecific (H x B) Bt hybrids** from M/S Mahyco Seeds Pvt. Ltd., Jalna, viz., MRC.6918Bt and MRC.6928Bt.

### Centres involved:

University of Agricultural Sciences, Cotton Research Station, Dharwad  
Tamil Nadu Agricultural Research University, RARS, Vaigai Dam  
Central Institute for Cotton Research, Regional Station, Coimbatore

### Test hybrid entries:

The following eight Bt hybrids were tested in this study in the above centres. There was also a Bt hybrid check in addition to zonal checks and local check hybrids.

INTERSPECIFIC (H x B) Bt hybrids with Bt Cry 1A (c) gene (Bollgard I)

MRC. 6918 Bt
MRC. 6928 Bt
Check hybrids DCH. 32 TCHB. 213 DHB. 105

### Bollgard I : H x H Entries - Coding details

Sr.No.	Code	Name
1	2393	MRC.6918 Bt
2	2394	MRC.6928 Bt
3	2395	DCH.32
4	2396	TCHB.213
5	2397	DHB.105
6	2398	MRC.6918
7	2399	MRC.6928

## BREEDING TRIAL

DESIGN-RBD - No. of treatments :7, 3 REPLICATIONS – 6 ROWS X 6 metre rows

R1	93	98	95	97	94	99	96
R2	95	94	93	97	96	98	99
R3	99	93	95	98	96	94	97

## PLANT PROTECTION TRIAL

DESIGN-RBD - No. of treatments :7, 3 REPLICATIONS – 6 ROWS X 6 metre rows

R1	93	98	95	97	94	99	96
R2	95	94	93	97	96	98	99
R3	99	93	95	98	96	94	97

## Breeding evaluation

### (Protected from bollworms at ETL)

The two inter-specific Bt hybrids as well as other check entries had a fairly high germination percentage. The under-mentioned tables provide the data on germination percentage, plant height and other biometric characteristics. These Bt hybrids also had similar height of 80 cm unlike DHB.105 (111.3 cm). MRC.6928 Bt had 2.2 sympodia while others had this below two.

### Germination percentage

Genotype	DHARWAD	VAIGAI	COIMBATORE	Mean
MRC. 6918	95.4	82.0	100.0	92.5
MRC. 6918 Bt	95.9	80.0	100.0	92.0
MRC. 6928	97.4	83.0	99.0	93.1
MRC. 6928 Bt	97.4	81.0	100.0	92.8
DCH. 32	96.9	85.0	100.0	94.0
TCHB. 213	92.4	85.0	99.0	92.1
DHB. 105	96.9	84.0	100.0	93.6
CD @ 5%	NS	-	-	
CV %	3.0	-	-	

Plant Height (cm)

Genotype	DHARWAD	COIMBATORE	Mean
MRC. 6918	81.9	80.1	81.0
MRC. 6918 Bt	82.7	85.3	84.0
MRC. 6928	75.9	85.9	80.9
MRC. 6928 Bt	77.0	79.4	78.2
DCH. 32	68.9	93.7	81.3
TCHB. 213	81.2	107.9	94.6
DHB. 105	96.6	125.9	111.3
CD @ 5%	13.2	30.7	
CV %	9.2	18.4	

No. of Monopodia

Genotype	DHARWAD	COIMBATORE	Mean
MRC. 6918	2.1	1.2	1.7
MRC. 6918 Bt	2.2	2.1	2.2
MRC. 6928	2.7	0.5	1.6
MRC. 6928 Bt	2.0	0.8	1.4
DCH. 32	2.0	0.9	1.5
TCHB. 213	2.9	1.6	2.3
DHB. 105	3.0	1.8	2.4
CD @ 5%	NS	1.0	
CV %	20.1	-	

The sympodial numbers were the highest in MRC.6918Bt (17.2) as is seen in the case of DHB.105. The two tables below depicts Sympodial characteristics. The length also was high in MRC.6918.

Number of Sympodia

Genotype	DHARWAD	COIMBATORE	Mean
MRC. 6918	15.9	18.5	17.2
MRC. 6918 Bt	16.5	17.9	17.2
MRC. 6928	13.1	17.9	15.5
MRC. 6928 Bt	13.3	17.9	15.6
DCH. 32	13.5	18.1	15.8
TCHB. 213	13.1	20.1	16.6
DHB. 105	14.8	19.9	17.4
CD @ 5%	2.0	3.9	
CV %	7.6	18.1	

Length of Sympodia (cm)

Genotype	DHARWAD	VAIGAI	Mean
MRC. 6918	34.5	21.7	28.1
MRC. 6918 Bt	29.6	34.1	31.9
MRC. 6928	38.7	23.6	31.2
MRC. 6928 Bt	31.7	21.3	26.5
DCH. 32	30.7	21.3	26.0
TCHB. 213	38.3	39.4	38.9
DHB. 105	23.3	37.1	30.2
CD @ 5%	16.2	-	
CV %	14.2	-	

No. of bolls/plant

Genotype	DHARWAD	VAIGAI	COIMBATORE	Mean
MRC. 6918	29.6	42.8	41.3	37.9
MRC. 6918 Bt	32.3	36.4	37.0	35.2
MRC. 6928	23.1	41.9	33.3	32.8
MRC. 6928 Bt	27.3	41.6	37.7	35.5
DCH. 32	24.1	38.8	39.0	34.0
TCHB. 213	20.8	44.0	42.0	35.6
DHB. 105	29.5	35.1	48.7	37.8
CD @ 5%	7.0	-	14.7	
CV %	14.7	-	31.6	

The boll weight of these Bt hybrids was around 4.0 g, the check hybrids, having lower boll weight, and the seed cotton yield showed that the Bt hybrids were better than their non-Bt counterparts during this *kharif* season. Although there was no appreciable seed cotton yield, as is south zone states known for, due to prevailing drought, the Bt hybrids were better than their non-Bt counterparts as well as with check hybrids. DHB.105 gave 1471 kg/ha seed cotton yield and was similar to Bt hybrids in this respect.

Boll weight (g)

Genotype	DHARWAD	VAIGAI	COIMBATORE	Mean
MRC. 6918	4.0	3.6	3.8	3.8
MRC. 6918 Bt	4.3	4.0	3.8	4.0
MRC. 6928	3.8	3.6	4.2	3.9
MRC. 6928 Bt	4.6	4.4	3.9	4.3
DCH. 32	3.9	3.7	3.8	3.8
TCHB. 213	3.7	4.1	4.2	4.0

DHB. 105	3.6	3.7	3.8	3.7
CD @ 5%	0.4	-	0.6	
CV %	6.2	-	9.3	

## Seed cotton yield

Although seed cotton yield was lower than expected, as south zone states were known for, due to prevailing drought, the Bt hybrids were better than their non-Bt counterparts as well as with check hybrids. The highest yield was in MRC.6918Bt (1628 kg/ha). DHB.105 gave 1618 kg/ha seed cotton yield and was similar to MRC.6928Bt hybrids in this respect.

Yield in Breeding evaluation plots (kg/ha) – sprayed plots

Genotype	DHARWAD	COIMBATORE	VAIGAI DAM	Mean
MRC. 6918Bt	1691	1280	2097	1689
MRC. 6918	718	1335	1462	1172
MRC. 6928Bt	1421	1141	2288	1617
MRC. 6928	447	1064	1711	1074
DCH. 32	839	1238	1243	1107
TCHB. 213	443	1555	1586	1195
DHB. 105	1139	1802	1914	1618
CD @ 5%	458	367	568	
CV %	13.2	15.32	18.1	

The boll weight of these Bt hybrids was around 4.0 g, the check hybrids, having lower boll weight, and the seed cotton yield showed that the Bt hybrids were better than their non-Bt counterparts during this *kharif* season.

There was no difference in Lint index while in Seed index, MRC.6926 Bt hybrid recorded the highest value of 12.4 g, it is significant to note that the highest GOT was obtained in DCB.105 (33.7%). In H x B hybrids, this is significant character that has to be looked at for better lint yield.

Lint Index (g)

Genotype	DHARWAD	COIMBATORE	Mean
MRC. 6918	5.1	5.1	5.1
MRC. 6918 Bt	6.3	5.6	6.0
MRC. 6928	5.2	5.6	5.4
MRC. 6928 Bt	6.1	5.5	5.8
DCH. 32	5.6	5.6	5.6

TCHB. 213	4.8	5.8	5.3
DHB. 105	5.4	5.4	5.4
CD @ 5%	0.4	1.0	
CV %	4.1	15.8	

#### Seed index (g)

Genotype	DHARWAD	COIMBATORE	Mean
MRC. 6918	11.8	11.2	11.5
MRC. 6918 Bt	12.6	12.1	12.4
MRC. 6928	11.5	13.0	12.3
MRC. 6928 Bt	12.0	11.3	11.7
DCH. 32	11.8	11.9	11.9
TCHB. 213	12.3	13.2	12.8
DHB. 105	10.8	10.6	10.7
CD @ 5%	0.7	2.4	
CV %	3.7	17.7	

#### Ginning outturn (%)

Genotype	DHARWAD	COIMBATORE	Mean
MRC. 6918	30.3	31.0	30.7
MRC. 6918 Bt	33.4	31.7	32.6
MRC. 6928	31.3	30.3	30.8
MRC. 6928 Bt	33.8	32.3	33.1
DCH. 32	32.3	32.7	32.5
TCHB. 213	28.2	30.7	29.5
DHB. 105	33.3	34.0	33.7
CD @ 5%	-	3.3	
CV %	-	8.8	

#### Fibre Property parameters

The data given below for various fibre property parameters data (as given below) at Dharwad and Vaigai Dam shows that the staple length of MRC.6918Bt (t/l=0.83) was superior over MRC.6928Bt. At Vaigai dam there was no entry that had recorded t/l value above 0.80, the CIRCOT norm as per requirement of

textile industry. A characteristic influence due to drought was seen in this location on fibre property.

Fibre properties of H x B hybrids at Dharwad

Genotypes	2.5% span length(mm) (l)	Bundle strength (g/tex) (t)	t/l ratio	Micronaire	Unifor mity ratio	Elongation
MRC. 6918	33.3	26.0	0.78	3.5	46.9	5.4
<b>MRC. 6918 Bt</b>	<b>31.9</b>	<b>26.6</b>	<b>0.83</b>	<b>3.0</b>	<b>48.0</b>	<b>5.3</b>
MRC. 6928	34.7	24.8	0.71	2.8	47.8	5.2
MRC. 6928 Bt	33.5	26.1	0.78	2.8	48.8	5.1
DCH. 32	30.5	24.3	0.80	3.3	46.1	5.3
TCHB. 213	32.2	26.3	0.82	3.1	47.8	5.2
DHB. 105	34.3	26.3	0.77	2.8	49.8	6.0

Fibre properties of H x B hybrids at Vaigai Dam

Genotypes	2.5% span length(mm) (l)	Bundle strength (g/tex) (t)	T/l ratio	Micronaire	Unifor mity ratio	Elongation
MRC. 6918	36.2	25.0	0.69	4.5	49.0	5.2
MRC. 6918 Bt	35.7	25.8	0.72	4.0	48.0	4.6
MRC. 6928	36.9	25.1	0.68	3.6	48.0	5.1
MRC. 6928 Bt	36.5	27.3	0.75	4.0	47.0	4.7
DCH. 32	33.4	23.8	0.71	4.4	49.0	6.1
TCHB. 213	36.6	24.3	0.66	4.3	46.0	5.5
DHB. 105	37.6	28.5	0.76	4.2	49.0	4.1





# PLANT PROTECTION EVALUATION

## Plant protection evaluations

These hybrids were evaluated in breeding plots at Coimbatore for their pest and disease under sprayed conditions. The following data indicates that the maximum percent square of Bt hybrids was less than that in DCH.32, although all other hybrids were at par. Similarly, boll (open boll and locules) damage percent was also significantly different between Bt hybrids and others except in MRC.6928 and DCH.32 hybrids. The data on bollworm population indicates that there was no serious pest pressure on test hybrids. The sucking pest population also did not vary between entries under sprayed condition.

Pest profile under sprayed condition at Coimbatore

Genotype	Maximum % squares	Maximum % open Boll damage	Maximum % Locule damage	H.armigera incidence	<i>Earias</i> larvae / 5 plants Maximum larval incidence	Pink bollworm damage at 128 DAS	Maximum Jassids per leaf	Maximum Aphid per plant	Maximum Whitefly per plant
MRC. 6918Bt	4.2	10.4	5.6	1.3	2.7	13.3	2.6	7.4	0.3
MRC. 6918	4.1	11.6	7.0	3.7	0.3	5.0	2.5	5.5	0.1
MRC. 6928Bt	5.3	7.3	4.1	5.3	1.3	18.3	3.9	13.6	0.2
MRC. 6928	4.7	21.4	11.6	2.0	1.7	21.7	2.6	14.9	0.3
DCH. 32	11.2	26.3	11.9	1.7	4.3	23.3	2.9	26.3	0.3
TCHB. 213	3.6	11.3	6.3	2.3	0.3	6.7	3.1	7.6	0.4
DHB. 105	4.3	13.2	5.6	3.3	2.3	20.0	2.5	10.5	0.2

## Results from Unprotected plot

### Dharwad

The pest phenology data from Dharwad indicates that there was appearance of Spotted and American bollworms in the test hybrids, as normally is expected under rainfed conditions. It is seen that the first larva of these bollworms were however, noted in these hybrids only at 100-120 DAS.

**PEST PHENOLOGY DETAILS**

Entry	First egg seen (DAS)			First 2 <sup>nd</sup> instar larva seen (DAS)		
	SBW	ABW	PBW	SBW	ABW	PBW
MRC.6918 Bt	27	40	Not seen	100	120	Not observed
MRC.6928 Bt	27	40	--	100	120	--
DCH.32	28	42	--	80	80	--
TCHB.213	28	41	--	80	80	--
DHB.105	28	42	--	80	90	--
MRC.6918	26	38	--	80	80	--
MRC.6928	29	39	--	80	80	--
80	28	40	--	90	90	--

DAS: Days after sowing

SBW = SPOTTED/SPINY BOLLWORM, ABW=AMERICAN BOLLWORM, PBW = PINK BOLLWORM

## Vaigai Dam

The first bollworm egg was seen around 72 day after sowing and the first second instar bollworms were noticed after a fortnight in these experimental entries. However, the weekly square damage data picturises a very low incidence of bollworms as the range of damage was 2.9 to 4.6% only. Hence, the pest pressure at this location was low. Similar impression is generated when the flower and boll damage are also considered, as given in the following tables.

**PEST PHENOLOGY DETAILS**

Genotype	First egg seen			First 2 <sup>nd</sup> instar larva seen		
	SBW	ABW	PBW	SBW	ABW	PBW
MRC. 6918	72 DAS	83 DAS	106 DAS	89 DAS	94 DAS	121 DAS
MRC. 6918 Bt	74 DAS	91 DAS	101 DAS	96 DAS	101 DAS	124 DAS
MRC. 6928	69 DAS	82 DAS	99 DAS	84 DAS	98 DAS	127 DAS
MRC. 6928 Bt	65 DAS	92 DAS	112 DAS	79 DAS	104 DAS	118 DAS
DCH. 32	77 DAS	87 DAS	102 DAS	93 DAS	99 DAS	109 DAS
TCHB. 213	73 DAS	84 DAS	109 DAS	91 DAS	96 DAS	121 DAS
DHB. 105	76 DAS	92 DAS	107 DAS	90 DAS	103 DAS	119 DAS

SBW=SPOTTED/SPINYBOLLWORM, ABW=AMERICAN BOLLWORM, PBW=PINK BOLLWORM

The under-mentioned data showed that there was no chance for the entries to be evaluated at this center in the absence of any incidence of bollworms.

#### BOLLWORMS

Genotype	Date at which threshold levels of eggs was crossed			
	Spotted bollworm	Spiny bollworm	<i>Helicoverpa armigera</i>	Pink Bollworm
MRC. 6918	Nil	Nil	Nil	Nil
MRC. 6918 Bt	Nil	Nil	Nil	Nil
MRC. 6928	Nil	Nil	Nil	Nil
MRC. 6928 Bt	Nil	Nil	Nil	Nil
DCH. 32	Nil	Nil	Nil	Nil
TCHB. 213	Nil	Nil	Nil	Nil
DHB. 105	Nil	Nil	Nil	Nil

## Coimbatore

During 2003 - 04 winter cotton season eight Bt cotton hybrids viz., RCH 2, RCH 20, RCH 344, RCH 362, RCH 368, MRC 6160, MRC 6322 and MRC 6703 were evaluated against cotton pests with special reference to bollworms along with their non-Bt counterparts and check hybrids viz., MECH 162 Bt, Savita and Bunny. Detailed observations on bollworms incidence, damage and seed cotton yield were carried out.

#### **Evaluation under ETL based sprayed condition in Breeding Evaluation**

Against sucking pests four sprays were given on 9, 24, 56 and 97 days after sowing (DAS), which kept sucking pests under check. The first spray on nine DAS was to prevent the damage by soil insects and stem weevil. Against bollworms 0-5 sprays were given to different entries as per ETL level.

**Sucking pests :** Sucking pests viz., jassid, aphid, and whitefly population were presented in table 2. In general, the population of jassid was at moderate level and ranged from 0.6 to 2.8 per plant. Aphid and whitefly were at low level and ranged from 0 to 65 and 0.2 to 0.6 per plant respectively.

**Bollworms incidence and damage :** The data on spotted bollworm- *Earias* spp. and pink bollworm shows that there were no significant differences among the entries in recording spotted bollworm and pink bollworm incidence. However *Heliothis* bollworm registered significant differences among the entries twice on 88 and 102 DAS. All the Bt hybrids recorded significantly low population, 0 to 0.5 larva per five plants as against 3.0 to 5.0 in four non-Bt hybrids viz., RCH 2, RCH 20, MRC 6160, MRC 6322 and the local check – Savita on 88 DAS. The same trend was seen on 102 DAS in all the Bt entries except MRC 6160 Bt, which had significantly higher population (2 larvae). The check hybrids Bunny and Savita recorded one and five larvae respectively.

**Square damage :** Square damage was recorded at weekly interval. The data revealed that there were significant differences six times on 81, 88, 96, 102, 116 and 123 DAS. The maximum damage observed was ranged from 2.1 to 3.5 in all the Bt hybrids except RCH 368 Bt and MRC 6322 Bt, which recorded the higher damage of 5.2 and 9.0 per cent respectively as compared to 5.6 to 11.1 per cent in their non-Bt counterparts. The check MECH 162 Bt, Savita and Bunny recorded 4.0, 7.7 and 8.7 per cent respectively.

**Boll damage :** There were significant differences among the entries in recording open boll damage at harvest. All the Bt entries except MRC 6703 Bt recorded significantly low boll damage ranging from 4.1 to 9.2 per cent as compared to MECH 162 Bt, Savita and Bunny, which had 11.3, 26.2 and 29.4 per cent respectively. With respect to locule damage the Bt entries recorded significantly low damage ranging from 2.2 to 6.6 per cent as compared to MECH 162 Bt, Savita and Bunny, which had 7.5, 15.4 and 16.1 per cent respectively.

**Seed cotton yield :** Seed cotton yield was significantly higher in two Bt hybrids viz., RCH 2 Bt (2181 kg / ha) and RCH 20 Bt (1996 kg / ha) as compared to MECH 162 Bt. Along with the former two entries, RCH 368 Bt also recorded (1975 kg / ha) significantly higher yield as compared to the best non-Bt check-Savita (1264 kg / ha).

## **Evaluation under unsprayed (for bollworms) condition**

### **Sucking pests protection**

Against sucking pests four sprays were given on 9, 24, 56 and 97 DAS to keep them under check. No spray was given against bollworms.

**Sucking pest incidence :** The incidence of sucking pest viz., aphid and whitefly were at moderate level and ranged from 2.7 to 16.9 and 0 to 1.2 per cent respectively.

**Bollworms incidence and damage :** There were significant differences in recording the *Earias* bollworm on 75, 83 and 87 DAS. All the Bt entries recorded almost nil population while the check hybrid, Savita and Bunny recorded 3.0 and 3.5 larvae per 5 plants respectively. Pink bollworm incidence and damage showed no significant differences among the entries. However, *Heliothis* bollworm showed significant differences six times on 83, 89, 103, 110, 117 and 124 DAS. As high as seven larvae were recorded in the check hybrid Savita while the Bt entries had 0-3.0 larvae.

**Square damage :** There were significant differences among the entries in recording square damage due to bollworms five times on 75, 83, 89, 117 and 124 DAS. The Bt entries recorded 0-5.8 per cent damage as against 5.2 and 19.4 per cent in MECH 162 Bt and Savita respectively.

**Boll damage :** There were significant differences among the entries in recording open boll damage at harvest. All the eight Bt entries and check Bt entry – MECH 162 Bt were on par and recorded significantly low boll damage (8.6 to 24.4 %) by bollworms over the best check – Bunny (39.8 %). It was also observed that one non-Bt entry – MRC 6703 also recorded significantly low damage (25.5 %) and were on par with the Bt entries. Locule damage also showed significant differences among the entries. All the Bt entries and two non-Bt entries viz., RCH 344 and MRC 6703 recorded significantly low damage (3.4 to 14.4 %) over the best non-Bt check – Bunny (22.2 %).

**Seed cotton yield :** There were significant among the entries in recording seed cotton yield. Three Bt entries viz., RCH 368, RCH 344 and RCH 2 recorded 1998, 1986 and 1891kg / ha respectively and were significantly superior to the best non-Bt check – Bunny which recorded 1093 kg / ha. It was also noted that

all the Bt entries including MECH 162 Bt and three non-Bt entries viz., RCH 368, MRC 6322 and MRC 6708 were on par and recorded yield ranging from 1272 to 1998 kg/ha while the rest of entries had significantly low yield.

The following data indicates that the maximum square damage, under prevailing pest pressure in the zone, was less in Bt hybrids over their non-Bt counterparts and check hybrids.

Maximum per cent Square damage

Genotype	DHARWAD	COIMBATORE	VAIGAI DAM	Mean
MRC. 6918Bt	11.76	0.9	3.4	5.4
MRC. 6918	15.44	7.3	4.1	8.9
MRC. 6928Bt	10.43	1.9	2.9	5.1
MRC. 6928	16.39	5.8	4.6	8.9
DCH. 32	15.96	12.2	3.2	10.5
TCHB. 213	16.57	14.0	3.1	11.2
DHB. 105	13.66	6.4	3.5	7.9
CD @ 5%		6.13		
CV %		30.8		

The green boll damage was recorded at Dharwad and Vaigai Dam trials. The following data shows that the Bt hybrids were superior to their non-Bt counterparts and check hybrids in providing better protection to their bolls.

Maximum per cent Boll damage

Genotype	DHARWAD	VAIGAI DAM	Mean
MRC. 6918Bt	4.11	3.2	3.7
MRC. 6918	13.56	3.1	8.3
MRC. 6928Bt	4.37	2.7	3.5
MRC. 6928	14.75	2.9	8.8
DCH. 32	11.90	3.0	7.5
TCHB. 213	14.05	2.9	8.5
DHB. 105	5.77	2.6	4.2

The unprotected plots recorded superior seed cotton yield over all the others. MRC.6928Bt recorded **1842** kg mean seed cotton yield in the south zone, while

MRC.6918Bt recorded 1731 kg/ha. The drought has affected the cotton yield profusely, especially for H x B hybrids.

Yield (kg/ha) – unprotected

Genotype	DHARWAD	COIMBATORE	Mean
<b>MRC. 6918Bt</b>	<b>2281</b>	<b>1181</b>	<b>1731</b>
MRC. 6918	1351	880	1116
<b>MRC. 6928Bt</b>	<b>2321</b>	<b>1362</b>	<b>1842</b>
MRC. 6928	1225	884	1055
DCH. 32	1318	715	1017
TCHB. 213	1107	992	550
DHB. 105	1297	1441	1369
CD @ 5%	-	302	
CV %	-	16.13	

The data from protected plots, especially against sap sucking jassids also gave similar yield and was similar to DHB.105, a check hybrid. There was no difference between the two Bt hybrids in yield although they were far superior to the check hybrids.

Yield (kg/ha) – sprayed plots

Genotype	DHARWAD	COIMBATORE	VAIGAI DAM	Mean
<b>MRC. 6918Bt</b>	<b>1691</b>	<b>1280</b>	<b>2097</b>	<b>1689</b>
MRC. 6918	718	1335	1462	1172
<b>MRC. 6928Bt</b>	<b>1421</b>	<b>1141</b>	<b>2288</b>	<b>1617</b>
MRC. 6928	447	1064	1711	1074
DCH. 32	839	1238	1243	1107
TCHB. 213	443	1555	1586	1195
<b>DHB. 105</b>	<b>1139</b>	<b>1802</b>	<b>1914</b>	<b>1618</b>
CD @ 5%	458	367	568	
CV %	13.2	15.32	18.1	

At Coimbatore center, the seed cotton yield and economics in terms of net returns after deducting plant protection cost was computed and given below. There is no increase in returns over other hybrids in this regard during this year since there was reduction in production.



Yield and Economics under sprayed condition

Entries	Yield kg/ha	Gross Returns Rs./ha	No. of spray		PP Cost Rs./ha	Net Returns Rs./ha	Percent Increase *
			SP	BW			
MRC. 6918 Bt	1280	33280	4	4	11700	21580	-
MRC. 6918	1335	34710	4	3	7825	26885	
MRC. 6928 Bt	1141	29666	4	4	11700	17996	-
MRC. 6928	1064	27664	4	4	9200	18464	
DCH 32	1238	32188	4	4	9200	22988	
TCHB 213	1555	40430	4	3	7825	32605	
DHB 105	1802	46852	4	4	9200	37652	

Sucking pest protection cost for 4 sprays Rs. 3700/ha and for bollworms @ Rs. 1375/ha/spray.

Additional seed cost for Bt hybrids assumed as Rs. 2500 /ha. Returns worked out @ Rs. 26/kg of seed cotton.

- Over corresponding non-Bt
- 

Under unsprayed conditions, the net seemed to be better, as given in the following table. MRC. 6928Bt gave 51.5% increase in net returns over its corresponding non-Bt hybrid. The other Bt hybrid was also similarly better in having higher net returns over its non-Bt counterpart.

Evaluation under unsprayed condition on Yield and Economics

Entries	Yield kg/ha	Gross Returns Rs./ha	PP Cost Rs./ha	Net Returns Rs./ha	Percent Increase *
MRC. 6918 Bt	1181	30706	6200	24506	27.8
MRC. 6918	880	22880	3700	19180	
MRC. 6928 Bt	1362	35412	6200	29212	51.5
MRC. 6928	884	22984	3700	19284	
DCH 32	715	18590	3700	14890	
TCHB 213	992	25792	3700	22092	
DHB 105	1441	37466	3700	33766	

Sucking pests protection cost for 4 sprays Rs. 3700/ha. Additional seed cost for Bt hybrids assumed as Rs. 2500 /ha.

Returns worked out @ Rs. 26 / kg of seed cotton.

\* Over corresponding non-Bt

## Reaction to Diseases

Observations on major Diseases, as given below, show that both at Coimbatore and Vaigai Dam there was no incidence of any cotton diseases in the entries in both Breeding and Entomology plots. The climatic conditions at Dharwad also did not favour outbreak of any disease. However, in protected plots of Breeding evaluation, mild root rot incidence was recorded in MRC.6918Bt and its non-Bt counterpart. Both test hybrids were also found to be susceptible to Grey mildew disease. The data of Dharwad showed that these diseases were at similar level in unprotected conditions also.

Percent incidence of various diseases

Genotypes	Dharwad			Coimbatore			Vaigai dam		
	BB	GM	AB	BB	GM	Others	BB	GM	Others
MRC. 6918 Bt	14.8	26.8	14.8	Nil	Nil	Nil	Nil	Nil	Nil
MRC. 6918	14.6	26.0	15.4	Nil	Nil	Nil	Nil	Nil	Nil
MRC. 6928 Bt	13.3	26.8	14.6	Nil	Nil	Nil	Nil	Nil	Nil
MRC. 6928	15.0	25.5	16.5	Nil	Nil	Nil	Nil	Nil	Nil
DCH 32	16.4	26.7	15.1	Nil	Nil	Nil	Nil	Nil	Nil
TCHB 213	14.8	22.4	15.7	Nil	Nil	Nil	Nil	Nil	Nil
DHB 105	15.4	26.2	19.4	Nil	Nil	Nil	Nil	Nil	Nil

Per cent incidence of BB=bacterial blight, GM=Grey mildew & AB=Alternaria blight

## CONCLUSIONS

### Evaluation of H x H hybrids:

- 1) A comparison of the seed cotton yield of both protected and non-protected plots showed that RCH.2Bt and RCH.362Bt hybrids had consistent superiority over other Bt hybrids. Under protected conditions, the performance of MRC.6703Bt and RCH.368Bt in terms of better seed cotton yield was distinct. The conclusion from this year's data is that although under drought conditions, the south zone evaluations showed that Bt hybrids are superior to all other test hybrids. The superiority of yield in the Bt hybrids such as RCH.2, RCH.362 and MRC.6703, even under unprotected condition is distinct.
- 2) From the first year of testing most of Bt hybrids as well as repetitions of RCH 2Bt and RCH 20Bt hybrids from last year, it is seen that seed cotton yield of both protected and non-protected

- plots showed that RCH.2Bt and RCH.362Bt hybrids had consistent superiority over other Bt hybrids. Under protected conditions, the MRC.6703Bt and RCH.368Bt were distinctly better in yield. The conclusion from this year's data is that although under drought conditions, the south zone evaluations showed that Bt hybrids are superior to all other test hybrids. The superiority of yield in the Bt hybrids such as RCH.2, RCH.362 and MRC.6703, even under unprotected condition is distinct.
- 3) Under rainfed condition of Nandyal, the fibre property data shows that RCH.368Bt recorded the best strength : length ratio of 0.90 followed by MRC.6160Bt and MRC.6322Bt. RCH.344 non-Bt also recorded 0.94 as this ratio. The local check hybrid had similar data as that of the best Bt hybrids. The fibre property recorded in the irrigated trial at Dharwad, although affected by a general drought, showed similar results as that of Nandyal. The Bt hybrids showed above 0.8 ratio of strength to length, RCH.368Bt being the highest (0.85). Amongst the others, MRC.6160 non-Bt hybrid recorded 0.86. The check hybrid also had 0.82.
  - 4) The percent open boll damage was virtually fifty percent of that in non-Bt hybrids as well as in check hybrids. The highest per cent was in MRC.6322Bt (20.88%) followed by RCH.362Bt (16.92%).
  - 5) The sap sucking pests were similar in pattern of infestation in unprotected and protected plots, as can be seen from the table below. Due to drought conditions, the general population of jassids was low; however, their numbers on three leaves per plant did show a significant difference between various entries.
  - 6) Based on the data of Coimbatore center, under sprayed conditions of Breeding plots, the highest per cent increase in net returns is recorded in MRC.6160Bt followed by RCH.2Bt hybrids over corresponding non-Bt hybrids as well as over Bt check hybrid. RCH.20 recorded better returns on investment over MECH.162 Bt. The unprotected plots at the same location gave high net returns in the case of RCH.2Bt, RCH.20Bt, RCH.344Bt, RCH.362Bt, RCH.368Bt and MRC.6160Bt over both corresponding non-Bt hybrids as well as over check Bt hybrid during this season.
  - 7) Due to inclement weather conditions, there was no disease outbreak in the test hybrids during this season in any of the centers, except in Dharwad, where report of Grey mildew disease at moderate levels was observed on most of the test hybrids. No significant variations in disease reaction to Grey mildew was seen in any of the Bt hybrids in comparison to check hybrids as well as their corresponding non-Bt hybrids.

## Evaluation of H x B hybrids:

1. There was no difference in Lint index while in Seed index, MRC.6926 Bt hybrid recorded the highest value of 12.4 g, it is significant to note that the highest GOT was obtained in DCB.105 (33.7%). In H x B hybrids, this is significant character that has to be looked at for better lint yield. The average Ginning outturn percentage was seen to be high in MRC.6703Bt followed by RCH.344Bt. All other Bt hybrids showed similar range as in the case Bt check hybrid, the lowest being in RCH.20Bt.
2. Although seed cotton yield was lower than expected, as south zone states were known for, due to prevailing drought, the Bt hybrids were better than their non-Bt counterparts as well as with check hybrids. The highest yield in Breeding plots under protection against sucking pests at ETL was in MRC.6918Bt (1628 kg/ha). DHB.105 gave 1618 kg/ha seed cotton yield and was similar to MRC.6928Bt hybrids in this respect.
3. The unprotected plots recorded superior seed cotton yield over all the others. MRC.6928Bt recorded **1842** kg mean seed cotton yield in the south zone, while MRC.6918Bt recorded 1731 kg/ha. The drought has affected the cotton yield profusely, especially for H x B hybrids.
4. There is no increase in net returns over other hybrids for Bt hybrids this year since there was reduction in production under protected conditions. Under unsprayed conditions, the net seemed to be better. MRC. 6928Bt gave 51.5% increase in net returns over its corresponding non-Bt hybrid. The MRC. 6918Bt hybrid was also similarly better in having higher net returns over its non-Bt counterpart.
5. The data for various fibre property parameters data at Dharwad and Vaigai Dam shows that the staple length of MRC.6918Bt ( $t/l=0.83$ ) was superior over MRC.6928Bt. At Vaigai dam, there was no entry that had recorded  $t/l$  value above 0.80, the CIRCOT norm as per requirement of textile industry, presumably due to adverse influence of drought on fibre property.
6. Observations on major Diseases show that both at Coimbatore and Vaigai Dam there was no incidence of any cotton diseases in the entries in both Breeding and Entomology plots. The climatic conditions at Dharwad also did not favour outbreak of any disease. However, in protected plots of Breeding evaluation, mild root rot incidence was recorded in MRC.6918Bt and its non-Bt counterpart. Both test hybrids were also found to be susceptible to Grey mildew disease. The data of Dharwad showed that these diseases were at similar level in unprotected conditions also.

# Annexure I

## SOUTH ZONE Bt MONITORING REPORT

### BREEDING REPORT

DETAILS	CICR, CBE	TNAU, VAIGAIMAM	UAS, DHARWAD	UAS, SIRU GUPPA	ANGRAU, NANDYAL
<b>Bt 1(Cry 1Ac)</b>					
Leaf hopper	Severe	Trial not conducted	Medium	Severe	MECH.162 Bt Jassid susceptible
BLB	Not severe		Not observed	No disease	
Fungal foliar	Not severe		No disease	No other diseases	No foliar disease observed
Specific comment	Trial was good and conducted as per technical programme		Trial was good and conducted as per technical programme. Stand was good.	Trial was good and conducted as per technical programme. Stand was good	Trial was good. There was severe adverse effects of moisture stress
<b>(Cry 1Ac) H x B hybrids</b>					
DETAILS	CICR, CBE	TNAU, VAIGAIMAM	UAS, DHARWAD	UAS, SIRU GUPPA	ANGRAU, NANDYAL
Leaf hopper	Severe	High incidence, all susceptible	Medium	Trial not conducted	Trial not conducted
BLB	Not severe	No disease	No disease		

Fungal foliar	Not severe	No disease	No disease		
Specific comment	Trial was good and conducted as per technical programme	Trial was good and plant stand was good.	Trial was good and conducted as per technical programme		

## ENTOMOLOGY TRIAL

<b>(Cry 1Ac) H x H hybrids</b>					
<b>DETAILS</b>	<b>CICR, CBE</b>	<b>UAS, DHARWAD</b>	<b>UAS, SIRUGUPPA</b>	<b>ANGRAU, NANDYAL</b>	<b>TNAU, VAIGAIMAM</b>
Sucking pests					Not conducted
Jassids		Medium	High up to 50 days	High	
Aphids		Low	Severe at monitoring	Medium	
Thrips		High	-	High	
White fly		-	-	Low	
Boll worms					
H. armigera		ETL crossed	Major (ETL crossed in 4 times)	Low	
Earias spp		High (higher than H. armigera)	Minor	Low to nil	
Pink boll worm		No	Low	Severe in early stage	
S.litura		-	-	-	
Boll damage per cent		10-30%	5-35%	23-40%	
Specific comment		Severe moisture stress. ETL	Trial was good and conducted as per technical programme. Severe incidence of boll worm (H.armigera)	Trial was good and conducted as per technical programme. Severe pink boll worm damage was observed and crossed ETL 4 times	

## PATHOLOGY TRIAL

DETAILS	CICR, CBE	UAS, DHARWAD	UAS, SGP	NDL	TNAU, VAIGAIM
<b>(Cry 1Ac) HxH Hybrids</b>					
Target disease	Leaf spot mild	Leaf spot (mixed) moderate to severe	Free from diseases	Disease free Trial	Not conducted
BLB	-	-	-	-	
Alternaria leaf spot	-	-	-	-	
Grey mildew	-	-	-	-	
Specific comment	-	Trial was good and conducted as per technical programme. Stand was good.	Trial was good and conducted as per technical programme. Stand was good	-	
<b>(Cry-1Ac) HxB hybrids</b>					
Target disease	Leaf spot mild	Leaf spot mild	Trial not conducted	Trial not conducted	Trial not conducted
BLB	-	-			
Alternaria leaf spot	-	-			
Grey mildew	-	-			
Specific comment	-	Trial was good and conducted as per technical programme. Severe moisture stress			

The visits to all centers except Coimbatore was made between 16-19 October, 2003 while at Coimbatore, the team visited between 16-19 December, 2003.

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