

# **Bt COTTON EVALUATION REPORT**

TRANSGENIC COTTON HYBRIDS WITH  
DELTA ENDOTOXIN CryIA(c) GENE

*NORTH ZONE*

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

Project Co-ordinator (Cotton Improvement)  
**All India Coordinated Cotton Improvement Project**  
CENTRAL INSTITUTE FOR COTTON RESEARCH  
Regional Station, Maruthamalai Road  
Coimbatore-641 003  
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# Executive Summary

- 1) *The All India Coordinated Cotton Improvement Project (AICCIP) undertook the evaluation of eight cotton hybrids possessing the Cry I 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 centers. The trials were laid out in accordance with the under-mentioned protocol and following standard package of practices of cotton cultivation, followed at respective centers, where the evaluations were undertaken. The untreated, acid delinted seeds of the relevant test hybrids and their non-Bt hybrids were provided by M/S Ankur Seeds Pvt. Ltd., Nagpur, M/S Rasi Seeds Pvt. Ltd., Athur and M/S Maharashtra Hybrid Seed Company (MAHYCO) seeds Pvt. Ltd., Jalna.*
- 2) *ANKUR-651Bt, ANKUR-2226Bt, ANKUR-2534Bt, RCH134Bt, RCH138Bt, RCH317Bt, MRC.6301Bt & MRC.6304Bt were evaluated along with LHH.144 and Omshankar hybrids as zonal checks, MECH.162Bt as Bt check hybrid and one G.hirsutum variety, as Station check. These evaluations were done at Punjab Agricultural University, Regional Agricultural Research Station, Faridkot, Punjab Agricultural University, Ludhiana, Chourdhary Charan Singh Haryana Agricultural University, Hisar, Rajasthan Agricultural University, Regional Agricultural Research Station, Sriganganagar and Central Institute for Cotton Research Regional Station, Sirsa. These hybrids were subjected to Plant Breeding and Plant Protection evaluations under standard protocols of AICCIP. The results of these evaluations are based on comparison with the respective Non-Bt hybrids in addition to Bt check hybrid as well as local checks (hybrids & variety), as the case may be.*

- 3) *Three out of five locations, viz., Hisar, Sriganaganagar and Sirsa had low germination percentage as compared to the other two centers in Punjab. The Bt hybrids had lower germination percentage over the other non-Bt entries in all locations, showing that these hybrids seeds were not of good quality. The ICAR Monitoring Committee Report mentioned about this aspect as well as about the mixtures and off-type plants in Ankur-651Bt and its non-Bt counterpart, Ankur-2226Bt, RCH.138, MRC.6304 at all locations. These two aspects are cause of concern for maintaining accuracy of these evaluations.*
- 4) *There was significant reduction in shoot boring incidence of Spotted bollworm in Bt hybrids over other entries. Mean per cent bollworm incidence in fruiting bodies showed that there is no difference amongst the Bt hybrids in sprayed and unsprayed plots.*
- 5) *American bollworm incidence in northern states began around 90-100 days of crop growth only, unlike its normal appearance of 75-85 days after germination of crop. The Bt hybrids did show their superiority in counteracting this pest, even in the late appearance of this pest. There was no difference in the mean per cent bollworm incidence in fruiting bodies between protected and unprotected plots, while significant difference between Bt hybrids and non-Bt hybrids as well as between check hybrids was seen. The gene action of Bt hybrids was evident to counteract bollworms infestation.*
- 6) *The inference about the performance of the eight test Bt hybrids during 2003-04 season has to be based on the fact that, in north zone centers, the Spotted bollworm incidence seemed to be reduced due to the gene's action in these test entries till 100 days of crop growth in Bt hybrids over their non-Bt counterparts and check hybrids. However, the American bollworm and Pink bollworm were not adequately present. There was significantly lower*

*locule damage over non-Bt and local check entries in both sprayed and unsprayed conditions in the first picking. The rest of Bt hybrids had similar damage as in the case of Bt check hybrid. Similar trend was also seen in the second picking.*

- 7) The test hybrids were not infested seriously with sap sucking insects such as Leaf hoppers (Jassids) and whitefly. The damage level was uniform for all entries throughout the experimental period, although there was significant difference in their population between sprayed and unsprayed plots during their peak population build up.*
- 8) The pest load, in general, being low in northern states in the crop during 2003-04 season, the predator (natural enemy) density was also low. There was no appreciable difference between their numbers in unprotected and protected conditions in the test Bt hybrids and their non-Bt counterparts.*
- 9) Ludhiana AICCIP center recorded observations on incidence of Semilooper caterpillars (Anomis flava) in both sprayed and unsprayed plots. All test entries in unsprayed plots had higher incidence than the sprayed plots. Certain Bt hybrids such as MRC.6301Bt and MRC.6304Bt had significantly lower incidence of this pest in comparison to other Bt hybrids at this AICCIP center.*
- 10) The pattern of sprayings of insecticides, undertaken in the experimental plots of each AICCIP centre to contain various pests show that the general pressure of pests in the early crop stage seemed to be low. Sprayings of insecticides in any hybrid was taken up only after 70-80 days. Sap sucking pests and bollworms built up on non-Bt hybrids and check varieties also at later stages. The gene action of Cry I A(c) against bollworms is known to be up to 90-100 days after germination of the crop in Bt hybrids. The first insecticide spray against bollworms in check*

hybrids was on 9<sup>th</sup> August, 2003 while it was done in Bt hybrids ten days after (at around 90 days).

- 11) It was also found that most of the Bt hybrids and their non-Bt counterparts were sprayed with systemic insecticides to manage sap sucking pests such as jassids and whitefly 2-3 times. Hence the total number of sprayings in the tested transgenic Bt genotypes was around 2.2 to 3.5 in comparison to 6-7 sprayings in irrigated northern AICCIP centres, during 2003-04.
- 12) In Breeding evaluation, all the three RCH hybrids, viz., RCH.134, RCH.138 and RCH.317 recorded appreciable yield increase (19 to 27%) over their non-Bt counterpart hybrids. Substantial superiority (45-52%) over Bt check hybrid (MECH.162Bt), zonal checks LHH.144 (86-94%) and hirsutum variety check (31-74%). Hybrid MRC.6301Bt also recorded higher seed cotton yield over the non-Bt hybrid (84%), Bt check hybrid (MECH.162Bt) (40%) and hirsutum variety check (27-61%). In the case of Ankur hybrids, all the three Bt hybrids recorded lower yield than Bt check hybrid. There was no appreciable yield difference between these Bt hybrids and their non-Bt hybrid counterparts. The mean seed cotton yield for the zone across Breeding and Plant Protection evaluation showed that showed that **RCH.134Bt (2476 kg/ha) followed by RCH.317Bt (2524 kg/ha) and MRC.6301Bt (2342 kg/ha).**
- 13) The fibre property data of the various test entries are provided in the following tables. These indicate that there is no appreciable difference in the various fibre properties such as staple length and tenacity and micronaire in the test entries. In accordance with the textile requirements and CIRCOT norms, the ratio of tenacity to strength shall be 0.8 and above. In this respect, RCH.134 and RCH. 138 stand superior over others. It is worthy to note that

*amongst check varieties, H.1117 and RS.2013 also are outstanding in this respect.*

14) *In accordance with the norms of Cotton Advisory Board (CAB), Indian Cotton Mills Federation (ICMF) and Central Institute for Research on Cotton Technology (CIRCOT), the fibre property of these hybrids were assessed. The standard fixed currently is 0.80 and above as the ratio of strength to length of fibre. Accordingly, RCH.134Bt and RCH.138Bt were comparable with check varieties to achieve this ratio. Given appropriate agronomic packages, it appears that other hybrids also could reach out to this standard.*

15) *Amongst diseases, the presence of Cotton Leaf Curl Virus (CLCuV) disease was the most important as this threatens the cultivation of American (hirsutum) cottons in the northern states currently. The AICCIP has a decision that none of the hirsutum entries susceptible to this pest shall be introduced for commercial cultivation in the three states of this zone. Ankur-651, Ankur-2226, Ankur-2534, RCH.134, RCH.138 and MRC.6304 have been found to be infected with CLCuV disease during 2003-04. It is suggested that all these Bt entries/non-Bt counterparts may be intensively screened at AICCIP center, Ludhiana and CICR, Sirsa during next season for reconfirmation.*

## **Introduction**

The All India Coordinated Cotton Improvement Project (AICCIP) undertook the evaluation of eight cotton hybrids possessing the Cry I 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 centers. The trials were laid out in accordance with the under-mentioned protocol and following standard package of practices of cotton cultivation, followed at respective centers, where the evaluations were undertaken. The untreated, acid de-linted seeds of the relevant test hybrid were provided by the M/S Ankur Seeds Pvt. Ltd., Nagpur, M/S Rasi Seeds Pvt. Ltd., Attur 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.

### **Centers involved:**

Punjab Agricultural University, Regional Agricultural Research Station, Faridkot  
Punjab Agricultural University, Ludhiana  
Chourdary Charan Singh Haryana Agricultural University, Hisar  
Rajasthan Agricultural University, Regional Agricultural Research Station, Sriganganagar  
Central Institute for Cotton Research, Regional Station, Sirsa

### **Test hybrid entries:**

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



ANKUR-651Bt
ANKUR-2226 Bt
ANKUR-2534 Bt
RCH.134 Bt
RCH.138 Bt
RCH.317 Bt
MRC.6301 Bt
MRC.6304 Bt
8 Non-Bt hybrid counterparts
MECH. 162 (Bt check)
LHH.144 & OMSHANKAR (Zonal checks)
Local Check cultivars: F.1861(Faridkot/Ludhiana), H.1117 (Hisar), RS.2013 (Sriganganagar)

**Coding for entries for testing:**

Sr.No.	Code No.	Codes for test entries
1	2301	ANKUR-651Bt
2	2302	RCH.134 Bt
3	2303	MRC.6301 Bt
4	2304	ANKUR-2226 Bt
5	2305	RCH.138 Bt
6	2306	ANKUR-2534 Bt
7	2307	MRC.6304 Bt
8	2308	RCH.317 Bt
9	2309	LHH.144 (Zonal check)
10	2310	OMSHANKAR (Zonal check)
11	2311	MECH.162Bt (Bt check)
12	2312	RCH.317
13	2313	MRC.6304
14	2314	ANKUR-2534
15	2315	RCH.138
16	2316	ANKUR-2226
17	2317	MRC.6301
18	2318	RCH.134
19	2319	ANKUR-651
20	2320	F.1861(Faridkot/Ludhiana) H.1117(Hisar) RS.2013 (Sriganganagar)

Experimental design and layout for Bt-1 evaluation *khariif*  
2003-04

**LAY OUT PLAN  
BREEDING TRIAL**

DESIGN-RBD - No. of treatments :20, 3 REPLICATIONS – 6 ROWS X 6 metre rows

R1	05	14	11	07	09	02	15	04	19	16	12	01	18	03	06	08	10	13	17	20
R2	08	15	03	07	06	18	10	12	16	01	04	11	13	19	14	17	02	20	09	05
R3	16	05	03	19	17	14	20	10	15	07	12	18	09	13	04	01	06	11	02	08

**PLANT PROTECTION TRIAL**

DESIGN: Split Plot with 2 MAIN PLOTS & 20 SUBPLOTS in 3 Replications  
– 6 ROWS X 6 metre rows

MAIN PLOT = M-1 – PROTECTED  
M-2 – UNPROTECTED  
SUB PLOTS = TEST HYBRID ENTRIES

**M-1 – PROTECTED**

R1	05	14	11	07	09	02	15	04	19	16	12	01	18	03	06	08	10	13	17	20
R2	08	15	03	07	06	18	10	12	16	01	04	11	13	19	14	17	02	20	09	05
R3	16	05	03	19	17	14	20	10	15	07	12	18	09	13	04	01	06	11	02	08

**M-2 – UNPROTECTED**

R1	05	14	11	07	09	02	15	04	19	16	12	01	18	03	06	08	10	13	17	20
R2	08	15	03	07	06	18	10	12	16	01	04	11	13	19	14	17	02	20	09	05
R3	16	05	03	19	17	14	20	10	15	07	12	18	09	13	04	01	06	11	02	08

**2320 = varietal Check (spacing = 67.5 x 30 cm)**

For Sirsa and Hisar = H.1117  
For Sriganagar = RS.2013  
For Faridkot & Ludhiana = F.1861

# RESULTS OF EVALUATIONS

The Breeding and Plant Protection evaluations were undertaken and the data recorded in the designated five centers. The results are given below in this report.

## BREEDING EVALUATION

The breeding evaluation concentrated on various observations on plant biometric characters such as number of monopodia per plant, number of sympodia per plant, nodes per plant, 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 (calculated) of seed cotton yield per hectare in addition to the fibre length, strength and micronaire of the entries tested.

### **Important dates the trial:**

The experiments were sown between 8<sup>th</sup> and 20<sup>th</sup> May, as given in the table below. The dates of harvest are also provide therein.

Dates	Faridkot	Ludhiana	Hisar	Sriganganagar	Sirsa
Date of sowing	10.5.04	20.5.03	15.5.03	18.5.03	08.5.03
Date of germination	14.5.04	25.5.03	19.5.03	22.5.03	12.5.03
Date of harvesting	01.12.03	-	29.10.03	12.11.03	17.11.03

### **Germination Data (%):**

Seed germination was low at three out of five locations as compared to two centers in Punjab. Plant population was low due to poor germinability of seeds in Ankur-651Bt, Ankur-2226Bt, RCH.138Bt, MRC.6304Bt. The Bt hybrids had lower germination percentage than other entries in all locations. The ICAR Monitoring Committee Report

mentioned about this aspect as well as about the mixtures and off-type plants in Ankur-651Bt and its non-Bt counterpart, Ankur-2226Bt, RCH.138, MRC.6304 at all locations. These two aspects are cause of concern in terms of maintaining accuracy of these evaluations.

#### GERMINATION PERCENTAGE

ENTRY	Faridkot		Ludhiana		Hisar		Sriganga nagar		Sirsa		Mean	
	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt
Ankur-651	88	97	85	95	19	41	40	49	37	58	54	68
Ankur-2226	90	92	87	87	23	35	45	53	39	52	57	64
Ankur-2534	88	96	85	94	23	41	40	47	26	49	67	66
RCH.134	95	94	87	94	52	47	54	56	57	58	79	70
RCH.138	94	97	92	95	43	41	57	55	52	61	67	70
RCH.317	96	96	93	94	44	41	54	54	50	58	67	69
MRC.6301	95	96	90	90	31	43	58	54	49	52	65	67
MRC.6304	90	93	88	91	23	23	45	50	39	55	57	62
CHECK HYBRIDS												
MECH.162	92	-	94	-	41	-	53	-	58	-	68	-
LHH.144	-	93	-	92		44	-	53	-	58	-	68
Omshankar	-	87	-	90		46	-	52	-	52	-	65
F.1861 (Fdkt/Ludh/ Sirsa)	-	96	-	93			-	-	-	-	-	94 .5
H.1117 Hisar	-	-	-	-		38	-	-	-	71	-	55
RS. 2013	-	-	-	-		-	-	54	-	-	-	54
CD 5%			NS		11.39		7.36		10.05			
CV%			1.76		19.05		8.37		11.82			

#### FIRST SYMPODIAL NODE:

Based on the data available from two centres, it is concluded that there is no difference in the appearance of the first sympodia between Bt and non-Bt hybrids, as given in the following table.

FIRST SYMPODIAL NODE

ENTRY	Faridkot		Ludhiana		Mean	
	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt
Ankur-651	7.0	6.8	7.2	8.8	7.1	7.8
Ankur-2226	8.3	9.3	8.9	8.2	8.6	8.75
Ankur-2534	7.5	7.3	7.5	7.1	7.5	7.2
RCH.134	9.3	7.5	9.9	9.3	9.6	9.4
RCH.138	10.4	9.4	8.8	9.8	9.6	9.6
RCH.317	8.8	7.3	10.9	7.5	9.9	7.4
MRC.6301	8.6	7.9	8.9	9.6	8.8	8.8
MRC.6304	8.5	9.0	9.8	8.1	8.8	8.6
CHECK HYBRIDS						
MECH.162	9.3	-	9.3	-	9.3	-
LHH.144	-	9.5	-	8.7	-	9.1
Omshankar	-	9.5	-	9.7	-	9.6
F.1861 (Fdk/Ludh/Sirsa)/Sirsa)	-	9.0	-	9.3	-	9.2
CD 5%	1.4		3.01		-	
CV%	9.8		20.49		-	

**MEAN LENGTH OF FIRST SYMPODIUM (cm):**

In general, non-Bt hybrids produced longer sympodia as compared to their Bt counterparts.

MEAN LENGTH OF FIRST SYMPODIUM (cm)

ENTRY	Faridkot		Ludhiana		Sirsa		Zone Mean	
	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt
Ankur-651	45.00	54.67	31.7	41.7	27.5	25.9	34.7	40.8
Ankur-2226	43.33	41.33	43.9	45.0	33.4	25.9	40.2	37.4
Ankur-2534	40.67	37.33	32.2	36.1	24.3	26.1	32.3	33.1
RCH.134	35.00	50.33	44.4	46.1	24.0	30.0	34.4	42.1
RCH.138	39.00	65.33	42.2	55.0	26.5	25.1	35.9	48.5
RCH.317	40.33	62.00	40.6	45.5	27.6	30.1	36.2	45.9
MRC.6301	32.00	50.00	40.0	38.3	21.5	31.2	31.1	40.0
MRC.6304	28.67	46.67	38.3	46.1	24.5	21.9	30.5	38.2
MECH.162	34.33	-	43.9	-	24.1	-	34.1	-
LHH.144	-	66.00	-	54.4	-	28.2	-	49.5
Omshankar	-	46.00	-	45.5	-	26.0	-	39.2
F.1861	-	26.33	-	44.4	-	-	-	35.3
H.1117	-	-	-	-	-	26.2	-	26.2
CD 5%	8.00		13.02		8.29		-	
CV%	18.23		18.63		18.98		-	

**MEAN FRUITING POINTS OF 1<sup>ST</sup> SYMPODIUM:**

The mean fruiting points, as given in the table below at Faridkot had significant differences between various Bt and non-Bt hybrids. The same significant difference was there in the other two locations.

MEAN FRUITING POINTS OF 1<sup>ST</sup> SYMPODIUM

ENTRY	Faridkot		Ludhiana		Sirsa		Zone Mean	
	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt
Ankur-651	10.7	12.5	7.9	9.2	7.0	6.1	8.5	9.2
Ankur-2226	9.9	8.3	7.7	7.2	8.1	6.4	8.5	7.3
Ankur-2534	10.4	9.2	7.5	7.9	6.0	6.3	8.0	7.8
RCH.134	7.8	9.7	7.1	7.8	6.1	8.8	7.0	8.8
RCH.138	7.0	8.3	6.9	8.0	6.9	6.8	6.9	7.7
RCH.317	9.5	11.9	7.2	7.9	6.8	8.8	7.8	9.5
MRC.6301	9.9	11.9	8.2	7.1	6.1	7.5	8.1	8.8
MRC.6304	9.3	10.6	7.4	7.9	7.1	4.9	7.9	7.8
CHECK HYBRIDS								
MECH.162	8.1	-	7.5	-	4.7	-	6.77	-
LHH.144	-	12.9	-	7.7	-	6.6	-	9.1
Omshankar	-	9.5	-	7.6	-	7.1	-	8.1
F.1861	-	5.6	-	6.4	-	5.9	-	6.0
H.1117	-	-	-	-	-	-	-	5.9
CD 5%	1.7		1.46		0.98		-	
CV%	18.53		11.63		8.88		-	

**MEAN FRUITING POINTS /PLANT:**

The mean fruiting points recorded at three centers did not differ within locations and within hybrids. While at Faridkot, the non-Bt and other check hybrids recorded more number of fruiting points per plant, the same in other centers did not follow this pattern.

MEAN FRUITING POINTS /PLANT

ENTRY	Faridkot		Ludhiana		Hisar		Mean	
	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt
Ankur-651	109	212	100	132	157	102	122	149
Ankur-2226	113	189	96	87	92	104	100	127
Ankur-2534	141	156	93	84	168	95	134	112
RCH.134	128	216	92	104	91	151	104	157
RCH.138	196	286	96	122	117	101	136	170
RCH.317	181	219	94	111	108	130	129	153
MRC.6301	172	197	109	92	121	109	134	133
MRC.6304	192	208	84	98	143	124	140	143
CHECK HYBRIDS								
MECH.162	149	-	87	-				
LHH.144	-	241	-	118	-	139	-	150
Omshankar	-	204	-	101	-	108	-	138
F.1861	-	188	-	78	-	-	-	133
H.1117		-	-	-	-	98	-	98
CD 5%	24.00		28.10		58.28		-	
CV%	7.7		17.20		29.13		-	

**TOTAL BOLLS/PLANT:**

The total bolls in Bt hybrid of Ankur 651 was less in Bt over their non-Bt hybrids in Faridkot and Sriganaganagar. In most other cases, Bt hybrids had numerical superiority over their non-Bt counterparts. Except in Faridkot and Ludhiana, the check hybrids had good number of bolls per plant. The under-mentioned table brings out these details.

TOTAL BOLLS/PLANT

ENTRY	Faridkot		Ludhiana		Hisar		Sriganganagar		Sirsa		Mean	
	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt
Ankur-651	42	45	54	28	80	57	48	58	68	58	58	49
Ankur-2226	51	41	46	18	47	49	41	53	66	53	50	43
Ankur-2534	43	35	51	33	77	43	64	50	66	49	60	54
RCH.134	45	25	32	14	33	55	54	65	48	47	42	41
RCH.138	51	25	36	13	58	49	41	53	53	43	48	37
RCH.317	54	29	44	14	50	46	53	61	55	54	51	41

MRC.6301	48	31	31	13	60	52	54	46	62	39	51	36
MRC.6304	39	20	32	23	47	43	53	56	52	41	45	61
CHECK HYBRIDS												
MECH.162	36	-	26	-	36	-	47	-	51	-	39	-
LHH.144	-	28	-	10	-	49	-	64	-	51	-	40
Omshankar	-	29	-	11	-	50	-	67	-	55	-	42
F.1861	-	24	-	13	-	-	-	-	-	-	-	19
H.1117	-	-	-	-	-	57	-	-	-	-	-	57
RS.2013	-	-	-	-	-	-	-	48	-	52	-	50
CD 5%	9.47		6.21		9.13				6.45		-	
CV%	15.52		6.01		11.20				8.42		-	

### BOLL WEIGHT (g):

None of the hybrids recorded higher boll weight over LHH.144. However, there has been a superiority over their non-Bt counterparts, as seen the table given below.

### BOLL WEIGHT (g)

ENTRY	Faridkot		Ludhiana		Hisar		Srigangana gar		Sirsa		Mean	
	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt
Ankur-651	3.4	3.3	3.5	4.2	3.2	3.5	3.5	3.1	3.2	2.9	3.36	3.4
Ankur-2226	4.1	4.2	4.5	4.8	4.1	4.2	5.0	4.3	4.0	3.9	4.34	4.3
Ankur-2534	3.5	3.8	4.0	4.0	3.2	3.8	3.5	3.6	3.2	3.3	3.48	3.7
RCH.134	3.5	3.6	4.1	4.5	3.4	3.7	4.1	4.1	3.6	3.2	3.74	3.8
RCH.138	3.1	3.3	4.3	4.3	3.3	3.3	3.2	3.2	3.3	2.9	3.44	3.48
RCH.317	3.4	3.1	4.0	3.9	3.3	3.2	4.0	3.4	3.1	2.9	3.56	3.3
MRC.6301	3.9	3.5	4.6	4.3	3.5	3.8	4.5	3.4	3.7	3.5	4.04	3.7
MRC.6304	3.5	3.1	4.2	4.4	3.7	3.7	4.2	2.7	3.8	3.5	3.88	3.5
CHECK HYBRIDS												
MECH.162	3.9	-	4.6	-	3.6	-	4.0	-	3.7	-	3.96	-
LHH.144	-	4.5	-	4.9	-	4.4	-	4.5	-	4.1		4.48
Omshankar	-	3.3	-	3.7	-	3.3	-	2.9	-	2.7		3.12
F.1861	-	3.3	-	3.8	-	-	-	-	-	-		3.55
H.1117	-	-	-	-	-	3.2	-	-	-	3.1		3.15
RS.2013	-	-	-	-	-	-	-	3.5	-	-		3.5
CD 5%	0.25		0.32		0.39				0.60		-	
CV%	4.23		4.63		5.19				10.73		-	



**PERCENT GINNING OUTTURN:**

The ginning outturn of various entries are given below. Only RCH.134Bt recorded 37.1% at Hisar as in the case of H.1117 at Hisar & Sirsa as well as for F.1861 at Faidkot and Ludhaina.

## PERCENT GINNING OUTTURN

ENTRY	Faridkot		Ludhiana		Hisar		Mean	
	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt
Ankur-651	34.1	33.9	35.6	32.6	37.6	35.8	35.7	34.0
Ankur-2226	36.7	32.0	32.3	33.3	34.9	34.4	34.6	33.2
Ankur-2534	34.4	35.6	32.5	32.9	34.7	32.8	33.9	33.8
RCH.134	36.3	35.5	32.6	32.1	37.1	36.5	35.3	34.6
RCH.138	32.6	34.4	32.3	31.2	33.2	33.3	32.7	33.0
RCH.317	34.8	30.6	32.9	33.1	35.6	33.7	34.4	32.5
MRC.6301	35.8	35.4	33.6	32.4	36.0	35.6	35.1	34.5
MRC.6304	37.0	35.6	33.3	31.7	35.8	34.8	35.3	34.0
MECH.162	37.3	-	35.1	-			36.1	-
LHH.144	-	31.6	-	31.2		32.0	-	31.6
Omshankar	-	34.5	-	31.8		35.3	-	33.8
F.1861	-	31.2	-	31.5		37.1	-	21.3
H.1117	-	-	-	-		37.1	-	37.1
RS.2013	-	-	-	-		37.1	-	37.1
CD 5%	1.0		0.60		1.09			
CV%	1.86		1.12		0.63			

**MEAN LINT INDEX (g):**

The mean lint index is given in the table below. These data indicate that there is no significance difference between Bt and non-Bt hybrids as well as these with check hybrids. Similar observations were recorded for seed index (g). The test hybrids showed significantly higher seed index over check varieties.

**MEAN LINT INDEX (g)**

ENTRY	Faridkot		Ludhiana		Hisar		Sirsa		Zone Mean	
	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt
Ankur-651	4.20	4.55	3.94	4.74	4.97	4.92	4.0	4.0	4.28	4.55
Ankur-2226	5.11	4.33	4.14	5.01	5.08	5.03	4.4	4.7	4.68	4.77
Ankur-2534	4.48	5.12	4.35	4.79	4.86	4.79	4.3	4.2	4.50	4.73
RCH.134	4.86	5.24	4.80	5.32	4.94	5.21	4.9	4.4	4.88	5.04
RCH.138	4.47	4.78	4.55	4.17	4.33	4.40	4.1	3.8	4.36	4.29
RCH.317	4.36	4.01	4.40	4.81	5.10	5.14	4.1	4.2	4.49	4.54
MRC.6301	5.28	4.99	4.79	4.60	5.51	5.23	5.1	4.5	5.17	4.33
MRC.6304	5.89	5.56	5.00	4.84	5.65	5.67	5.3	4.7	5.46	5.19
Check hybrids										
MECH.162	5.32	-	5.11	-			4.6	-		
LHH.144	-	5.07	-	4.76		5.00	-	4.4		4.81
Omshankar	-	4.09	-	4.62		3.91	-	3.5		4.03
F.1861	-	3.83	-	4.47		4.36	-	3.7		4.81
H.1117	-	-	-	-		4.36	-	-		4.36
CD 5%	0.22		0.46		0.29		0.53		-	
CV%	2.74		5.96		3.60		7.44		-	

**MEAN SEED INDEX (g):**

**MEAN SEED INDEX (g)**

ENTRY	Faridkot		Ludhiana		Hisar		Sirsa		Zone Mean	
	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt
Ankur-651	8.1	8.9	7.79	9.82	8.27	8.82	7.8	7.6	7.99	8.79
Ankur-2226	8.8	9.2	8.67	10.06	9.50	9.57	8.4	8.4	8.84	9.31
Ankur-2534	8.5	9.3	9.04	9.77	9.17	9.80	8.2	7.9	8.73	9.19
RCH.134	8.5	9.5	9.93	11.26	8.37	9.17	9.1	8.4	8.98	9.58
RCH.138	9.2	9.1	9.51	9.22	8.70	8.80	8.9	7.9	9.08	8.76
RCH.317	8.2	9.1	8.96	9.73	9.23	10.10	7.7	8.0	6.52	9.23
MRC.6301	9.5	9.1	9.47	9.59	9.80	9.44	9.0	8.6	9.44	9.18
MRC.6304	10.0	10.1	10.01	10.43	10.13	10.63	9.9	9.4	10.0	10.14
Check hybrids										
MECH.162	8.9	-	9.45	-			8.3	-		
LHH.144	-	11.0	-	10.52		10.60	-	9.8	-	10.48
Omshankar	-	7.8	-	9.94		7.18	-	7.2		8.03
F.1861	-	8.4	-	9.73		7.39	-	7.2		6.33
H.1117	-	-	-	-		7.39	-	-		7.39
CD 5%	0.20		0.94		0.29		1.00		-	
CV%	1.55		5.89		3.60		7.27		-	

## SEED COTTON YIELD

All the three RCH hybrids, viz., RCH.134, RCH.138 and RCH.317 recorded appreciable yield increase (63 to 83%) over their non-Bt counterpart hybrids. Substantial superiority (45-52%) over Bt check hybrid (MECH.162Bt), zonal checks LHH.144 (86-94%) and hirsutum variety check (31-74%). Hybrid MRC.6301Bt also recorded higher seed cotton yield over the non-Bt hybrid (84%), Bt check hybrid (MECH.162Bt) (40%) and hirsutum variety check (27-61%). In the case of Ankur hybrids, all the three Bt hybrids recorded lower yield than Bt check hybrid. There was no appreciable yield difference between these Bt hybrids and their non-Bt hybrid counterparts.

# SEED COTTON YIELD (Kg/ha)

## PLANT BREEDING EVALUATION

ENTRY	Faridkot		Ludhiana		Hisar		Sriganganagar		Sirsa		Mean	
	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt
Ankur-651	2227	2080	1885	1745	1893	1989	1454	1694	2246	1838	1913	1869
Ankur-2226	2745	2258	1750	1152	1907	2044	1824	1934	2486	1940	2011	1922
Ankur-2534	2443	2059	1798	1594	2071	1962	1440	1269	1975	1992	1846	1796
RCH.134	3373	2026	2698	873	3004	2538	3361	2263	2949	1632	2565	2372
RCH.138	3433	1810	2852	1023	2648	2140	2620	1742	3391	1434	2407	2184
RCH.317	3611	1944	2619	1154	2758	1660	2538	1797	3086	1781	2352	2149
MRC.6301	3650	2219	2169	1141	2360	1893	2791	1111	3182	1320	2280	2021
MRC.6304	2834	1520	1863	1003	1866	1070	2003	967	1948	1139	1675	1487
Check hybrids												
MECH.162	2773	-	1592	-	2099	-	1577	-	2037	-	2016	-
LHH.144	-	1976	-	705	-	1975	-	1523	-	1691	-	1574
Omshankar	-	1813	-	881	-	2126	-	1550	-	2047	-	1683
F.1861(Fdkt/Ludh/Sirsa)	-	2273	-	794	-	-	-	-	-	1722	-	1596
H.1117 (Hisar)	-	-	-	-	-	2221	-	1852	-	-	-	2037
RS.2013	-	-	-	-	-	2222	-	-	-	-	-	2222
CD 5%	435		420		553.52		347		450		-	
CV%	10.73		16.25		15.69		8.95		13.04		-	

**Per cent Yield increase**  
PLANT BREEDING EVALUATION

Name of entry	Over non-Bt hybrids	Over Bt check hybrid	Over local check hybrids		Over Local check varieties		
			LHH.144	Omshankar	F.1861 (Fdkt/Ludh/Sirsa)	H.1117 (Hisar)	<b>RS.2013</b> (Sreegngr)
Ankur-651	5.3	-3.7	23.3	15.3	10.7	-9.8	-12.6
Ankur-2226	-9.2	-15.9	7.7	0.7	-3.3	-16.8	-23.7
Ankur-2534	9.5	-3.5	12.8	15.6	11.0	-4.5	-12.4
RCH.134	63.8	51.7	94.2	81.6	74.4	50.1	37.6
RCH.138	83.3	48.3	89.9	77.6	70.5	46.7	34.5
RCH.317	75.3	45.0	85.7	73.6	66.7	43.5	31.5
MRC.6301	84.2	40.4	79.8	68.1	61.5	38.9	27.4
MRC.6304	84.5	43.0	33.6	24.9	20.0	3.2	-5.4

## Fibre property data

The fibre property data of the various test entries are provide in the following tables. These indicate that there is no appreciable difference in the various fibre properties such as staple length and tenacity and micronaire in the test entries. In accordance with the textile requirements and CIRCOT norms, the ratio of tenacity to strength shall be 0.8 and above.

In this respect, RCH.134 and RCH. 138 stand superior over others. It is worthy to note that amongst check varieties, H.1117 and RS.2013 also are outstanding in this respect.

### Mean staple length, tenacity and ratio of fibre tenacity and length in various test entries

Name of entry	2.5% Span length in mm (l)	Tenacity (g/tex) (t)	Ratio of t/l
Ankur-651 Bt	28.6	20.9	0.73
Ankur-2226 Bt	27.3	20.3	0.74
Ankur-2534 Bt	28.6	21.6	0.76
RCH.134 Bt	27.6	22.3	0.81
RCH.138 Bt	27.8	22.6	0.81
RCH.317 Bt	28.8	21.1	0.71
MRC.6301 Bt	28.8	21.4	0.74
MRC.6304 Bt	29.1	22.3	0.76
<b>CHECK HYBRIDS AND VARITIES</b>			
MECH.162	26.8	21.1	0.78
LHH.144	28.0	21.1	0.75
Omshankar	27.7	20.3	0.73
F.1861((Fdkt/Ludh/Sirsa)/Sirsa)	26.9	21.4	0.75
H.1117(Hisar)	24.0	19.2	0.80
RS.2013(Sreegngr)	25.3	20.3	0.84

## Plant protection against insect pests in breeding trials

Spraying of insecticides, undertaken in the experimental plots of each AICCIP centre to contain the various pests are provided. The general pressure of pests seemed to be low, since it can be seen that the spraying of insecticides in any hybrid was taken up only 70-80 days. Both sap sucking pests and bollworms built up even on non-Bt hybrids and check varieties at later stages. The gene action of Cry I A(c) is known to be up to 90-100 days after germination of the crop in Bt hybrids. Hence, it is difficult to assess the exact and effectiveness of gene action of these genetically modified hybrids in north zone.

### Faridkot

The Bt hybrids of Ankur-651, RCH.134, MRC.6304, Omshankar, MECH.162 Bt, non-Bt hybrids of MRC.6304, Ankur-2534 & F.1861 entries received spraying against jassids after 80 days of crop growth. The sprayings against Spotted bollworm damage was in non Bt and check entries at 100 days of growth. However, RCH.138 Bt and RCH.317 Bt received the first bollworm spray at 100 days.

Entry	Name of insecticide	Dosage (ml/ha)	Date of spraying	Target pest species
Bt hybrids of Ankur-651, RCH.134, MRC.6304, Omshankar, MECH.162 Bt, non Bt hybrids of MRC.6304, Ankur-2534 & F.1861	Confidor 200 SL		05.08.2003	Jassid
RCH.138 Bt, RCH.317 Bt, Non-Bt and check hybrids	Thiodan 35 EC	2500	27.08.2003	Spotted bollworm
Non-Bt and check hybrids	Ekalux 25 EC	2000	03.09.2003	Spotted bollworm
All entries	Oxydemeton methyl 25 EC	750	15.09.2003	Whitefly and aphid
All entries	Oxydemeton methyl 25 EC	750	24.09.2003	Whitefly
Non-Bt and check entries	Curacron 50 EC	1250	25.09.2003	Spotted bollworm
Non-Bt EXCEPT RCH.134 and check entries except MECH.162	Hostathion 40 EC	1500	05.10.2003	Spotted and Pink bollworms
All entries	Oxydemeton methyl 25 EC	750	13.10.2003	Whitefly and aphid
Non-Bt EXCEPT MRC.6304 and check entries except MECH.162	Thiodan 35 EC	2500	15.10.2003	Spotted and Pink bollworms

## Ludhiana

Blanket spray to all entries against jassids was done 45 after germination. Only non-Bt entries were sprayed with insecticides for Spotted bollworm protection after 60 days after germination.

Entry	Name of insecticide	(Dosage ml/acre)	Date of spraying	Target pest species
All entries	Confidor 200 SL	40	10.7.03	Jassid & whitefly
LHH.144, Omshankar & non-Bt entries	Thiodan 35 EC	1000	28.7.03	<i>Earias</i> Spp.
LHH.144, Omshankar & non-Bt entries	Ekalux 25 EC	800	7.8.03	<i>Earias</i> Spp.
LHH.144, Omshankar & non-Bt entries	Ethion 50 EC	800	18.8.03	<i>Earias</i> Spp. & whitefly
All entries	Confidor 200 SL	40	22.8.03	Jassid
LHH.144, Omshankar & non-Bt entries	Acephate 75 SP	800 g	25.8.03	<i>Earias</i> Spp.
All entries	Curacron 50 EC	500	5.9.03	<i>Earias</i> Spp.
LHH.144, Omshankar & non-Bt entries	Chlorpyrifos 20 EC	2000	17.9.03	<i>Earias</i> Spp.

## HISAR

A blanket spray to all entries of methyl demeton, systemic insecticide to protect from jassids was done after 71 days after germination. This was repeated a fortnight with another systemic insecticide such as dimethoate and in a week's time with imidachlopid. Spotted bollworm damage was seen to cross beyond threshold level after 102 days of germination in some Bt entries, all non-Bt entries and check hybrids.



Entry name	Name of insecticide	(Dosage ml/ha)	Date of spraying	Target pest species
	Methyl demeton 25 EC	1000	26.7.03	Jassid
Ankur-651 Bt, RCH.134 Bt Ankur-2226 Bt, MRC.6301 Bt, RCH.138 Bt, Ankur-2534 Bt, RCH.317 Bt, MRC.6304 Bt, MECH.162 Bt, Omshankar, non Bt hybrids except Ankur- 2534 and Ankur-651	Dimethoate 30 EC	1000	8.8.03	jassids
All Bt hybrids except Ankur- 651, RCH.134, MRC.6301, Ankur 2226; Non-Bt hybrids except MRC.6301 & RCH.134, all check hybrids/variety	Confidor 200 SL	100	16.8.03	jassids
RCH.138Bt RCH.317 Bt, check hybrids/variety except MECH.162 Bt, all non-Bt hybrids	Endosulfan 35 EC	1500	27.8.03	<i>Earias</i> Spp.
MECH.162 Bt, check hybrids, MRC.6304, RCH.138, MRC.6301, RCH.134, Ankur- 651 & H.1117	Alphamethrin	300	10.9.03	<i>Earias</i> Spp.
RCH.138 Bt, RCH.317 Bt, non-Bt hybrids except RCH.138, Ankur 2534, and H.1117	Quinalphos 25 EC	2000	24.9.03	<i>Earias</i> Spp.

## Sriganganagar

The spraying against jassids was taken up at 77 days in most of the test entries. Bollworm management spraying with Spinosad was also taken up in non-Bt and check entries at the same time. Spraying against whitefly was done in certain Bt entries such as RCH.134 and RCH.138 as well as Ankur 2226 and 2534 and in non-Bt counterparts as also in LHH.144 by 104 days after germination. A mixture of Ethion and Achook was given against whitefly in all Breeding evaluation plots against whitefly at 134 day.

Entry	Name of insecticide	(Dosage ml/ha)	Date of spraying	Target pest species
All Bt entries except RCH.134 Bt & Ankur-2226 Bt, Omshankar, non-Bt entries except RCH.317, Ankur-2534, RCH.138, Ankur-2226, Ankur-651	Confidor 200 SL	100	9.8.03	Jassid
LHH.144, Omshankar, MECH.162 Bt, RCH.317, MRC.6304, RCH.138, Ankur-2226, RS.2013	Spinosad 48 EC	350	09.08.03	Bollworms
RCH.134 Bt, MRC.6304 Bt, RCH.317 Bt, all non-Bt entries and check entries	Spinosad 48 EC	350	19.08.03	Bollworms
RCH.134 Bt, Ankur-2226 Bt, RCH.138 Bt, Ankur-2534 Bt, LHH.144, all non-Bt entries except Ankur-2226	Triazophos	3000	03.09.03	Whitefly
All entries	Ethion 40 EC + Achhook 1500 ppm	2500 ml + 3000 ml	4.10.03	Whitefly

The jassid threshold was crossed in most entries after 73 days of germination. The threshold of Spotted bollworm incidence by 90<sup>th</sup> day after germination in RCH.134 Bt, MRC.6304 Bt and RCH.317 Bt hybrids. A surge in whitefly population was seen after 3<sup>rd</sup> September (about 100 days after germination).

#### Date of crossing the ETL of Sap Sucking Pests and Bollworms

Entry Code	Date at which Threshold Level was crossed				
	SAP SUCKING PESTS			BOLLWORMS	
	Jassid	Whitefly	Thrips	Square damage	Boll damage
ANKUR-651Bt	08/08	03/10	---	----	----
RCH.134 Bt	---	03-10	---	18/8	02/09
MRC.6301 Bt	08/08	03/10	---	8/8	----
ANKUR-2226 Bt	---	03/10	---	2/9	----
RCH.138 Bt	---	03/10	---	18/8	2/9
ANKUR-2534 Bt	18/08	19/09	---	2/9	----
MRC.6304 Bt	25/07	03/10	---	8/8	----
RCH.317 Bt	25/07	19/09	---	8/8	----

LHH.144 (Zonal check)	---	03/10	---	8/8	02/09
OMSHANKAR (Zonal check)	25/07	03/10	---	8/8	----
MECH.162Bt (Bt check)	25/07	03/10	---	8/8	----
RCH.317	---	03/10	---	8/8	02/09
MRC.6304	25/07	19/09	---	8/8	2/9
ANKUR-2534	---	03/10	---	18/8	2/09
RCH.138	---	03-10	---	8/8	02/09
ANKUR-2226	---	03/10	---	8/8	----
MRC.6301	08/08	03/10	---	18/8	2/9
RCH.134	08/08	19/09	---	8/8	02/09
ANKUR-651	---	03/10	---	18/8	02/09
RS.2013	---	03/10	---	8/8	----

---- = ETL not crossed

## Sirsa

At Sirsa, in spite of no seed treatment with any systemic insecticides on the test entries, the jassid threshold was crossed in the test entries only on 1<sup>st</sup> August, 03. In the case of bollworms, the infestation of Spotted bollworms was only noticed and the threshold was crossed on 25<sup>th</sup> August 03 (100 days) in Ankur-2226 Bt, Ankur-2534 Bt, MRC.6304, Ankur 2534 and Ankur-651 while in MRC.6301 Bt, LHH.144, MRC.6304, Ankur-2534, Ankur-651 and H.1117 had this bollworm species infested above threshold levels from 26<sup>th</sup> September (130 days).

On the basis of this data, one has to look at the efficacy of the Cry IA (c)gene against Spotted bollworms that was predominant in this zone. The expression of gene and consequent protection of squares of some of the Bt genotypes from 8<sup>th</sup> August onwards is to be examined in detail.

Entry	Name of insecticide	(Dosage ml/ha)	Date of spraying	Target pest species
All entries	Confidor	100 ml	02.08.03	Jassids
Ankur-2226 Bt, Ankur-2534 Bt and non-Bt, MRC.6304, Ankur-651	Quinalphos	2000 ml	28.08.03	Spotted bollworm
MRC.6301 Bt, LHH.144, MRC.6304, Ankur-2534, Ankur-651, H.1117,	Methomyl	625 g	29.09.03	Spotted bollworm

A major conclusion that has to be drawn based on the results of the centers from north zone is that American bollworm and Pink bollworm were not adequately present to convincingly spell out the action of Cry I A (c) gene in the test hybrids, However, it is significant to note that the persistent Spotted bollworm incidence seemed to be reduced due to this gene's action in these test entries till 100 days of crop growth in Bt hybrids over their non-Bt counterparts and check hybrids.

### Disease incidence:

The observations on Cotton Leaf Curl Virus disease incidence in Breeding evaluation is tabulated below. It is evident that Ankur-651, Ankur-2226 and Ankur-2534 are susceptible to this virus disease along with Omshankar.

Incidence of Cotton Leaf Curl Virus Disease in various entries

Entry	Bt	Non-Bt	Remarks
Ankur-651	0	0.67	
Ankur-2226	0	S	*Monitoring committee report
Ankur-2534	0.33	0	
RCH.134	0	S	Monitoring committee report
RCH.138	S	0	Monitoring committee report
RCH.317	0	0	
MRC.6301	0	0	
MRC.6304	0	S	Monitoring committee report
LHH.144	-	0	
Omshankar	-	12.33	
F.1861(Fdkt/Ludh/Sirsa) iana	-	0	
H.1117Hisar	-	S	Monitoring committee report
RS.2013 (Ganganagar)	-	0	

\*ICAR Monitoring team

In conclusion, it can be derived that in the Breeding evaluation, the Cry I A (c) gene was seen to be performing well in all locations and in all Bt hybrids up to 100 days.

The jassid damage also commenced this season in most locations after 60-75 days in spite of the fact that there was no seed treatment with imidachlopid or other systemic insecticides to suppress early season jassids. However, at Ludhiana and Hisar, sprays were commenced at 45 days.

In the Breeding evaluation plots, Cotton Leaf Curl virus (CLCuV) disease was noticed in hybrids such as Ankur-651, Ankur-2534Bt, RCH.134, RCH.138Bt, MRC.6304 amongst the test hybrids.



**PLANT PROTECTION  
EVALUATION**

# PLANT PROTECTION EVALUATION

The FIVE AICCIP CENTRES in north zone were directed to evaluate the performance of the eight Bt hybrid entries for reaction to all the prevailing pests and diseases along with their non-Bt counterparts as well as with their Bt check and local check variety. Data were recorded on the incidence and damage due to various pests and diseases prevalent during the season in these five AICCIP centers.

Under protected and un-protected conditions, the performance of test hybrids against prominent pests such as leaf hoppers (jassids), whitefly amongst sap sucking insects and all the bollworm species in addition to other minor pests such a leaf feeding caterpillars was evaluated. Amongst diseases, the presence of Cotton Leaf Curl Virus (CLCuV) disease was the most important as this threatens the cultivation of American (hirsutum) cottons in the northern states currently. The AICCIP has also a decision that none of the hirsutum entries susceptible to this pest shall be introduced for commercial cultivation in the three states of this zone.

## Entomology Evaluation

The Entomology evaluation was targeted primarily to test the action of Cry IA (c) gene in eight Bt trial hybrids, viz., Ankur-651Bt, Ankur-2226Bt, Ankur-2354Bt, RCH.134Bt, RCH.138Bt, RCH.317Bt, MRC.6301Bt & MRC.6304Bt against the following bollworms.

**SPOTTED BOLLWORM- *Earias vittella* Fabricius**

**SPINY BOLLWORM – *Earias insulana* Boisdual**

**AMERICAN BOLLWORM – *Heicoverpa armigera* Hubner**

**PINK BOLLWORM – *Pectinophora gossypiella* (Saunders)**

This was undertaken in sprayed and unsprayed plots in all the five locations. The insecticides sprayings were decided based on the threshold levels of sap sucking pest species and bollworms that invaded the various test hybrids. The sprayings were undertaken in both the plots of the two replications, once it is made sure that one of the plots in a replication has crossed the threshold level of bollworm infestation in respect of the candidate hybrid. The incidence of American bollworm was low in almost all AICCIP centres in the North Zone during the entire season.

The experiments were sown between 8<sup>th</sup> to 20<sup>th</sup> May, as given in the table below. The dates of harvest are also provide therein.

Dates	Faridkot	Ludhiana	Hisar	Sriganganagar	Sirsa
Date of sowing	10.5.04	20.5.03	15.5.03	18.5.03	08.5.03
Date of germination	14.5.04	25.5.03	19.5.03	22.5.03	12.5.03
Date of harvesting	01.12.03	-	29.10.03	12.11.03	17.11.03

Three out of five locations, viz., Hisar, Srenganganagar and Sirsa had low germination percentage as compared to the two centers in Punjab in Ankur-651Bt, Ankur-2226Bt, RCH.138Bt, MRC.6304Bt. In general, the Bt hybrids had lower germination percentage over other entries in all locations, showing that these hybrids seeds were not of good quality. The ICAR Monitoring Committee Report mentioned about this aspect as well as about the mixtures and off-type plants in Ankur-651Bt and its non-Bt counterpart, Ankur-2226Bt, RCH.138, MRC.6304 at all locations. These two aspects are cause of concern for maintaining accuracy of these evaluations.



## Faridkot

The Bt hybrids of ANKUR-651, RCH.134, MRC.6304, Omshankar, MECH.162 Bt, non-Bt hybrids of MRC.6304, Ankur-2534 & F.1861 entries were sprayed against jassids after 80 days of crop growth. The sprayings against Spotted bollworm damage was in non-Bt hybrids and check entries at 100 days of growth. However, RCH.138 Bt and RCH.317 Bt received the first bollworm spray at 100 days. The following table provides the details on the date of application of various pesticides that are targeted for different pests in the test entries, as and when the threshold population was crossed, given pesticide against the target pest species.

Entry	Name of insecticide	Dosage (ml/ha)	Date of spraying	Target pest species
ANKUR-651Bt,RCH.134Bt, MRC.6304Bt,Omshankar, MECH.162Bt,MRC.6304, Ankur-2534 & F.1861	Confidor 200 SL	100 ml	05.08.2003	Jassid
RCH.138Bt, RCH.317Bt, Non-Bt and check hybrids	Thiodan 35 EC	2500 ml	27.08.2003	Spotted bollworm
Non-Bt and check hybrids	Ekalux 25 EC	2000 ml	03.09.2003	Spotted bollworm
All entries	Oxydemeton methyl 25 EC	750 ml	15.09.2003	Whitefly and aphid
All entries	Oxydemeton methyl 25 EC	750 ml	24.09.2003	Whitefly
Non-Bt and check entries	Curacron 50 EC	1250 ml	25.09.2003	Spotted bollworm
Non-Bt EXCEPT RCH.134 and check entries except MECH.162	Hostathion 40 EC	1500 ml	05.10.2003	Spotted and Pink bollworms
All entries	Oxydemeton methyl 25 EC	750 ml	13.10.2003	Whitefly and aphid
Non-Bt EXCEPT MRC.6304 and check entries except MECH.162	Thiodan 35 EC	2500 ml	15.10.2003	Spotted and Pink bollworms

The following table shows the season's average per cent bollworm incidence on intact fruiting bodies (squares, flowers and bolls) in sprayed and unsprayed plots. While the un-sprayed plots had more than

one larva per fruiting body, on an average, in Bt hybrids, the insecticide treatment did reduce the same to below one in these hybrids. However, the other non-Bt hybrids and check hybrids harboured more than 2 bollworms per fruiting body on an average in both types of plots. However, the percent bollworm damage was found to be reduced due to spraying of insecticides in Bt hybrids as well as in other test hybrids.

Average per cent bollworm incidence in intact fruiting bodies

Test hybrids	Sprayed	Unsprayed
ANKUR-651Bt	0.77 (4.76)	1.32 (5.44)
ANKUR-651	4.12 (10.57)	1.91 (6.84)
ANKUR-2226 Bt	0.93 (5.04)	0.89 (5.01)
ANKUR-2226	2.65 (8.32)	4.36 (10.02)
ANKUR-2534 Bt	0.78 (4.70)	1.25 (5.45)
ANKUR-2534	3.61(9.87)	4.19 (9.64)
MRC.6301 Bt	0.75 (4.64)	1.36 (5.43)
MRC.6301	5.43 (12.11)	5.18 (11.37)
MRC.6304 Bt	0.60 (4.37)	1.29 (5.64)
MRC.6304	4.68 (11.30)	4.38 (10.12)
RCH.134 Bt	0.70 (4.16)	1.50 (6.10)
RCH.134	3.33 (8.88)	4.95 (11.48)
RCH.138 Bt	0.76 (4.77)	1.09 (5.31)
RCH.138	4.53 (11.10)	5.08 (11.96)
RCH.317 Bt	0.98 (5.28)	1.00 (5.18)
RCH.317	4.06 (10.69)	6.46 (12.52)
MECH.162Bt	1.76 (6.71)	2.10 (7.07)
LHH.144)	3.85 (9.98)	5.01 (11.31)
OMSHANKAR	4.63 (11.98)	5.12 (11.51)
F.1861	4.47 (11.12)	4.88 (10.90)
CD 5%	(2.40)	(2.61)

The bollworm incidence in harvestable bolls at Faridkot AICCIP center, as given below showed that the per cent boll damage under sprayed condition in Bt hybrids was ranging from 4.21 in RCH.317Bt to 13.45 MRC.6301Bt. Under unsprayed condition, the boll damage ranged from 7.5 per cent (MRC.6301Bt) to 16.73% (MRC.6304Bt). When the locule damage was considered, the sprayed plots had a range of 1.82% in RCH.317 to 5.11% in MRC.6301Bt. Under unsprayed condition, the

locule damage was the lowest in Ankur-2534Bt (3.22%) and ANKUR-651Bt (3.37%) as compared to 8.17% in MRC.6304Bt.

#### Bollworm incidence in harvestable bolls

Test Hybrids	Boll damage (%)		Locule damage (%)	
	Sprayed	Unsprayed	Sprayed	Unsprayed
ANKUR-651Bt	6.66 (14.69)	8.16 (13.63)	2.89 (9.54)	3.76 (9.02)
ANKUR-651	43.38 (41.08)	35.68 (36.67)	17.13 (24.25)	14.11 (21.91)
ANKUR-2226 Bt	8.42 (16.86)	13.31 (20.80)	3.69 (11.04)	5.88 (13.12)
ANKUR-2226	40.50 (39.48)	31.27 (33.89)	18.12 (25.11)	14.62 (22.30)
ANKUR-2534 Bt	8.55 (16.52)	8.21 (16.35)	3.88 (11.01)	3.37 (10.29)
ANKUR-2534	39.23 (38.69)	37.96 (37.97)	21.08 (27.21)	18.15 (25.10)
MRC.6301 Bt	13.45 (21.10)	7.50 (15.59)	5.11 (12.92)	3.22 (10.26)
MRC.6301	47.10 (43.33)	52.93 (46.67)	20.05 (26.27)	23.16 (28.71)
MRC.6304 Bt	10.15 (18.54)	16.73 (23.55)	4.61 (12.25)	8.17 (15.93)
MRC.6304	42.74 (40.69)	50.29 (51.15)	19.00 (5.66)	17.15 (24.44)
RCH.134 Bt	12.45 (20.52)	9.56 (17.89)	4.71 (12.33)	4.18 (11.74)
RCH.134	52.89 (46.65)	52.57 (46.46)	23.75 (29.02)	24.45 (29.60)
RCH.138 Bt	8.67 (25.01)	9.84 (18.06)	7.44 (15.41)	4.77 (12.38)
RCH.138	42.79 (40.81)	56.10 (48.52)	19.43 (26.09)	26.06 (30.64)
RCH.317 Bt	4.21 (11.83)	10.29 (18.58)	1.82 (7.74)	4.54 (12.15)
RCH.317	42.98 (40.83)	38.89 (38.30)	19.57 (26.16)	15.92 (3.11)
MECH.162Bt (Bt check)	25.02 (29.02)	16.06 (23.12)	10.27 (18.13)	8.47 (15.71)
LHH.144 (Zonal check)	59.61 (15.66)	47.75 (43.69)	28.56 (32.16)	22.30 (27.77)
OMSHANKAR (Zonal check)	43.35 (41.10)	49.46 (44.63)	17.77 (24.67)	20.44 (26.53)
F.1861	43.08 (40.98)	55.14 (48.04)	19.71 (26.14)	17.27 (24.52)
C.D. (p = 0.05)	(9.74)	(10.89)	(5.48)	(7.71)

Significant incidence of Pink bollworm (PBW) in fruiting bodies was noticed in Faridkot centre in the tested entries. The average incidence of Pink bollworm based on observation in three plants per Test hybrids is given below. Minimum damage of PBW was recorded in all Bt hybrids over their non-Bt counterparts. 31.67% incidence of PBW was recorded in F.1861 variety under unsprayed condition. Amongst non-Bt counterpart, the maximum per cent incidence was found on MRC.6301 followed by RCH.138, Ankur-651 and Ankur-2226.

Mean per cent incidence of Pink bollworm in fruiting bodies

Test Hybrids	No. of PBW diapausing larvae per 3 plants	
	Unsprayed	Sprayed
ANKUR-651Bt	1.00 (1.33)	2.00 (1.54)
ANKUR-651	18.33 (4.29)	4.33 (2.06)
ANKUR-2226 Bt	0.00 (1.00)	2.00 (1.73)
ANKUR-2226	17.67 (4.27)	6.67 (2.76)
ANKUR-2534 Bt	1.67 (1.57)	0.33 (1.13)
ANKUR-2534	10.00 (3.31)	5.67 (2.32)
MRC.6301 Bt	0.00 (1.00)	1.33 (1.48)
MRC.6301	23.33 (4.79)	14.67 (3.90)
MRC.6304 Bt	0.33 (1.13)	3.33 (2.03)
MRC.6304	2.33 (1.61)	10.33 (3.29)
RCH.134 Bt	0.33 (1.13)	1.67 (1.49)
RCH.134	12.67 (3.27)	14.00 (3.84)
RCH.138 Bt	0.00 (1.00)	0.67 (1.24)
RCH.138	20.00 (3.97)	8.00 (2.83)
RCH.317 Bt	0.67 (1.24)	1.67 (1.48)
RCH.317	8.33 (3.05)	6.00 (2.61)
MECH.162 Bt	3.33 (1.96)	3.00 (1.80)
LHH.144	14.00 (3.78)	2.67 (1.67)
OMSHANKAR	9.67 (3.25)	18.00 (3.99)
F.1861	31.67 (5.44)	9.33 (3.19)
CD (p=0.05)	(1.87)	(1.57)

The test Bt entries did not have any difference in regard to the incidence of leaf hoppers (jassid) and whitefly in unsprayed and sprayed plots in comparison to check hybrids. However, their non-Bt counterparts showed more jassids as in the case of MRC.6304 in comparison to others in both sprayed and unsprayed condition. The MECH.162 Bt check hybrid had similar jassid population.

Season's average per cent jassids and whitefly incidence

Test hybrids	Jassids		Whitefly	
	Sprayed	unsprayed	Sprayed	unsprayed
ANKUR-651Bt	0.36 (1.13)	0.42 (1.17)	5.30 (1.98)	2.44 (1.75)
ANKUR-651	0.48 (1.19)	0.40 (1.16)	3.30 (1.83)	3.44 (1.75)
ANKUR-2226 Bt	0.37 (1.14)	0.48 (1.16)	5.09 (2.00)	3.33 (2.07)
ANKUR-2226	0.45 (1.19)	0.45(1.17)	3.34(1.79)	2.77 (1.94)
ANKUR-2534 Bt	0.54 (1.21)	0.55 (1.22)	3.91 (1.88)	3.33 (2.00)
ANKUR-2534	0.55 (1.24)	0.77 (1.28)	3.59 (1.86)	2.33 (1.75)
MRC.6301 Bt	0.61 (1.23)	0.49 (1.19)	3.49 (1.87)	3.66 (2.09)
MRC.6301	0.47 (1.19)	0.54 (1.21)	2.83 (1.72)	2.66 (1.84)
MRC.g6304 Bt	0.84 (1.28)	1.33 (1.46)	3.11 (1.73)	3.11 (1.99)
MRC.6304	1.09 (1.37)	1.97 (1.64)	2.50 (1.66)	2.44 (1.85)
RCH.134 Bt	0.61 (1.33)	0.66 (1.27)	5.08 (2.08)	3.21 (2.04)
RCH.134	0.45 (1.27)	0.75 (1.28)	3.38 (1.83)	2.66 (2.08)
RCH.138 Bt	0.48 (1.19)	0.60 (1.22)	4.52 (2.05)	2.55 (1.85)
RCH.138	0.40 (1.16)	0.39 (1.16)	4.03 (1.94)	4.88 (2.38)
RCH.317 Bt	0.76 (1.28)	0.75 (1.28)	4.17 (1.91)	2.77 (1.93)
RCH.317	0.37 (1.16)	0.67 (1.26)	4.09 (1.93)	3.55 (2.09)
MECH.162 Bt	1.05 (1.32)	1.17 (1.41)	2.80 (1.75)	4.88 (2.32)
LHH.144	0.71 (1.30)	0.53 (1.20)	3.19 (1.81)	2.66 (1.89)
OMSHANKAR	0.74 (1.22)	0.48 (1.20)	4.97 (2.05)	4.66 (2.29)
F.1861	0.66 (1.24)	0.67(1.27)	3.14 (1.81)	2.11 (2.04)
CD (p=0.05)	NS	(0.15)	(NS)	NS

## Seed cotton yield (Kg/ha)

ENTRY	Faridkot	
	*S	*US
Ankur-651Bt	2020	1615
Ankur-651	3095	2636
Ankur-2226 Bt	3093	2906
Ankur-2226	2267	2465
Ankur-2534 Bt	3045	2636
Ankur-2534	2066	1431
MRC.6301 Bt	2307	1989
MRC.6301	3136	2927
MRC.6304 Bt	1454	1153
MRC.6304	1335	1044
RCH.134Bt	2120	1580
RCH.134	1699	1195
RCH.138 Bt	1227	1052
RCH.138	1555	1362
RCH.317 Bt	1439	1185
RCH.317	1661	1293
MECH.162 Bt	1395	1273
LHH.144	1630	1492
Omshankar	1808	1303
F.1861	1719	1325
CD at 5%	232	297
CV%	15.99	13.97

## Ludhiana

The plant population per plot of Ankur-Bt and non-Bt hybrids was reported low in comparison to other test hybrids. Shoot damage due to spotted bollworm was recorded at Ludhiana Centre of AICCIP. From the data given below, it is found that Check hybrid, LHH.144 had a maximum of 18% shoot damage due to Spotted bollworm in the sprayed and unsprayed plots. However, all Bt hybrids recorded this pest incidence between 2.14 to 5.32 per cent in sprayed plots and 2.17 to 4.9

per cent in unsprayed plots. There is significant reduction in shoot boring incidence of Spotted bollworm in Bt hybrids over other entries. Mean per cent bollworm incidence in fruiting bodies, as given below, showed that there is no difference amongst the Bt hybrids in sprayed and unsprayed plots. However, the check hybrids had approximately 40 to 50% reduction in bollworm incidence in sprayed plots over unsprayed plots.

Shoot damage by Spotted Bollworm  
(Figures in parentheses are n+1 square root transformations)

Test hybrids	Per cent shoot damage	
	Sprayed	Unsprayed
ANKUR-651Bt	2.97 (9.90)	3.44 (10.67)
ANKUR-651	6.41 (14.59)	8.68 (16.99)
ANKUR-2226 Bt	4.12 (11.63)	4.26 (11.85)
ANKUR-2226	15.56 (23.10)	16.18 (23.61)
ANKUR-2534 Bt	5.32 (13.08)	4.89 (12.77)
ANKUR-2534	13.58 (21.43)	12.22 (20.41)
MRC.6301 Bt	2.69 (9.07)	3.24 (10.21)
MRC.6301	10.47 (18.66)	10.33 (18.61)
MRC.6304 Bt	4.00 (11.51)	4.90 (12.77)
MRC.6304	11.08 (19.32)	9.54 (17.86)
RCH.134 Bt	2.14 (8.29)	2.63 (9.24)
RCH.134	10.27 (18.41)	10.34 (18.63)
RCH.138 Bt	2.29 (8.55)	2.17 (8.35)
RCH.138	7.88 (16.01)	8.38 (16.71)
RCH.317 Bt	2.46 (8.74)	2.83 (9.58)
RCH.317	7.82 (16.11)	8.36 (16.70)
MECH.162 Bt	7.42 (15.65)	4.49 (12.15)
LHH.144	18.01 (25.09)	18.77 (25.58)
OMSHANKAR	7.53 (15.86)	6.71 (14.90)
F.1861	12.97 (20.95)	14.46 (22.29)
CD (at 0.05)	(4.53)	(3.69)
CV (%)	17.91	14.40

The table below provides the mean per cent bollworm incidence in fruiting bodies. While there was no difference between protected and protected plots in regard to the incidence per cent of bollworms, significant difference between Bt hybrids and non-Bt hybrids as well as between check hybrids was seen. The gene action of Bt hybrids was evident to counteract this pest.

Mean Percent bollworms incidence in intact fruiting bodies  
(Note: Figures in parentheses are n+1 arc sine transformations)

Test entry	Mean per cent bollworms	
	Sprayed	Unsprayed
ANKUR-651Bt	3.96 (11.41)	4.50 (12.12)
ANKUR-651	8.91 (17.31)	15.41 (22.53)
ANKUR-2226 Bt	3.98 (11.41)	4.89 (12.62)
ANKUR-2226	8.36 (16.77)	16.16 (23.22)
ANKUR-2534 Bt	3.49 (10.61)	5.00 (12.59)
ANKUR-2534	7.86 (16.19)	12.88 (20.53)
MRC.6301 Bt	3.86 (11.18)	4.74 (12.39)
MRC.6301	8.06 (16.33)	14.16 (21.68)
MRC.6304 Bt	3.86 (11.09)	4.65 (12.11)
MRC.6304	8.47 (16.89)	15.69 (22.68)
RCH.134 Bt	3.70 (10.83)	4.32 (11.69)
RCH.134	7.61 (15.51)	15.00 (21.46)
RCH.138 Bt	3.94 (11.19)	4.25 (11.57)
RCH.138	8.36 (16.56)	15.22 (21.65)
RCH.317 Bt	3.58 (10.67)	4.61 (12.24)
RCH.317	8.31 (16.70)	15.07 (22.19)
MECH.162 Bt	3.92 (11.31)	4.89 (12.38)
LHH.144	8.57 (16.97)	17.17 (23.82)
OMSHANKAR	8.67 (17.07)	14.76 (22.03)
F.1861	8.76 (17.14)	15.25 (22.03)
CD (at 0.05)	(1.49)	(2.80)
CV (%)	9.95	14.94

When the open boll damage of first picking was considered as given in the following Table, significant reduction in Bt hybrid entries was seen under sprayed conditions. Under unsprayed conditions, this incidence in Bt hybrids was more than that in sprayed conditions, especially in all Ankur Bt entries and MRC Bt entries. The RCH Bt entries showed less variation in bollworm damage in first picked open bolls. Similar trend existed in the second picking too as seen from following table.

As regards, locule damage, in the first picked bolls, there was significantly lower damage over other entries in both sprayed and unsprayed conditions. They had similar damage as in the case of Bt check hybrid in this regard. Similar trend was seen in the second picking.



Mean Percent Bollworms incidence in open bolls in first picking

Test hybrids	Open boll damage		Locule damage	
	Sprayed	Unsprayed	Sprayed	Unsprayed
ANKUR-651Bt	7.99 (16.37)	11.54 (19.79)	4.43 (12.11)	6.24 (14.45)
ANKUR-651	14.17 (22.10)	42.33 (40.56)	7.77 (16.17)	27.63 (31.62)
ANKUR-2226 Bt	6.70 (14.91)	12.82 (20.96)	4.65 (12.45)	7.03 (15.32)
ANKUR-2226	14.41 (22.25)	35.03 (36.26)	8.26 (16.68)	20.76 (27.09)
ANKUR-2534 Bt	8.68 (17.11)	13.10 (21.10)	5.36 (13.35)	6.81 (15.04)
ANKUR-2534	10.59 (18.95)	36.71 (37.23)	6.74 (15.03)	24.29 (29.49)
MRC.6301 Bt	6.58 (14.79)	11.35 (19.66)	4.06 (11.60)	6.00 (14.16)
MRC.6301	15.20 (22.85)	41.30 (39.90)	7.36 (15.69)	28.33 (32.01)
MRC.6304 Bt	8.29 (16.68)	11.39 (19.64)	5.17 (13.12)	7.01 (15.35)
MRC.6304	16.45 (23.89)	47.08 (43.31)	9.72 (18.15)	32.55 (34.74)
RCH.134 Bt	6.02 (14.19)	7.99 (16.31)	3.58 (10.89)	4.29 (11.91)
RCH.134	12.31 (20.51)	41.95 (40.30)	6.73 (15.00)	25.15 (30.02)
RCH.138 Bt	6.36 (14.58)	7.54 (15.79)	3.97 (11.47)	4.55 (12.22)
RCH.138	13.90 (21.86)	41.78 (40.13)	8.00 (16.40)	27.45 (31.29)
RCH.317 Bt	6.77 (15.06)	9.12 (17.49)	4.06 (11.61)	5.33 (13.31)
RCH.317	11.92 (20.16)	38.00 (38.55)	7.02 (15.36)	24.21 (29.33)
MECH.162 Bt	8.04 (16.45)	10.32 (18.67)	4.95 (12.85)	6.23 (14.43)
LHH.144	18.95 (25.71)	51.41 (45.79)	10.78 (19.11)	33.02 (35.01)
OMSHANKAR	14.36 (22.25)	39.23 (38.75)	7.63 (16.03)	29.94 (33.15)
F.1861	14.81 (22.57)	43.28 (41.11)	7.65 (16.02)	28.65 (32.28)
Mean	11.12 (19.16)	27.71 (30.57)	6.39 (14.45)	17.78 (23.61)
CD (at 0.05)	a= (0.99)	b= (3.26)	a= (1.02)	b= (2.49)
	a x b= (4.60)		a x b= (3.53)	
CV (%)	a= 5.08	b= 11.39	a= 6.84	b= 11.39

(Note: Figures in parentheses are n+1 arc sine transformations)

Mean Percent Bollworms incidence in open bolls in second picking  
(Note: Figures in parentheses are n+1 arc sine transformations)

Test hybrids	Open boll damage		Locule damage	
	Sprayed	Unsprayed	Sprayed	Unsprayed
ANKUR-651Bt	10.03 (18.31)	11.14 (19.29)	6.00 (14.16)	9.13 (17.41)
ANKUR-651	33.33 (34.58)	48.61 (44.19)	9.59 (17.97)	29.18 (32.68)
ANKUR-2226 Bt	11.09 (19.40)	11.74 (19.97)	7.04 (15.26)	8.23 (16.57)
ANKUR-2226	36.12 (36.27)	53.95 (47.26)	9.36 (17.78)	35.60 (36.57)
ANKUR-2534 Bt	13.94 (21.55)	16.44 (23.56)	6.79 (15.02)	9.42 (17.75)
ANKUR-2534	30.22 (32.64)	44.58 (41.86)	8.92 (17.31)	29.68 (32.89)
MRC.6301 Bt	11.02 (19.21)	11.85 (20.09)	5.67 (13.69)	7.92 (16.24)
MRC.6301	35.09 (35.49)	53.66 (47.09)	9.07 (17.48)	34.58 (35.99)
MRC.6304 Bt	10.91 (19.17)	12.13 (20.32)	5.88 (13.96)	8.25 (16.61)
MRC.6304	36.99 (36.82)	55.11 (47.92)	10.76 (19.09)	36.85 (37.34)
RCH.134 Bt	7.87 (16.25)	8.04 (16.43)	5.35 (13.32)	6.03 (14.16)
RCH.134	34.74 (35.53)	50.85 (45.50)	10.06 (18.43)	27.69 (31.45)
RCH.138 Bt	7.51 (15.86)	7.11 (15.45)	4.61 (12.37)	5.60 (13.65)
RCH.138	36.98 (36.75)	55.85 (48.35)	9.66 (18.07)	33.57 (35.38)
RCH.317 Bt	8.13 (16.39)	10.04 (18.38)	4.38 (11.98)	6.87 (15.16)
RCH.317	33.70 (34.95)	47.85 (43.74)	10.14 (18.51)	36.91 (37.39)
MECH.162 Bt	9.31 (17.62)	11.24 (19.57)	5.19 (13.13)	6.78 (15.04)
LHH.144	37.65 (37.06)	58.22 (49.77)	9.90 (18.26)	37.09 (37.48)
OMSHANKAR	34.14 (35.01)	51.47 (45.84)	10.59 (18.93)	31.18 (33.86)
F.1861	37.87 (37.27)	57.50 (49.31)	9.98 (18.38)	34.71 (36.07)
Mean	-	33.87 (34.20)	7.94 (16.15)	21.76 (26.49)
CD (at 0.05)	a= (0.73)	b= 11.55	a= (1.71)	b= (2.69)
CD 5%	a= 3.35	b= 3.69	a= 10.20	b= 10.97
	a x b= 5.22		a x b= (3.81)	

The Pink bollworm incidence in the crop was absent; hence no data on this bollworm is available during this season.

This AICCIP center also recorded observations on incidence of Semilooper caterpillars in both sprayed and unsprayed plots. The table below provides the data that show that all test entries in unsprayed plots had higher incidence than the sprayed plots. Certain Bt hybrids such as MRC.6301Bt and MRC.6304Bt had significantly lower incidence of this

pest in comparison to other Bt hybrids at this AICCIP center. Under protected conditions, RCH.317Bt was free from this pest the most, followed by other RCH Bt hybrids.

Number of Semilooper caterpillars in sprayed and unsprayed plots  
(Figures in parentheses are n+1 square root transformations)

Test entry	Number of Semilooper caterpillars/plant	
	Sprayed	Unsprayed
ANKUR-651Bt	0.18 (1.48)	0.29 (1.51)
ANKUR-651	0.31 (1.52)	0.39 (1.54)
ANKUR-2226 Bt	0.15 (1.46)	0.24 (1.49)
ANKUR-2226	0.27 (1.51)	0.35 (1.53)
ANKUR-2534 Bt	0.27 (1.51)	0.22 (1.49)
ANKUR-2534	0.24 (1.49)	0.35 (1.53)
MRC.6301 Bt	0.20 (1.48)	0.11 (1.45)
MRC.6301	0.27 (1.51)	0.50 (1.58)
MRC.6304 Bt	0.22 (1.49)	0.13 (1.46)
MRC.6304	0.20 (1.48)	0.58 (1.60)
RCH.134 Bt	0.13 (1.46)	0.22 (1.49)
RCH.134	0.44 (1.56)	0.44 (1.56)
RCH.138 Bt	0.18 (1.48)	0.16 (1.47)
RCH.138	0.35 (1.53)	0.35 (1.53)
RCH.317 Bt	0.02 (1.42)	0.20 (1.48)
RCH.317	0.33 (1.53)	0.33 (1.52)
MECH.162 Bt	0.18 (1.48)	0.39 (1.54)
LHH.144	0.27 (1.51)	0.37 (1.54)
OMSHANKAR	0.33 (1.53)	0.40 (1.55)
F.1861	0.11 (1.45)	0.31 (1.52)
CD (at 0.05)	(0.04)	(0.04)
CV (%)	2.26	2.47

The Leaf hopper (jassid) damage was recorded and the data in the table below show that all the hybrids had a low level of jassid incidence under both protected and unprotected conditions at Ludhiana. MRC.6304Bt and MRC.6301Bt had higher leaf hoppers along with Bt check hybrid over other test hybrids.

### Mean jassids on test hybrids

(Figures in parentheses are n+1 square root transformations)

Test entry	Number of jassids per leaf	
	Sprayed	Unsprayed
ANKUR-651Bt	2.29 (1.81)	2.58 (1.89)
RCH.134 Bt	2.71 (1.92)	2.97 (1.98)
MRC.6301 Bt	2.27 (1.80)	2.67 (1.90)
ANKUR-2226 Bt	2.07 (1.74)	2.21 (1.77)
RCH.138 Bt	2.40 (1.83)	2.67 (1.90)
ANKUR-2534 Bt	2.08 (1.74)	2.45 (1.85)
MRC.6304 Bt	3.19 (2.04)	3.35 (2.08)
RCH.317 Bt	2.74 (1.93)	2.90 (1.96)
LHH.144	2.01 (1.73)	2.62 (1.89)
OMSHANKAR	2.48 (1.85)	2.69 (1.91)
MECH.162 Bt	3.21 (2.04)	3.27 (2.05)
RCH.317	2.31 (1.81)	2.70 (1.92)
MRC.6304	3.15 (2.03)	3.22 (2.05)
ANKUR-2534	2.15 (1.77)	2.72 (1.92)
RCH.138	2.19 (1.78)	2.52 (1.87)
ANKUR-2226	2.12 (1.76)	2.67 (1.91)
MRC.6301	2.31 (1.81)	2.50 (1.86)
RCH.134	2.31 (1.81)	2.77 (1.94)
ANKUR-651	2.07 (1.74)	2.54 (1.87)
F.1861	2.38 (1.83)	2.89 (1.96)
CD (at 0.05)	(0.11)	(0.10)
CV (%)	6.22	5.70

At Ludhiana center the incidence of whitefly did not differ between various test entries of hybrids, as the data provided in the table below shows.

Mean whitefly on test hybrids  
(Figures in parentheses are n+1 square root transformations)

Test entry	Number of whitefly per leaf	
	Sprayed	Unsprayed
ANKUR-651Bt	4.08	4.39
ANKUR-651	4.51	4.51
ANKUR-2226 Bt	3.91	4.27
ANKUR-2226	4.21	3.92
ANKUR-2534 Bt	4.31	4.29
ANKUR-2534	4.39	4.38
MRC.6301 Bt	4.37	4.28
MRC.6301	4.32	3.80
MRC.6304 Bt	4.61	4.59
MRC.6304	4.75	4.18
RCH.134 Bt	4.26	4.71
RCH.134	4.38	4.21
RCH.138 Bt	4.24	4.13
RCH.138	4.10	4.24
RCH.317 Bt	4.50	4.58
RCH.317	4.39	4.16
MECH.162 Bt	4.28	4.71
LHH.144	3.95	4.16
OMSHANKAR	4.73	4.13
F.1861	4.16	4.77
CD (at 0.05)	NS	NS
CV (%)	5.46	5.69

This center recorded the observation on the natural enemy profile of predators in all the test hybrids under protected and unprotected conditions. The data given below points out that there was no appreciable difference between their numbers in unprotected and protected conditions in these test hybrids.

Number of predators in sprayed and unsprayed plots  
(Figures in parentheses are n+1 square root transformations)

Test entry	Number of predators	
	Sprayed	Unsprayed
ANKUR-651Bt	2.37	2.04 (1.73)
ANKUR-651	2.09	2.13 (1.76)
RCH.134 Bt	2.20	2.72 (1.91)
RCH.134	2.30	2.31 (1.81)
MRC.6301 Bt	2.52	2.50 (1.86)
MRC.6301	2.28	2.61 (1.89)
ANKUR-2226 Bt	2.16	2.16 (1.76)
ANKUR-2226	2.35	2.44 (1.85)
RCH.138 Bt	2.17	2.26 (1.80)
RCH.138	2.31	2.35 (1.82)
ANKUR-2534 Bt	2.56	2.38 (1.83)
ANKUR-2534	2.22	2.65 (1.90)
MRC.6304 Bt	2.15	2.50 (1.87)
MRC.6304	2.35	2.53 (1.87)
RCH.317 Bt	2.30	2.18 (1.78)
RCH.317	2.22	2.31 (1.82)
MECH.162 Bt	2.33	2.24 (1.79)
LHH.144	2.15	2.22 (1.79)
OMSHANKAR	2.40	2.49 (1.86)
F.1861	2.29	2.33 (1.82)
CV (%)	4.56	4.25
CD (at 0.05)	NS	(0.09)

The seed cotton yield, recorded at this center, in these test hybrids under sprayed and unsprayed conditions is given below. The highest seed cotton yield under protected condition was harvested in RCH.134 and RCH.317 respectively. Under unprotected condition, the same is recorded in RCH.134Bt followed by RCH.138Bt and RCH.317Bt. hybrids. All other hybrids including Bt check hybrid yielded less than these Bt hybrids in both situations. Within the fact that there was low plant population in certain hybrids, the yield record of seed cotton show that there was significant difference between Bt hybrids in unprotected and protected conditions. Protection from insect pests seems to be better option to harvest more seed cotton yield in non-Bt hybrids and check variety.

Seed cotton yield of Bt and non-Bt cotton cultivars evaluated under sprayed and unsprayed conditions

Test hybrids	Total Seed cotton yield (kg/ha)		
	Sprayed	Unsprayed	Mean
<b>ANKUR-651Bt</b>	<b>1824</b>	<b>1614</b>	<b>1719</b>
ANKUR-651	1568	760	1164
<b>ANKUR-2226 Bt</b>	<b>1883</b>	<b>1385</b>	<b>1635</b>
ANKUR-2226	1823	676	1250
<b>ANKUR-2534 Bt</b>	<b>1267</b>	<b>1554</b>	<b>1410</b>
ANKUR-2534	1683	882	1282
<b>MRC.6301 Bt</b>	<b>2007</b>	<b>1932</b>	<b>1969</b>
MRC.6301	1538	819	1178
<b>MRC.6304 Bt</b>	<b>2128</b>	<b>1996</b>	<b>2062</b>
MRC.6304	1216	696	956
<b>RCH.134 Bt</b>	<b>2492</b>	<b>2400</b>	<b>2446</b>
RCH.134	1634	674	1154
<b>RCH.138 Bt</b>	<b>2382</b>	<b>2356</b>	<b>2369</b>
RCH.138	1992	697	1344
<b>RCH.317 Bt</b>	<b>2429</b>	<b>1773</b>	<b>2101</b>
RCH.317	1671	706	1188
<b>MECH.162Bt</b>	1954	1829	1892
LHH.144	1014	324	670
OMSHANKAR	1468	714	1091
F.1861	1240	747	994
Mean	1747	1227	-
CD (5%)	A = 84; B = 119; A X B = 168		
CV	A = 7.13; B = 6.91		

## Hisar

The general plant stand was below par in Hisar due to prolonged drought after sowing. The Ankur-Bt hybrids had less population in each plot at this AICCIP center. In addition, RCH.138Bt and MRC.6304 Bt and non-Bt entries along with check variety, H.1117 had low plant population.

This could vitiate the yield data; however, the observations and incidence of pests and diseases under protected and unprotected conditions are valid to arrive at proper conclusions about the gene action of Cry IA(c) that the test hybrids possess.

Germination in different genotypes ranged between 21.38 to 69.44 per cent. The first egg seen and first larva seen data are given below. It shows that the American bollworm was late to arrive and could be first located in a Bt hybrid only on 6<sup>th</sup> September (100 DAG) on RCH.138 Bt.

The other hybrids were seen to have the eggs of American bollworm only after ten days or beyond this date.

FIRST APPEARANCE OF LIFE STAGES BOLLWORMS

Hybrid entry	First egg seen (date)	First 2 <sup>nd</sup> instar larva seen (date)		
	ABW	SBW	ABW	PBW
ANKUR-651Bt	-	-	-	-
ANKUR-651	6.10.03	28.8.03	20.9.03	-
ANKUR-2226 Bt	-	-	-	-
ANKUR-2226	28.9.03	25.8.03	20.9.03	-
ANKUR-2534 Bt	-	31.8.03	-	-
ANKUR-2534	28.9.03	8.8.03	16.9.03	-
MRC.6301 Bt	-	-	-	-
MRC.6301	6.10.03	10.8.03	10.9.03	-
MRC.6304 Bt	-	-	-	-
MRC.6304	16.9.03	12.8.03	20.9.03	-
RCH.134 Bt	-	-	-	-
RCH.134	17.9.03	10.8.03	16.9.03	-
RCH.138 Bt	6.9.03	20.7.03	-	-
RCH.138	-	8.8.03	20.9.03	-
RCH.317 Bt	-	-	-	-
RCH.317	16.9.03	10.8.03	10.9.03	-
MECH.162Bt (Bt check)	6.10.03	25.8.03	-	-
LHH.144 (Zonal check)	26.9.03	2.8.03	24.8	-
OMSHANKAR (Zonal check)	26.9.03	2.8.03	16.9	-
H.1117	16.9.03	12.8.03	16.9.03	-

In the case of Spotted bollworm, the first larva was noticed On 20<sup>th</sup> July (65<sup>th</sup> day after germination) on RCH.138 Bt while on Ankur-2534 Bt, it was seen on 31<sup>st</sup> August (105 days after germination). The check hybrids were seen to have first larva around 77 days after germination. The American bollworm larva was seen only in the check hybrids all along the season, the first date being 24<sup>th</sup> August (99 days after germination) in LHH.144.

Under unprotected conditions, the percent damage to buds, flowers and bolls was considered across standard weeks, RCH.138Bt, RCH.317Bt, Ankur 2534Bt and MRC.6304Bt recorded bollworms at 34<sup>th</sup> and 35<sup>th</sup> standard week. In check hybrids, this happened by 32<sup>nd</sup> (84 days after germination) and 33<sup>rd</sup> week (91days after germination). The non-Bt hybrids recorded bollworms weeks ahead of that in Bt hybrids during



this season under unprotected conditions. In the experiment where protection for sap sucking pests was given to all entries, there was further delay in the incidence of bollworms in Bt hybrids to 37<sup>th</sup> standard week (119 days after germination). However, it has to be noted that the per cent damage to fruiting forms was of the range between 1.0 to 12% under sprayed conditions while in unsprayed plots the damage ranged from 1.0 to 24%, as in the case of certain non-Bt hybrids.

Percent damage to buds, flowers and bolls (unsprayed)

Hybrid entry	Standard week									
	32	33	34	35	36	37	38	39	40	41
ANKUR-651Bt	-	-	-	-	-	-	-	-	-	-
ANKUR-651	1.0	1.8	3.2	4.3	4.6	12.5	18.5	4.7	9.9	5.6
ANKUR-2226 Bt	-	-	-	-	-	-	-	-	-	-
ANKUR-2226	-	-	4.7	6.2	3.9	11.9	17.0	7.9	8.3	6.1
ANKUR-2534 Bt	-	-	-	2.0	2.0	2.0	-	1.0	1.6	1.2
ANKUR-2534	1.0	2.0	2.0	5.4	4.4	12.9	18.1	9.6	7.1	7.5
MRC.6301 Bt	-	-	-	-	-	-	-	-	-	-
MRC.6301	1.8	1.2	1.0	5.5	5.5	17.8	23.9	12.5	11.6	9.9
MRC.6304 Bt	-	-	-	2.3	1.6	2.0	2.0	2.0	1.8	1.2
MRC.6304	-	2.0	4.3	6.0	4.0	10.7	15.8	6.4	6.9	4.9
RCH.134 Bt	-	-	-	-	-	-	-	-	-	-
RCH.134	1.2	1.8	3.2	6.9	4.5	13.5	19.6	7.7	8.2	7.6
RCH.138 Bt	-	-	2.0	5.0	2.0	2.0	1.0	1.2	1.9	1.2
RCH.138	2.8	3.2	2.6	7.1	4.4	13.0	19.1	10.5	11.3	7.6
RCH.317 Bt	-	-	-	5.9	2.0	1.2	0.8	1.6	1.0	1.6
RCH.317	-	2.2	2.6	4.4	4.8	12.9	18.4	8.9	9.4	6.8
MECH.162Bt (Bt check)	-	-	1.6	1.2	4.4	8.6	10.4	8.2	8.8	6.4
LHH.144 (Zonal check)	-	0.8	2.8	6.4	7.1	17.4	24.0	7.6	9.1	8.4
OMSHANKAR (Zonal check)	-	3.5	2.1	5.1	13.6	14.0	21.9	8.3	10.8	5.8
H.1117	0.6	0.8	1.5	6.0	4.6	9.3	13.2	11.7	12.4	6.7

The bollworm infestation on open boll basis is given below. This data shows that the Bt hybrids had less than 5% damage in comparison to a

maximum of 29% in certain unsprayed non-Bt hybrids. The local checks recorded bollworms damage on open boll basis 25% in unsprayed conditions.

Damage on open boll-basis Bt and non-Bt genotypes to bollworms

Hybrid entry	Unsprayed plots		Sprayed plots for sucking and bollworm pests at their threshold level	
	Boll basis	Locule basis	Boll basis	Locule basis
ANKUR-651Bt	0.74	0.70	3.51	1.34
ANKUR-651	27.55	11.25	7.21	3.30
ANKUR-2226 Bt	1.56	0.38	2.27	0.67
ANKUR-2534 Bt	0.73	0.17	2.72	1.20
ANKUR-2534	12.85	5.36	13.95	5.47
ANKUR-2226	22.36	10.15	6.55	2.63
MRC.6301 Bt	0.74	0.25	1.48	0.40
MRC.6301	20.00	7.85	8.45	4.21
MRC.6304 Bt	3.84	2.49	2.86	1.03
MRC.6304	12.28	6.57	9.55	3.58
RCH.134 Bt	4.83	1.91	3.64	2.08
RCH.134	25.85	10.19	8.45	4.21
RCH.138 Bt	4.22	1.72	1.18	0.29
RCH.138	29.70	15.23	7.51	2.91
RCH.317 Bt	0.73	0.12	3.84	2.23
RCH.317	22.29	10.17	14.21	6.60
MECH.162Bt (Bt check)	2.08	0.87	8.21	3.70
LHH.144 (Zonal check)	24.99	10.3	6.76	3.65
OMSHANKAR (Zonal check)	21.38	8.97	5.94	3.12
H.1117	21.88	10.43	10.33	4.27
HHH 223	22.46	12.84	9.62	5.21
HHH 287	20.85	11.68	10.55	4.10

The following table provides the use pattern of insecticides in this evaluation at Hisar. From this, it is concluded that Bt hybrids of RCH.138 and Ankur-2534 require two sprayings, while other Bt hybrids did not need any sprayings for bollworm management at Hisar.

Pesticides used on different Bt and non-Bt genotypes against bollworms

Genotype code	No. of sprays	Name of insecticide with dose/ha	Date of spraying	Target pest
ANKUR-651Bt	-	-	-	-
ANKUR-651	2	Alphamethrin @ 0.3 L	10.9.03	SBW
		Quinalphos @ 2 L	24.9.03	Bollworms

ANKUR-2226 Bt	-	-	-	-
ANKUR-2226	2	Endosulfan @ 1.5 L	27.8.03	Bollworms
		Quinalphos @ 2 L	24.9.03	Bollworms
ANKUR-2534 Bt	1	Alphamethrin @ 0.3 L	10.9.0	SBW
Ankur-2534	2	Endosulfan @ 1.5 L	27.8.03	Bollworms
		Quinalphos @ 2 L	10.9.03	SBW
MRC.6301 Bt	-	-	-	-
MRC.6301	3	Endosulfan @ 1.5 L	27.8.03	Bollworms
		Alphamethrin @ 0.3 L	10.9.03	SBW
		Quinalphos @ 2 L	24.9.03	Bollworms
MRC.6304 Bt	-	-	-	-
MRC.6304	3	Endosulfan @ 1.5 L	27.8.03	Bollworms
		Alphamethrin @ 0.3 L	10.9.03	SBW
		Quinalphos @ 2 L	24.9.03	Bollworms
RCH.134 Bt	-	-	-	-
RCH.134	3	Endosulfan @ 1.5 L	27.8.03	Bollworms
		Alphamethrin @ 0.3 L	10.9.03	SBW
		Quinalphos @ 2 L	24.9.03	Bollworms
RCH.138 Bt	1	Endosulfan @ 1.5 L	27.8.0	Bollworms
RCH.138	3	Endosulfan @ 1.5 L	27.8.03	Bollworms
		Alphamethrin @ 0.3 L	10.9.03	SBW
		Quinalphos @ 2 L	24.9.03	Bollworms
RCH.317 Bt	2	Endosulfan @ 1.5 L	27.8.03	Bollworms
		Alphamethrin @ 0.3 L	10.9.03	SBW
RCH.317	3	Quinalphos @ 2 L	24.9.03	Bollworms
		Endosulfan @ 1.5 L	27.8.03	Bollworms
		Alphamethrin @ 0.3 L	10.9.03	SBW
		Quinalphos @ 2 L	24.9.03	Bollworms
LHH.144	3	Endosulfan @ 1.5 L	27.8.03	Bollworms
		Alphamethrin @ 0.3 L	10.9.03	SBW
		Quinalphos @ 2 L	24.9.03	Bollworms
Omshankar	3	Endosulfan @ 1.5 L	27.8.03	Bollworms
		Alphamethrin @ 0.3 L	10.9.03	SBW
		Quinalphos @ 2 L	24.9.03	Bollworms
H.1117	3	Endosulfan @ 1.5 L	27.8.03	Bollworms
		Alphamethrin @ 0.3 L	10.9.03	SBW
		Quinalphos @ 2 L	24.9.03	Bollworms

From the above table, at Hisar AICCIP center, the number of insecticide sprayings required for bollworm management in various test hybrids shows that all Bt hybrids except RCH.138Bt and RCH.317Bt, that crossed threshold level, had to receive insecticide spraying for bollworm management.

The following insecticides were applied in all entries for jassid management. There was general tolerance to jassids in Ankur-651Bt, RCH.134Bt, MRC.6301 Bt and RCH.317Bt in this center and they received one spray to suppress this pest in comparison to two sprays for other hybrids.

#### Sap Sucking pests (Jassid and whitefly) management

Test hybrids	No. of sprays	Name of insecticide with dose/ha	Date of spraying
ANKUR-651Bt	1	Rogor @ 1L	8.8.03
ANKUR-651		Rogor @ 1L	8.8.03
ANKUR-2226 Bt	2	Metasystox @ 1L	26.7.03
ANKUR-2226		Rogor @ 1L	8.8.03
ANKUR-2534 Bt	2	Rogor @ 1L	8.8.03
ANKUR-2534		Confidor @ 0.1L	16.8.03
MRC.6301 Bt	1	Metasystox @ 1L	26.7.03
MRC.6301		Confidor @ 0.1L	16.8.03
MRC.6304 Bt		Confidor @ 0.1L	16.8.03
MRC.6304	2	Metasystox @ 1L	26.7.03
RCH.134 Bt	1	Rogor @ 1L	8.8.03
RCH.134	2	Metasystox @ 1L	26.7.03
RCH.138 Bt		Rogor @ 1L	8.8.03
RCH.138	3	Metasystox @ 1L	26.7.03
RCH.317 Bt	2	Rogor @ 1L	8.8.03
RCH.317	1	Rogor @ 1L	8.8.03
MECH.162 Bt		Confidor @ 0.1L	16.8.03
LHH.144		Confidor @ 0.1L	16.8.03
OMSHANKAR	2	Metasystox @ 1L	26.7.03
H.1117	3	Metasystox @ 1L	26.7.03

Due to poor plant stand per plot, the yield data was not recorded. The yield data of breeding evaluation shall be used for considering this parameter for evaluating the Cry IA(c) gene in the eight test hybrids. The seed cotton yield under protected condition in Breeding yield was in decreasing order: MRC.6301 Bt (3650 kg/ha)>RCH.317 Bt (3611 kg/ha)> RCH.134 Bt (3434 kg/ha)> RCH.138 Bt (3373 kg/ha)>MRC.6304 Bt (2834 kg/ha)>Ankur- 2226 Bt (2745 kg/ha)> Ankur-2534 Bt (2443 kg/ha)>ANKUR-651 Bt (2227 kg/ha). It is noteworthy that the check hybrids had a range of 1813 to 2273 kg/ha while non-Bt hybrids ranged in yield from 1520 to 2258 kg/ha. The statistical treatment of the data showed that the first four Bt hybrids are at par in yield in comparison to check hybrids including MECH.162 Bt (2773 kg/ha).

## Sriganganagar

The peak square damage under unprotected condition was found to be in August. Bt Hybrids such as Ankur-651, Ankur-2226, Ankur-2534 had the least square damage, as seen from the data given below, in comparison to other Bt hybrids. The per cent green boll damage occurred during September and the same Bt hybrids of Ankur Seeds Pvt. Ltd. showed lower damage over other Bt hybrids.

Per cent Square and green boll damage due to bollworms - Unprotected trial

Entry	% SQUARE DAMAGE				% GREEN BOLL DAMAGE	
	July	August	September	October	September	October
ANKUR-651Bt	1.05 (5.82*)	3.29 (10.35)	1.27 (6.26)	0.00	3.18 (9.81)	2.34 (8.70)
ANKUR-651	0.80 (5.02)	5.50 (13.50)	3.22 (10.32)	0.00	5.03 (12.92)	1.00 (5.61)
ANKUR-2226 Bt	0.95 (5.54)	3.30 (10.34)	2.90 (9.69)	0.00	4.61 (12.24)	2.63 (9.30)
ANKUR-2226	1.8 (7.69)	8.01 (16.41)	3.08 (10.00)	0.00	4.07 (11.62)	0.37 (3.41)
ANKUR-2534 Bt	1.10 (6.02)	3.60 (10.76)	3.69 (11.01)	0.00	2.71 (9.41)	2.79 (9.53)

ANKUR-2534	0.70 (4.73)	7.45 (13.42)	3.94 (10.76)	0.00	8.17 (16.55)	2.16 (8.41)
MRC.6301 Bt	2.05 (8.19)	7.97 (16.33)	5.45 (13.45)	0.00	4.24 (11.81)	1.60 (7.19)
MRC.6301	0.93 (5.53)	6.48 (14.68)	6.03 (14.10)	0.00	7.86 (16.38)	3.12 (10.10)
MRC.6304 Bt	2.30 (8.71)	8.39 (16.76)	2.45 (9.00)	0.00	4.54 (12.24)	3.29 (10.35)
MRC.6304	1.40 (6.79)	7.85 (16.17)	7.26 (15.60)	3.29	7.37 (15.70)	3.43 (10.66)
RCH.134 Bt	0.10 (2.81)	4.40 (12.02)	5.47 (13.46)	0.00	6.09 (14.27)	1.84 (7.66)
RCH.134	2.20 (8.52)	8.98 (17.37)	4.02 (11.52)	0.00	6.66 (14.90)	1.75 (7.72)
RCH.138 Bt	1.00 (5.73)	5.41 (13.32)	4.41 (12.01)	1.97	7.20 (15.54)	3.03 (9.88)
RCH.138	2.40 (8.90)	7.65 (15.99)	5.14 (12.90)	4.54	6.46 (14.68)	2.59 (9.24)
RCH.317 Bt	2.60 (9.27)	8.19 (16.56)	3.01 (10.05)	0.00	5.11 (13.01)	0.27 (2.92)
RCH.317	1.81 (7.69)	7.29 (15.57)	3.67 (11.02)	0.00	6.77 (14.98)	1.97 (8.02)
MECH.162Bt	2.57 (9.11)	9.61 (17.97)	3.00 (9.88)	0.00	5.95 (14.00)	2.01 (8.09)
LHH.144	1.20 (6.29)	7.50 (15.84)	6.71 (14.94)	0.00	6.99 (15.14)	2.37 (8.81)
OMSHANKAR	2.27 (8.63)	8.10 (16.45)	5.89 (14.00)	0.00	6.72 (14.93)	2.02 (8.15)
RS.2013	2.40 (8.82)	9.13 (17.52)	6.06 (14.23)	5.15	8.51 (16.91)	4.49 (12.20)
SEm±	0.35	0.35	0.63	-	1.06	0.62
CD at 5%	1.00	1.00	1.82	-	3.06	1.79
CV %	8.56	4.05	9.32		13.26	12.92

\* = angular transformed values

The Protected trial at this center provided the following data on square damage to show the similar results as in the case of Unprotected conditions. The data seem to indicate that there is poor pest pressure with which the real test on the ability of Bt hybrids to withstand bollworm pressure was not available.

Per cent Square and green boll damage due to bollworms - Protected Trial

Entry Code	% SQUARE DAMAGE				% GREEN BOLL DAMAGE	
	July	August	September	October	September	October
ANKUR-651Bt	0.90 (5.33)	2.23 (8.53*)	2.84 (9.58)	0.00	2.03 (8.15)	1.76 (7.53)
ANKUR-651	0.20 (2.06)	2.57 (9.20)	4.07 (11.57)	0.00	5.11 (13.01)	0.95 (5.51)
ANKUR-2226 Bt	0.60 (4.36)	2.28 (8.59)	0.93 (5.45)	0.00	2.51 (8.99)	1.58 (7.12)
ANKUR-2226	1.85 (7.85)	6.92 (15.19)	5.52 (13.54)	0.00	4.15 (11.71)	1.09 (5.83)
ANKUR-2534 Bt	1.0 (5.72)	3.09 (10.12)	1.03 (5.76)	0.00	2.17 (8.41)	1.73 (7.47)
ANKUR-2534	1.20 (7.01)	2.64 (9.20)	3.56 (10.70)	0.00	5.81 (13.90)	1.86 (7.72)
RCH.134 Bt	1.05 (5.83)	4.70 (12.47)	3.23 (10.32)	0.00	4.08 (11.57)	1.58 (7.12)
RCH.134	0.90 (5.40)	5.08 (12.97)	3.61 (10.78)	0.00	5.27 (13.22)	1.60 (7.19)
MRC.6301 Bt	2.10 (8.33)	6.36 (14.55)	3.02 (10.01)	0.00	1.95 (7.92)	1.96 (7.88)
MRC.6301	1.30 (6.51)	6.95 (15.19)	4.00 (11.48)	0.00	3.47 (10.66)	1.91 (7.79)
MRC.6304 Bt	1.10 (5.98)	5.15 (13.07)	3.20 (10.30)	0.00	3.35 (10.53)	1.96 (7.88)
MRC.6304	1.85 (7.77)	7.67 (16.05)	4.64 (12.28)	5.21	5.23 (13.18)	2.23 (8.38)
RCH.134 Bt	1.05 (5.83)	4.70 (12.47)	3.23 (10.32)	0.00	4.08 (11.57)	1.58 (7.12)
RCH.134	0.90 (5.40)	5.08 (12.97)	3.61 (10.78)	0.00	5.27 (13.22)	1.60 (7.19)
RCH.138 Bt	1.90 (7.92)	6.00 (14.15)	3.28 (10.38)	2.32	3.47 (10.68)	3.34 (10.49)
RCH.138	0.00 (0.00)	4.17 (11.71)	5.81 (13.85)	0.00	5.71 (13.77)	2.30 (8.50)
RCH.317 Bt	1.40 (6.70)	6.69 (14.94)	2.84 (9.69)	0.00	2.28 (8.59)	0.95 (5.50)
RCH.317	1.60 (6.59)	7.37 (15.72)	3.30 (10.40)	0.00	5.12 (13.05)	1.83 (7.66)
MECH.162Bt	1.05 (5.81)	5.30 (13.27)	4.67 (12.40)	0.00	4.99 (12.88)	2.13 (8.21)
LHH.144	3.10 (10.08)	10.99 (19.33)	7.50 (15.81)	3.34	5.61 (13.61)	1.52 (7.05)
OMSHANKAR	1.20 (6.29)	6.69 (14.94)	4.23 (13.00)	2.77	4.10 (11.62)	1.60 (7.19)
RS.2013	4.10 (11.64)	9.03 (17.42)	5.09 (13.01)	2.04	4.13 (11.67)	2.97 (9.50)
SEm±	0.48	0.66	0.88	-	0.62	NS
CD at 5%	1.37	1.90	2.54	-	1.79	NS
CV %	12.96	8.53	13.82		9.43	22.97

\* = angular transformed values

The pink bollworm damage in Unprotected trial was higher in terms of per cent damage in open bolls and locules over Protected conditions. The Bt hybrids had lower damage than non-Bt counterparts. Bt check hybrid had very low damage and was comparable to that Ankur-651Bt and Ankur-2534Bt in unprotected plots. In protected plots, Ankur-2226Bt and RCH.138Bt had the highest damage, although less than their non-Bt counterparts.

The locule damage was lower in Bt hybrids in unprotected and protected plots than the non-Bt and Bt check hybrids.

PINK BOLLWORM DAMAGE IN OPEN BOLLS AND LOCULI (%)

Test hybrids	Protected		Unprotected	
	Boll	Locule	Boll	Locule
ANKUR-651Bt	9.23	3.06	10.65	3.56
ANKUR-651	20.33	7.45	48.06	19.42
ANKUR-2226 Bt	10.83	3.63	21.71	7.59
ANKUR-2226	31.13	11.79	39.83	16.41
ANKUR-2534 Bt	12.06	3.76	3.24	0.71
ANKUR-2534	40.71	14.66	41.38	14.88
MRC.6301 Bt	11.87	3.61	27.35	9.94
MRC.6301	68.27	32.63	71.45	39.60
MRC.6304 Bt	6.82	2.09	24.19	9.96
MRC.6304	72.66	37.23	83.50	47.08
RCH.134 Bt	4.06	1.28	15.76	5.94
RCH.134	49.83	22.33	85.56	53.78
RCH.138 Bt	22.22	7.34	24.19	10.46
RCH.138	40.06	17.52	73.14	35.53
RCH.317 Bt	19.87	6.18	20.87	7.57
RCH.317	58.36	28.30	69.96	35.75
LHH.144	51.70	26.51	83.14	42.35
OMSHANKAR	36.85	14.33	76.49	39.41
MECH.162Bt	33.38	16.39	12.17	4.48
RS.2013	35.57	14.03	69.81	36.44



The general situation of sap sucking pest incidence was low and the Bt hybrids had crossed the threshold level to jassids only towards the end of July, around 60 days after germination. The square damage due to bollworms in MRC Bt hybrids and RCH.317Bt hybrid crossed the threshold level in early August (74 days after germination), while other Bt hybrids crossed the same in mid-August, at around 90 days from germination. The whitefly population was low in the mid season and seems to have crossed threshold only in October.

Date of crossing the Threshold level Against Sap Sucking Pests And  
Bollworms

Entry	Date at which Threshold Level was crossed				
	SAP SUCKING PESTS			BOLLWORMS (%)	
	Jassid	Whitefly	Thrips	Square damage	Boll damage
ANKUR-651Bt	08/08	03/10	---	----	----
ANKUR-651	---	03/10	---	18/8	02/09
ANKUR-2226 Bt	---	03/10	---	2/9	----
ANKUR-2226	---	03/10	---	8/8	----
ANKUR-2534 Bt	18/08	19/09	---	2/9	----
ANKUR-2534	---	03/10	---	18/8	2/09
MRC.6301 Bt	08/08	03/10	---	8/8	----
MRC.6301	08/08	03/10	---	18/8	2/9
MRC.6304 Bt	25/07	03/10	---	8/8	----
MRC.6304	25/07	19/09	---	8/8	2/9
RCH.134 Bt	---	03-10	---	18/8	02/09
RCH.134	08/08	19/09	---	8/8	02/09
RCH.138 Bt	---	03/10	---	18/8	02/9
RCH.138	---	03-10	---	8/8	02/09
RCH.317 Bt	25/07	19/09	---	8/8	----
RCH.317	---	03/10	---	8/8	02/09
MRC.162Bt (Bt check)	25/07	03/10	---	8/8	----
LHH.144 (Zonal check)	---	03/10	---	8/8	02/09
OMSHANKAR (Zonal check)	25/07	03/10	---	8/8	----
RS.2013	---	03/10	---	8/8	----

---- = Threshold not crossed

The insecticides applied for sap sucking pests and bollworms are given below. It is found that all test Bt hybrids received only one spray against bollworms after 80 days of germination.

Test hybrids	Name of insecticides with dose	Date of spraying	Target insect-pest
ANKUR-651Bt	Confidor 200 SL @ 0.3ml/lit of water	9-8-2003	Jassid
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
ANKUR-651	Spinosad 48 SC @ 0.35ml/lit of water	19-8-2003	Bollworms
	Triazophos @ 3ml/lit of water	03-09-2003	Whitefly
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	
Ankur-2226Bt	Triazophos @ 3ml/lit of water	3-9-2003	Whitefly
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
Ankur-2226	Spinosad 48 SC @ 0.35ml/lit of water	9-8-2003	Bollworms
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
ANKUR-2534Bt	Confidor 200 SL @ 0.3ml/lit of water	19-8-2003	Jassid
	Triazophos @ 3ml/lit of water	03-09-2003	Whitefly
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
ANKUR-2534	Spinosad 48 SC @ 0.35ml/lit of water	19-08-2003	Bollworms
	Triazophos @ 3ml/lit of water	03-09-2003	Whitefly
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
RCH.134Bt	Spinosad 48 SC @ 0.35ml/lit of water	19-8-2003	Bollworms
	Triazophos @ 3ml/lit of water	3-9-2003	Whitefly
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
RCH.134	Confidor 200 SL @ 0.3ml/lit of water	9-8-2003	Jassid
	Spinosad 48 SC @ 0.35ml/lit of water	11-08-2003	Bollworms
	Triazophos @ 3ml/lit of water	03-09-2003	Whitefly

	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	23-9-2003	Whitefly
RCH.138Bt	Spinosad 48 SC @ 0.35ml/lit of water	19-8-2003	Bollworms
	Triazophos @ 3ml/lit of water	03-09-2003	Whitefly
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
RCH.138	Spinosad 48 SC @ 0.35ml/lit of water	19-8-2003	Bollworms
	Triazophos @ 3ml/lit of water	03-09-2003	Whitefly
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
RCH.317Bt	Confidor 200 SL @ 0.3ml/lit of water	26-7-2003	Jassid
	Spinosad 48 SC @ 0.35ml/lit of water	9-08-2003	Bollworms
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	23-9-2003	Whitefly
RCH.317	Spinosad 48 SC @ 0.35ml/lit of water	9-08-2003	Bollworms
	Triazophos @ 3ml/lit of water	03-09-2003	Whitefly
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
MRC.6301Bt	Confidor 200 SL @ 0.3ml/lit of water	9-8-2003	Jassid
	Spinosad 48 SC @ 0.35ml/lit of water	11-8-2003	Bollworms
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
MRC.6301	Confidor 200 SL @ 0.3ml/lit of water	9-8-2003	Jassid
	Spinosad 48 SC @ 0.35ml/lit of water	19-8-2003	Bollworms
	Triazophos @ 3ml/lit of water	03-09-2003	Bollworms
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
MRC.6304Bt	Confidor 200 SL @ 0.3ml/lit of water	19-8-2003	Jassid
	Spinosad 48 SC @ 0.35ml/lit of water	9-8-2003	Bollworms
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
MRC.6304	Confidor 200 SL @ 0.3ml/lit of water	9-8-2003	Jassid

	Spinosad 48 SC @ 0.35ml/lit of water	19-08-2003	Bollworms
	Triazophos @ 3ml/lit of water	03-09-2003	Bollworms
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
MECH.162Bt	Confidor 200 SL @ 0.3ml/lit of water	26-7-2003	Jassid
	Spinosad 48 SC @ 0.35ml/lit of water	9-08-2003	Bollworms
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
LHH.144 (Zonal check)	Spinosad 48 SC @ 0.35ml/lit of water	9-8-2003	Bollworms
	Triazophos @ 3ml/lit of water	03-09-2003	
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
OMSHANKAR	Confidor 200 SL @ 0.3ml/lit of water	26-7-2003	Jassid
	Spinosad 48 SC @ 0.35ml/lit of water	9-08-2003	Bollworms
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly
RS.2013	Spinosad 48 SC @ 0.35ml/lit of water	9-8-2003	Bollworms
	Ethion 40 EC + Achook 1500ppm @ 2.5ml+3ml/lit of water	4-10-2003	Whitefly

Under protected conditions, Sreeganganagar trial showed that the highest seed cotton yield under protected condition was given by RCH.1334Bt, followed by RCH.317Bt and MRC.6301Bt. In unprotected plots, the highest seed cotton yield was in RCH Bt hybrids followed by Mahyco hybrids and lastly by Ankur hybrids. The yield data also shows that all Bt hybrids (including check hybrid) were way above non-Bt hybrids. There is difference in the relationship between open boll damage and seed cotton yield. The absence of optimum plant population and purity of hybrids could have a role in such cases.

## SEED COTTON YIELD (Kg/ha.)

Entry	UNPROTECTED CROP	PROTECTED CROP
ANKUR-651Bt	2464	2660
ANKUR-651	1757	2843
ANKUR-2226 Bt	2518	2465
ANKUR-2226	1676	2537
ANKUR-2534 Bt	2481	2186
ANKUR-2534	1686	2320
MRC.6301 Bt	2770	2928
MRC.6301	1177	1676
MRC.6304 Bt	1397	2436
MRC.6304	776	1375
RCH.134 Bt	2775	3661
RCH.134	885	2969
RCH.138 Bt	2495	2772
RCH.138	727	2033
RCH.317 Bt	2793	2963
RCH.317	1376	2672
MECH.162Bt (Bt check)	1590	1908
OMSHANKAR (Zonal check)	1355	1823
LHH.144 (Zonal check)	805	1972
RS.2013	1352	2013
SEm±	128	183
CD at 5%	371	528
CV %	12.77	13.03

## SIRSA

The data from CICR, Sirsa Station shows that under unprotected conditions, there was no significant square damage due to bollworms amongst various hybrids and checks in the entire trial period. In the Sprayed plots, significant square damage due to bollworm was seen only by 90<sup>th</sup> day after germination at Sirsa even in non-Bt hybrids and check entries. This data indicates that the bollworm pressure was low at Sirsa during the season.

### Square damage (%) in Bt Cotton Trials under Protected Conditions

Test Hybrids	Dates of observation		
	1.8.03	8.8.03	18.8.03
ANKUR-651Bt	1.01(5.43)	1.06(5.57)	0.50(4.10)
ANKUR-651	0.50(4.100)	0.79(4.90)	0.50(4.10)
ANKUR-2226 Bt	0.50(4.10)	0.50(4.10)	0.89(5.16)
ANKUR-2226	0.50(4.10)	0.50(4.10)	3.83(10.2)
ANKUR-2534 Bt	1.05(5.50)	0.50(4.10)	0.96(5.30)
ANKUR-2534	0.50(4.10)	0.50(4.10)	1.57(6.83)
MRC.6301 Bt	1.18(5.76)	0.50(4.10)	0.96(5.30)
MRC.6301	1.41(6.56)	0.50(4.10)	2.51(8.90)
MRC.6304 Bt	0.50(4.10)	0.50(4.10)	0.50(4.10)
MRC.6304	0.50(4.10)	0.50(4.10)	0.50(4.10)
RCH.134 Bt	0.50(4.10)	0.50(4.10)	0.50(4.10)
RCH.134	1.35(6.10)	0.50(4.10)	1.22(6.10)
RCH.138 Bt	0.50(4.10)	0.50(4.10)	1.52(6.33)
RCH.138	1.51(6.33)	0.50(4.10)	1.92(7.43)
RCH.317 Bt	0.50(4.10)	0.50(4.10)	1.23(6.20)
RCH.317	1.37(6.50)	1.79(7.26)	0.50(4.10)
MECH.162Bt	1.15(5.70)	0.50(4.10)	0.50(4.10)
LHH.144	4.34(9.20)	1.65(7.03)	1.67(7.03)
OMSHANKAR	1.02(5.40)	0.50(4.10)	2.50(8.86)
F.1861	1.57(6.43)	0.50(4.10)	0.50(4.10)
CD(P≤0.05)	NS	1.79	3.84

The values in parentheses are arcsin (+0.5) transformed value.

The boll damage and other ancillary data to measure bollworm pressure on the test entries did not show any significant effect indicating poor pest pressure on the hybrids.

### Boll damage (%) under unprotected Conditions

Entries	Boll damage( % )
	On 2.9.03
ANKUR-651Bt	0.50(4.10)
ANKUR-651	3.51(10.56)
ANKUR-2226 Bt	0.50(4.10)
ANKUR-2226	2.66(8.96)
ANKUR-2534 Bt	1.10(5.73)
ANKUR-2534	0.50(4.10)
MRC.6301 Bt	1.19(5.76)
MRC.6301	4.34(10.83)
MRC.6304 Bt	1.01(5.43)
MRC.6304	4.49(11.16)
RCH.134 Bt	0.50(4.10)
RCH.134	3.30(10.1)
RCH.138 Bt	1.24(5.9)
RCH.138	4.05(10.63)
RCH.317 Bt	2.73(7.93)
RCH.317	2.99(9.8)
MECH.162Bt	0.50(4.10)
LHH.144	3.41(3.03)
OMSHANKAR	4.38(11.93)
F.1861	5.11(11.76)
CD (P≤0.05)	5.78

Except for jassids (Leaf hoppers), there was no other sap sucking pests including whitefly that invaded the test hybrids seriously. Under unprotected conditions, the jassid incidence was significantly seen after 62<sup>nd</sup> day, 86<sup>th</sup> day and on 96<sup>th</sup> day (Table below). RCH.138Bt, RCH.317Bt and MRC.6304Bt had higher jassid population on 62<sup>nd</sup> day. There was a surge of jassid population in the 86<sup>th</sup> day observation and continued at lower level in the 96<sup>th</sup> day under unsprayed conditions.

Average populations of jassids per plant (3 leaves)  
under unprotected conditions

Entry hybrids	Dates of observations		
	15.7.03	1.8.03	18.8.03
ANKUR-651Bt	0.27(1.12)	4.33(2.30)	1.67(1.62)
ANKUR-651	0.93(1.33)	4.87(2.38)	1.67(1.62)
ANKUR-2226 Bt	0.47(1.20)	5.0(2.44)	2.80(1.94)
ANKUR-2226	0.53 (1.09)	4.87(2.41)	2.80(1.94)
ANKUR-2534 Bt	0.13(1.06)	2.27(2.67)	1.06(1.41)
ANKUR-2534	0.20(1.09)	5.00(2.44)	3.20(2.04)
MRC.6301 Bt	0.73(1.31)	5.47(2.54)	2.73(1.93)
MRC.6301	0.27(1.12)	5.2(2.47)	1.73(1.65)
MRC.6304 Bt	1.20(1.47)	5.73(2.58)	2.67(1.91)
MRC.6304	2.53(1.86)	7.06(2.82)	2.33(1.81)
RCH.134 Bt	0.53(1.23)	4.53(2.35)	1.60(1.60)
RCH.134	0.47(1.19)	5.27(2.48)	2.40(1.84)
RCH.138 Bt	1.06(1.42)	3.67(2.14)	3.06(2.01)
RCH.138	0.20(1.09)	5.33(2.51)	2.33(1.82)
RCH.317 Bt	1.53(1.57)	6.26(2.68)	1.67(1.62)
RCH.317	0.13(1.06)	3.67(2.15)	2.40(1.84)
MECH.162Bt	1.47(1.52)	6.40(2.69)	3.06(2.01)
LHH.144	0.40(1.17)	4.20(2.27)	1.87(1.69)
OMSHANKAR	1.47(1.53)	6.13(2.67)	2.33(1.81)
F.1861	0.47(1.19)	4.06(2.24)	2.47(1.85)
CD (P<0.05)	0.39	0.36	0.22

The jassid population in various test hybrids as measured at 62 days after germination is given below. The Bt hybrids had less population over their non-Bt counterparts under protected conditions. This was the only week when there was significant variation in their numbers between test hybrids.

Average populations of jassids per plant (3 leaves)  
under protected conditions

Entries	Average jassids
	On 15.7.03
ANKUR-651Bt	0.13(1.06)
ANKUR-651	0.33(1.15)
RCH.134 Bt	0.66(1.28)
RCH.134	0.53(1.23)
MRC.6301 Bt	0.86(1.35)
MRC.6301	0.53(1.23)
ANKUR-2226 Bt	0.26(1.12)
ANKUR-2226	0.46(1.19)
RCH.138 Bt	1.13(1.43)
RCH.138	0.53(1.23)
ANKUR-2534 Bt	0.33(1.15)
ANKUR-2534	0.60(1.25)
MRC.6304 Bt	3.06(2.01)
MRC.6304	4.06(2.23)
RCH.317 Bt	0.60(1.26)
RCH.317	0.20(1.09)
MECH.162Bt	1.46(1.56)
LHH.144	0.40(1.17)
OMSHANKAR	0.53(1.24)
F.1861	0.26(1.12)
CD (P≤0.05)	0.26

Details of plant protections against insect pests:

a) Sap Sucking.Pests :

Entry	Date at which threshold level was crossed			
	Aphids	Thrips	Jassids	Whitefly
All entries except MRC.6301,Omshankar & Ankur-2226	-----	-----	01.08.03	-----
	Confidor @ 100 ml / ha on 02.08.03			

b) Bollworms :

Entry	ETL based on fruiting bodies (square / boll) damage
Ankur-2226Bt, Ankur-2534Bt, MRC.6304, Ankur-2534 & H.1117	25.08.03 (103 days after germination) Quinalphos @ 2 l/ha on 28.8.03
MRC.6301Bt, LHH.144, MRC.6304, Ankur-2534, Ankur-651 & H.1117	26.09.03 (133 DAG) Methomyl @ 625 g /ha on 03.10.03



The egg and larval population was found very rarely. The plant protection measures was carried out based on ETL on fruiting bodies damage (5 %)

The seed cotton yield under protected plots was higher than that under unsprayed conditions in all test hybrids. RCH.138Bt recorded the highest seed cotton yield (3591 kg/ha) in sprayed plots followed by RCH.317Bt (3354 kg/ha) and MRC.6301Bt (2949 kg/ha). RCH.138Bt yielded the best under unsprayed conditions (2709 kg/ha) and was at par with RCH.138Bt (2705 kg/ha) and MRC.6301Bt and RCh.317Bt. The apparent superiority in seed cotton yield, both in sprayed and unsprayed conditions of Bt hybrids over their non-Bt counterparts as well as check entries was significant.

Yield (kg/ha) under protected / unprotected conditions

Treatments	Protected			Unprotected		
	Ist picking	IInd picking	Total	Ist picking	IInd picking	Total
ANKUR-651Bt	1961.58	181.07	2142.65	1138.54	116.59	<b>1255.13</b>
ANKUR-651	1748.95	61.72	1810.68	1296.29	102.87	1399.16
ANKUR-2226 Bt	2164.59	144.03	<b>2308.62</b>	1598.07	68.58	<b>1666.65</b>
ANKUR-2226	1681.74	130.31	1812.06	1152.25	82.30	1234.55
ANKUR-2534 Bt	1927.28	226.33	<b>2153.62</b>	1399.17	178.32	<b>1577.49</b>
ANKUR-2534	1628.24	219.47	1847.72	1275.71	178.32	1454.03
MRC.6301 Bt	1906.70	1124.75	<b>3031.45</b>	1886.13	537.12	<b>2423.25</b>
MRC.6301	823.04	294.92	1117.96	647.45	144.03	791.49
MRC.6304 Bt	1005.48	1179.69	<b>2185.17</b>	1165.97	706.44	<b>1872.41</b>
MRC.6304	645.39	137.17	782.57	393.68	68.58	462.27
RCH.134 Bt	2064.45	884.76	<b>2949.22</b>	1694.09	1015.08	<b>2709.17</b>
RCH.134	1209.86	319.21	1539.08	762.68	185.18	947.86
RCH.138 Bt	2452.66	1138.54	<b>3591.20</b>	2005.47	699.58	<b>2705.05</b>
RCH.138	1083.64	480.10	1563.74	939.63	342.93	1282.56
RCH.317 Bt	2620.01	733.87	<b>3353.89</b>	2146.65	315.49	<b>2462.26</b>
RCH.317	1460.89	205.76	1666.65	936.89	116.59	1053.49
MRC.162Bt (Bt check)	1989.01	397.80	2386.81	1063.09	226.33	1289.43
LHH.144 (Zonal check)	1209.86	157.74	1367.61	860.07	96.02	956.09
OMSHANKAR (Zonal check)	1264.73	144.03	1408.77	898.48	68.58	967.07
F.1861	703.70	390.94	1094.64	496.57	130.31	626.88
CD(at5%)	454.83	246.22	509.71	666.10	199.53	766.83

In the Plant Protection evaluation, the highest zonal mean seed cotton yield was recorded in RCH.134Bt (2568 kg/ha) followed by MRC.6301Bt(2423 kg/ha) under sprayed condition; amongst the unsprayed plots, the highest yield was for RCH.134Bt (which, in fact exceeded that in protected plots) with 2652 kg/ha followed by RCH.138Bt, RCH.317Bt and MRC.6301 being at par. The best yield of the Plant Protection evaluation for RCH.134 testifies that this hybrid is very much adapted as well as has adequate bollworm-tolerance to retain bolls that yielded the best seed cotton yield.

## Seed cotton yield (kg/ha)

ENTRY	Faridkot		Ludhiana		Sriganganagar		Sirsa		Mean	
	*S	*US	S	US	S	US	S	US	S	US
Ankur-651Bt	2020	1615	1824	1614	2464	2660	2143	1255	2049	1939
Ankur-651	3095	2636	1568	760	1757	2843	1811	1399	2067	1825
Ankur-2226 Bt	3093	2906	1883	1385	2518	2465	2309	1667	2366	2162
Ankur-2226	2267	2465	1823	676	1676	2537	1812	1234	1894	1746
Ankur-2534 Bt	3045	2636	1267	1554	2481	2186	2154	1576	2189	1979
Ankur-2534	2066	1431	1683	882	1686	2320	1848	1454	1702	1615
MRC.6301 Bt	2307	1989	2007	1932	2770	2928	3031	2423	2423	2440
MRC.6301	3136	2927	1538	819	1177	1676	1118	791	1770	1435
MRC.6304 Bt	1454	1153	2128	1996	1397	2436	2186	1872	1821	1881
MRC.6304	1335	1044	1216	696	776	1375	783	462	1032	907
RCH.134Bt	2120	1580	2492	2400	2775	3661	2949	2709	2568	2652
RCH.134	1699	1195	1634	674	885	2969	1539	948	1514	1406
RCH.138 Bt	1227	1052	2382	2356	2495	2772	3591	2705	2268	2479
RCH.138	1555	1362	1992	697	727	2033	1564	1283	1419	1380
RCH.317 Bt	1439	1185	2429	1773	2793	2963	3354	2462	2277	2423
RCH.317	1661	1293	1671	706	1376	2672	1667	1054	1578	1491
MECH.162 Bt	1395	1273	1954	1829	1590	1908	2387	1289	1762	1747
LHH.144	1630	1492	1014	324	1355	1823	1368	956	1287	1190
Omshankar	1808	1303	1468	714	805	1972	1409	967	1354	1234
F.1861	1719	1325	1240	747	-	-	1095	627	1225	1007
RS. 2013					1352	2013			1352	2013
CD at 5%	232	297			371	528	509	767		
CV%	15.99	13.97			12.77	13.03				

\* S=sprayed plot, US=unsprayed plot

### OVERALL ASSESSMENT OF BT COTTON PERFORMANCE IN NORTH ZONE

The percent boll damage shows that the unsprayed Bt hybrids had a certain level of tolerance to contain the bollworm infestation to within 20-25% over the respective non-Bt hybrids as well as more than 35% over all check varieties, currently cultivated in north zone. The explicit action of Cry I A(c) is vivid from the data given on Table: 1. The boll damage due to Spotted bollworms and American bollworms was the most in all cases. The Bt hybrids definitely showed consistent reduction of this in the respective test entries.

Table: 1 Per cent boll damage in the test hybrids

ENTRY	Faridkot		Ludhiana		Hisar		Sriganga nagar		Sirsa		Mean	
	*S	*US	S	US	S	US	S	US	S	US	S	US
Ankur-651Bt	6.66	8.16	10.03	11.14	0.74	3.51	9.23	10.65	4.07	7.16	7.13	7.19
Ankur-651	43.38	35.68	7.87	8.04	27.55	7.21	20.3	48.06	2.55	4.05	22.29	17.92
Ankur-2226 Bt	12.45	9.56	11.02	11.85	4.83	3.64	4.06	15.76	2.26	4.05	8.38	7.45
Ankur-2226	52.89	52.57	11.09	11.74	25.85	8.45	49.8	85.56	2.56	0.5	33.39	27.57
Ankur-2534 Bt	13.45	7.5	7.51	7.11	0.74	1.48	11.8	27.35	4.02	1.95	9.00	7.72
Ankur-2534	47.1	52.93	13.94	16.44	20	8.45	68.2	71.45	3.03	0.5	33.50	28.33
MRC. 6301 Bt	8.42	13.31	10.91	12.13	1.56	2.27	10.8	21.71	2.51	3.39	9.29	8.73
MRC. 6301	40.5	31.27	8.13	10.04	22.36	6.55	31.1	39.83	1.86	3.2	21.29	17.15
MRC. 6304 Bt	8.67	9.84	37.65	58.22	4.22	1.18	22.2	24.19	4.9	0.5	19.01	18.10
MRC. 6304	42.79	56.1	34.14	51.47	29.7	7.51	40	73.14	3.66	6.56	37.61	33.59
RCH. 134Bt	8.55	8.21	9.31	11.24	0.73	2.72	12	3.24	2.46	9.6	6.50	6.61
RCH.134	39.23	37.96	33.7	47.85	12.85	13.95	40.7	41.38	4.51	0.5	30.24	25.93
RCH.138 Bt	10.15	16.73	36.99	55.11	3.84	2.86	6.8	24.19	0.75	0.5	17.49	16.42
RCH.138	42.74	50.29	30.22	44.58	12.28	9.55	72.6	83.5	1.9	2.58	38.63	34.17
RCH.317 Bt	4.21	10.29	36.98	55.85	0.73	3.84	19.8	20.87	7.29	4.86	17.76	17.83
RCH.317	42.98	38.89	36.12	53.95	22.29	14.21	58.3	69.96	3.71	0.5	37.82	33.10
MECH. 162 Bt	25.02	16.06	35.09	53.66	2.08	8.21	33.3	12.17	6.56	3.39	21.35	18.95
LHH. 144	59.61	47.75	34.74	50.85	24.99	6.76	51.7	83.14	4.02	3.06	40.40	34.11
Omshankar	43.35	49.46	33.33	48.61	21.38	5.94	36.8	76.49	2.87	0.5	35.36	30.60
F.1861	43.08	55.14	37.87	57.5	-	-	-	-	5.26	0.5	39.77	31.25
H.1117	-	-	-	-	21.88	10.33	-	-	-	-	-	-
RS. 2013	-	-	-	-	-	-	35.57	69.81	-	-	-	-

\* S=sprayed plot, US=unsprayed plot

Table:2 Mean jassid incidence in north zone centers

ENTRY	Faridkot		Ludhiana		Hisar		Sirsa		Mean	
	*S	*US	S	US	S	US	S	US	S	US
Ankur-651Bt	0.36 (1.13)	0.42 (1.17)	2.29 (1.81)	2.58 (1.89)	2.43	2.66	0.13 (1.06)	4.33 (2.30)	1.55	2.12
Ankur-651	0.48 (1.19)	0.40 (1.16)	2.71 (1.92)	2.97 (1.98)	1.20	1.63	0.33 (1.15)	4.87 (2.38)	1.39	2.02
Ankur-2226 Bt	0.37 (1.14)	0.48 (1.16)	2.27 (1.80)	2.67 (1.90)	2.33	2.56	0.26 (1.12)	5.0 (2.44)	1.56	2.22
Ankur-2226	0.45 (1.19)	0.45 (1.17)	2.07 (1.74)	2.21 (1.77)	2.26	2.27	0.46 (1.19)	4.87 (2.41)	1.45	2.08
Ankur-2534 Bt	0.54 (1.21)	0.55 (1.22)	2.40 (1.83)	2.67 (1.90)	2.53	2.16	0.33 (1.15)	2.27 (2.67)	1.60	1.84
Ankur-2534	0.55 (1.24)	0.77 (1.28)	2.08 (1.74)	2.45 (1.85)	1.30	1.66	0.60 (1.25)	5.00 (2.44)	1.34	1.98
MRC.6301 Bt	0.61 (1.23)	0.49 (1.19)	3.19 (2.04)	3.35 (2.08)	0.93	1.80	0.86 (1.35)	5.47 (2.54)	1.60	2.30
MRC.6301	0.47 (1.19)	0.54 (1.21)	2.74 (1.93)	2.90 (1.96)	2.30	2.20	0.53 (1.23)	5.2 (2.47)	1.67	2.34
MRC.6304 Bt	0.84 (1.28)	1.33 (1.46)	2.01 (1.73)	2.62 (1.89)	1.50	1.83	3.06 (2.01)	5.73 (2.58)	1.88	2.58
MRC.6304	1.09 (1.37)	1.97 (1.64)	2.48 (1.85)	2.69 (1.91)	2.30	2.66	4.06 (2.23)	7.06 (2.82)	2.46	3.32
RCH.134Bt	0.61 (1.33)	0.66 (1.27)	3.21 (2.04)	3.27 (2.05)	2.23	2.46	0.66 (1.28)	4.53 (2.35)	1.87	2.43
RCH.134	0.45 (1.27)	0.75 (1.28)	2.31 (1.81)	2.70 (1.92)	2.00	2.63	0.53 (1.23)	5.27 (2.48)	1.62	2.31
RCH.138 Bt	0.48 (1.19)	0.60 (1.22)	3.15 (2.03)	3.22 (2.05)	2.03	2.06	1.13 (1.43)	3.67 (2.14)	1.81	2.27
RCH.138	0.40 (1.16)	0.39 (1.16)	2.15 (1.77)	2.72 (1.92)	2.13	2.03	0.53 (1.23)	5.33 (2.51)	1.48	2.18
RCH.317 Bt	0.76 (1.28)	0.75 (1.28)	2.19 (1.78)	2.52 (1.87)	2.20	2.43	0.60 (1.26)	6.26 (2.68)	1.64	2.42
RCH.317	0.37 (1.16)	0.67 (1.26)	2.12 (1.76)	2.67 (1.91)	2.23	2.53	0.20 (1.09)	3.67 (2.15)	1.54	2.01
MECH.162 Bt	1.05 (1.32)	1.17 (1.41)	2.31 (1.81)	2.50 (1.86)	2.40	2.80	1.46 (1.56)	6.40 (2.69)	1.96	2.72
LHH.144	0.71 (1.30)	0.53 (1.20)	2.31 (1.81)	2.77 (1.94)	1.43	1.73	0.40 (1.17)	4.20 (2.27)	1.41	1.91
Omshankar	0.74 (1.22)	0.48 (1.20)	2.07 (1.74)	2.54 (1.87)	2.13	2.10	0.53 (1.24)	6.13 (2.67)	1.51	2.28
F.1861	0.66 (1.24)	0.67 (1.27)	2.38 (1.83)	2.89 (1.96)	-	-	0.26 (1.12)	4.06 (2.24)	1.37	2.05
H.1117					1.30	1.66			1.30	1.66
RS.2013										

\* S=sprayed plot, US=unsprayed plot

Table:3 Mean whitefly incidence in north zone centers

ENTRY	Faridkot		Ludhiana		Sirsa		Mean	
	*S	*US	S	US	S	US	S	US
Ankur-651Bt	5.3	2.44	4.08	4.39	12.4	2.47	5.72	5.16
Ankur-651	3.3	3.44	4.26	4.71	5.8	3.33	4.30	4.31
Ankur-2226 Bt	5.09	3.33	4.37	4.28	8.46	3.13	5.11	4.71
Ankur-2226	3.34	2.77	3.91	4.27	8.46	2.33	4.55	4.35
Ankur-2534 Bt	3.91	3.33	4.24	4.13	8.6	2.67	4.84	4.59
Ankur-2534	3.59	2.33	4.31	4.29	4.87	2.33	3.88	3.63
MRC.6301 Bt	3.49	3.66	4.61	4.59	8.8	3.73	5.03	5.08
MRC.6301	2.83	2.66	4.5	4.58	7.8	2.33	4.47	4.37
MRC.6304 Bt	3.11	3.11	3.95	4.16	6.87	2.47	4.24	4.11
MRC.6304	2.5	2.44	4.73	4.13	8.2	3.06	4.40	4.51
RCH.134	3.38	2.66	4.39	4.16	10	2.6	4.92	4.76
RCH.138 Bt	4.52	2.55	4.75	4.18	3.47	2.33	3.89	3.46
RCH.138	4.03	4.88	4.39	4.38	5.6	2.93	4.66	4.44
RCH.317 Bt	4.17	2.77	4.1	4.24	7.8	2.27	4.62	4.24
RCH.317	4.09	3.55	4.21	3.92	9.06	2.27	4.97	4.60
MECH.162 Bt	2.8	4.88	4.32	3.8	6.6	2.13	4.48	4.35
LHH.144	3.19	2.66	4.38	4.21	7.86	2.33	4.46	4.29
Omshankar	4.97	4.66	4.51	4.51	7.47	3.13	5.22	4.86
F.1861	3.14	2.11	4.16	4.77	8	3.4	4.44	4.49

\* S=sprayed plot, US=unsprayed plot

The zonal average of the percent boll damage indicated that RCH.134Bt and Ankur-2534Bt hybrids recorded the least damage in both unprotected and protected conditions.

The data on jassid damage and whitefly incidence, as given in Tables 2 & 3 show that there was no difference between test genotypes in their susceptibility to these pests during 2003-04.

The mean seed cotton yield (Table:4) for the zone across Breeding and Plant Protection evaluation showed that showed that RCH.134Bt (2476 kg/ha) followed by RCH.317Bt (2524 kg/ha) followed by MRC.6301Bt (2342 kg/ha). All Bt hybrids had yielded better than their non-Bt counterparts and Bt check hybrid.

Table:4 Mean seed cotton yield across the two evaluations(kg/ha)

Test entries	Breeding	Plant protection		Mean
		S	US	
Ankur-651 Bt	1913	2049	1939	1944
Ankur-651	1869	2067	1825	1920
Ankur-2226Bt	2011	2366	2162	2180
Ankur-2226	1922	1894	1746	1854
Ankur-2534Bt	1846	2189	1979	2005
Ankur-2534	1796	1702	1615	1704
RCH.134Bt	2565	2423	2440	<b>2476</b>
RCH.134	2372	1770	1435	1859
RCH.138Bt	2407	1821	1881	2036
RCH.138	2184	1032	907	1374
RCH.317Bt	2352	2568	2652	<b>2524</b>
RCH.317	2149	1514	1406	1690
MRC.6301Bt	2280	2268	2479	<b>2342</b>
MRC.6301	2021	1419	1380	1607
MRC.6304Bt	1675	2277	2423	2125
MRC.6304	1487	1578	1491	1519
MECH.162Bt	2016	1762	1747	1842
LHH.144	1574	1287	1190	1350
Omshankar	1683	1354	1234	1424
F.1861	1596	1225	1007	1276
H.1117	2037	-	-	2037
RS.2013	2222	1352	2013	1862

As recorded elsewhere, the general insect pest pressure was low in north zone during this season of 2003-04. The number of insecticides sprayed on various test entries in Breeding and Entomology evaluations are tabulated in Table: 5. It is found that all Bt hybrids received on an average less than 0.5 sprays for bollworm management, when both the evaluations are considered. The non-Bt counterparts received 1.2 to 2.7 numbers of sprays in the zone. The check Bt hybrid had received 0.8 number of sprayings. However, the highest number of sprays had to be given to the variety, F.1861 of Punjab.

It was also found that most of the Bt hybrids and their non-Bt counterparts were sprayed with systemic insecticides to manage sap sucking pests such as jassids and whitefly 2-3 times. Hence the total number of sprayings in the tested transgenic Bt genotypes was around 2.2 to 3.5 in comparison to 6-7 sprayings in irrigated northern AICCIP centres, during 2003-04.

Table: 5 Number of insecticide spray on Bt and non-Bt hybrids in northern zone

ENTRY	Faridkot		Ludhiana		Hisar		Sriganganagar		Sirsa		Mean of locations & trials
	BR	Ent	BR	Ent	BR	Ent	BR	Ent	BR	Ent	
Ankur-651Bt	0	0	1	1	0	0	0	0	0	0	0.2
Ankur-651	3	3	6	6	2	2	1	1	1	2	2.7
Ankur-2226 Bt	0	0	1	1	0	2	0	0	1	1	0.6
Ankur-2226	3	3	6	6	2	2	1	1	0	0	2.4
Ankur-2534 Bt	0	0	1	1	2	2	0	0	1	1	1.3
Ankur-2534	3	3	6	6	1	1	1	1	2	2	2.6
MRC.6301 Bt	0	0	1	1	0	1	1	1	1	1	0.7
MRC.6301	3	3	6	6	0	0	1	2	1	2	2.8
MRC.6304 Bt	0	0	1	1	3	3	1	1	1	2	1.2
MRC.6304	3	3	6	6	0	0	1	2	1	2	2.1
MECH.162 Bt	0	1	1	1	3	0	0	1	0	0	0.8
RCH.134Bt	0	0	1	1	0	0	1	1	0	0	0.4
RCH.134	3	3	6	6	3	3	1	0	0	0	2.5
RCH.138 Bt	0	0	1	0	2	2	1	1	0	0	0.7
RCH.138	3	3	6	6	2	2	1	1	0	0	2.4
RCH.317Bt	0	0	1	0	0	2	0	0	0	0	0.5
RCH.317	3	3	6	6	3	1	1	1	0	0	2.4
LHH.144	3	3	6	6	3	3	1	0	1	0	2.6
Omshankar	3	3	6	6	3	3	1	1	0	0	2.6
F.1861	3	3	6	6	-	-	-	-	-	-	4.5
H.111	-	-	-	-	3	3	-	-	2	2	2.5
RS.2013	-	-	-	-	-	-	1	1	-	-	1.0



## PLANT PATHOLOGY EVALUATION

The experimental plots of the Entomology Evaluation was also utilized for observations on the major diseases that infected all the entries. The most prominent disease that has been the anguish for this zone is Cotton Leaf Virus (CLCuV) disease. The various entries in this evaluation were screened for this disease under field condition. Generally, in most of the stations, the disease intensity in these experimental plots was low, although in certain susceptible entries such as Omshankar, CLCuV disease was quite high. Based on the report of centres, the following table provides a glimpse of the disease incidence in Plant Protection evaluation plots.

Per cent Cotton Leaf curl Disease incidence in various test entries

ENTRY	Faridkot		Ludhiana		Hisar		Sriganganagar		Sirsa	
	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt	Bt	Non-Bt
Ankur-651	0	0	0	0	0	0	0	0.67	0	0
Ankur-2226	0	0	0	0	0	0	0	0		G-1
Ankur-2534	0.9	0	0	0	0	34	0.33	0	0	0
RCH.134	0	0	0	0	*G-2	0	0	0	0	0
RCH.138	0	0	0	0	G-2	0	0	0	0	0
RCH.317	0	0	0	0	0	0	0	0	0	0
MRC.6301	0	0	0	0	G-2	0	0	0	0	0
MRC.6304	0	0	0	0	0	0	0	0	0	0
CHECK HYBRIDS	0	0	0	0	0	0	0	0	0	0
MECH.162	0	0	0	0	0	0	0	0	0	0
LHH.144	0	0	0	0	0	0	0	0	0	0
Omshankar	-	39	-	S		22	0	12.33	-	11.9
F.1861 (Fdkt/Ludh/Sirsa)	-	0	-	0	-	-	-	-	-	-
H.1117 Hisar	-	-	-	-	-	S*	-	-	-	2.63
RS.2013	-	-	-	-	-	-	-	0	-	-

\* G-2 = grade 2, as reported by ICAR Monitoring team

Based on the observations Breeding and Entomology evaluation plots, Ankur-651, Ankur-2226 Ankur-2534Bt, RCH.134 and RCH.138Bt and

MRC.6304 are found susceptible to this disease. Amongst check cultivars, Omshankar hybrid and H.1117 variety were found susceptible during this year. It is important to note that the disease was not in a severe form in the test plots. Hence, it has to be borne in mind that the reaction of all the test hybrids in the next season shall be important to verify their true reaction to the infection of this disease.

#### OTHER DISEASES:

No foliar diseases were reported on any Test hybrids from any center during this year. The same was the status of Root rot disease in all the five centers during the current year. However, these cultures have to be intensively screened for infection to all potential diseases of north zone before being released as in the case of other AICCIP test entries.

#### **CONCLUSIONS:**

- In the case of north zone, Leaf Curl Virus disease is a major biotic deterrent for hirsutum cotton cultivation. Hence, the primary consideration shall be to avoid introduction of susceptible genotypes to be released for cultivation in north zone states. Even if the non-Bt counterparts of the test Bt hybrids are susceptible, the sword of uncertainty regarding susceptibility to this virus disease hangs around, if allowed for large scale cultivation and hence, these genotypes are not recommended for further evaluations or consideration for release in the north zone. Ankur-651, Ankur-2226, Ankur-2534, RCH.134, RCH.138 and MRC.6301 have been found to be infected with CLCuV disease during 2003-04. It is suggested that all the Bt entries/non-Bt counterparts may be

- intensively screened at AICCIP center, Ludhiana and CICR, Sirsa during next season for reconfirmation.
- Under this background, it may further be added that there has been very good tolerance to the incidence and damage due to Spotted bollworms that dominated this season in the test centers in the Bt hybrids of M/S Rasi Seeds Pvt. Ltd. as well as those provided by M/S Maharashtra Hybrid Seed Company Ltd.
  - The zonal average of the percent boll damage indicated that RCH.134Bt and Ankur-2534Bt hybrids recorded the least damage in both unprotected and protected conditions.
  - The data on jassid damage and whitefly incidence, as given in Tables 2 & 3 show that there was no difference between test genotypes in their susceptibility to these pests during 2003-04.
  - It was also found that most of the Bt hybrids and their non-Bt counterparts were sprayed with systemic insecticides to manage sap sucking pests such as jassids and whitefly 2-3 times. Hence the total number of sprayings in the tested transgenic Bt genotypes was around 2.2 to 3.5 in comparison to 6-7 sprayings in irrigated northern AICCIP centres, during 2003-04.
  - In Breeding evaluation, all the three RCH hybrids, viz., RCH.134, RCH.138 and RCH.317 recorded appreciable yield increase (19 to 27%) over their non-Bt counterpart hybrids. Substantial superiority (45-52%) over Bt check hybrid (MECH.162Bt), Zonal checks LHH.144 (86-94%) and hirsutum variety check (31-74%). Hybrid MRC.6301Bt also

recorded higher seed cotton yield over the non-Bt hybrid (84%), Bt check hybrid (MECH.162Bt) (40%) and hirsutum variety check (27-61%). In the case of Ankur hybrids, all the three Bt hybrids recorded lower yield than Bt check hybrid. There was no appreciable yield difference between these Bt hybrids and their non-Bt hybrid counterparts. The mean seed cotton yield for the zone across Breeding and Plant Protection evaluation showed that showed that **RCH.134Bt (2476 kg/ha) followed by RCH.317Bt (2524 kg/ha) and MRC.6301Bt (2342 kg/ha).**

- Both Bt hybrids of M/S Rasi Seed Pvt. Ltd. and M/S Maharashtra Hybrid Seed Co. Ltd. Seeds have superior increase in yield over all the check hybrids and local check varieties. RCH Bt hybrids stood out the best in respect of seed cotton yield. When we consider the percent increase of seed cotton yield, as given in the following table, it is found that the Ankur-651 and Ankur-2534 hybrids had marginal advantage over Bt check hybrid, while Ankur-2226 had no advantage over MECH.162 Bt.
- The fibre property data of the various test entries are provided in the following tables. These indicate that there is no appreciable difference in the various fibre properties such as staple length and tenacity and micronaire in the test entries. In accordance with the textile requirements and CIRCOT norms, the ratio of tenacity to strength shall be 0.8 and above. In this respect, RCH.134 and RCH. 138 of Rasi Seeds Pvt. Ltd. stand superior over others. It is worthy to note that amongst check varieties, H.1117 and RS.2013 also are outstanding in this respect.

## FUTURE OUTLOOK

- ✓ Before offering the entries for testing in NORTH ZONE, the data on the reaction to major diseases of the zone such as Cotton leaf curl disease shall be provided. Genotypes that are susceptible to major diseases shall be avoided for being provided for AICCIP testing so as to avoid wasteful efforts.
- ✓ A major consideration in recent years by the textile industry has been enhancement fibre quality in cotton. Considering this vital aspect, the data on fibre property of the test hybrid may be provided for the test entries. The presently approved values 0.8 and above as ratio of the mean span length (mm) to tensile strength (g/tex) under both HVI and ICC mode shall be the only yardstick for sponsoring the entries for AICCIP evaluations.
- ✓ All test entries shall have very good germinability of seeds to ensure that the trial plots shall have good plant stand. All the hybrids shall be true to type plants and the basic distinct identification characters may be provided for verification of the plant stand in trial plots. No insecticide or other seed treatment shall be there and the acid delinted seeds may be supplied in sufficient quantity including for gap filling, if need arises. The seeds shall be provided to Project Co-ordinator's office one month before the actual planting period of the desired centers of respective zones.

## Report of the Monitoring of Bt cotton in North Zone

The following committee members constituted by the Council to monitor the Bt cotton trials in North Zone.

1. Dr. B.M. Khadi, Principal Scientist, Agricultural Research Station, Dharwad
2. Shri. A. Kannan, Principal Scientist, CICR, Regional Station, Coimbatore
3. Dr. N. Hariprasada Rao, Principal Scientist, Agricultural Research Station, LAM FARM, Guntur

Visited the trials as scheduled below :

- 1.9.2003 – PAU, Ludhiana
- 2.9.2003 – PAU, Faridkot
- 3.9.2003 – RAU, Sriganaganagar
- 4.9.2003 – CICR, Regional Station, Sirsa and CCS HAU, Hisar

### 1. Punjab Agricultural University, Ludhiana

The trials are conducted as per the protocol with slight modification in Plot Size., instead of 6 rows of 6mtr. length, 5 rows of 7.2 m have been adopted with the plant population remaining same as given in the protocol. The crop was 100 days old with peak boll formation.

High incidence of spotted bollworm was observed. Four sprays against bollworm for selective entries were given.

Three genotypes MRC.6304Bt, MECH.162Bt and MRC.6304 were found susceptible to jassid with 2 and above grade and received two sprays, while the rest of the entries received only one spray.

Generally, the plant population was low i.e. ANKUR-651Bt, ANKUR-2226Bt, ANKUR-2534Bt and MRC.6304Bt, as compared to other genotypes.

In the unprotected trial, the boll formation was excellent in entries ANKUR-651Bt, RCH.134 Bt, MRC.6301 Bt, ANKUR-2226 Bt, RCH.138 Bt, ANKUR-2534 Bt, MRC.6304 Bt, RCH.317 Bt, LHH.144 (Zonal check). The boll formation was very low in rest of the entries and damage due to spotted bollworm was very much evident and bushy growth could be observed. No bolls could be observed in the Test hybrids LHH.144. No disease was observed in any Test hybrids in all the trials.

The trials were well laid and retention matured and good bolls were observed.

## **2. Punjab Agricultural University, Faridkot**

At Faridkot also, a slight deviation in the plot size was observed. Five rows of 7.2mt have been maintained in each Test hybrids maintaining same population level. Plant population was maintained in a fair way.

Incidence by spotted bollworm alone was observed. Only entries from LHH.144 to F.1861 were protected with endosulfan for bollworm control, while entries ANKUR-651Bt, RCH.134 Bt, MRC.6304 Bt, OMSHANKAR (Zonal check), MECH.162Bt (Bt check hybrid), MRC.6304, ANKUR-2534 and F.1861 received one spray of 'Confidor' for sucking pest control.

The crop was in peak bolling stage (116 DAS). Leaf Curl Virus incidence was observed in Test hybrids OMSHANKAR (Zonal check) to an extent of 34.6% and showed grade 3 symptoms. No other foliar diseases were observed.

In unprotected conditions, besides the Test hybrids OMSHANKAR (Zonal check), the entries ANKUR-2534 Bt and F.1861 registered 2 and 1% of Leaf Curl virus incidence respectively. Rest of the entries was free from CLV.

The population was found less in entries ANKUR-651Bt, ANKUR-2226 Bt and ANKUR-2534 Bt, while the rest of the entries had fairly good population.

In general, trials are maintained properly and good results are expected.

## **3. Rajasthan Agricultural University, Sriganganagar**

The trials were laid out as per the protocol and population was up to the mark in rest in all the entries except ANKUR-651Bt, ANKUR-2226 Bt, ANKUR-2534 Bt, MRC.6304 Bt. The trials were sown on 18.5.2003.

The CLCV incidence was noticed in the entries OMSHANKAR (Zonal check) and ANKUR-651. The entries MRC.6304 Bt, MECH.162Bt, MRC.6304 and RCH.134 were found more susceptible to jassid than others. The square damage was more in entries LHH.144 (Zonal check) and ANKUR-2226, while boll damage was more in RCH.134Bt, LHH.144, RCH.317, RCH.138, RCH.134 and ANKUR-651. So far no spraying of insecticide was given for control of insect pests in any trial.

In general, the trials are well maintained. No appreciable visible difference could be observed between protected and unprotected plots.

#### **4. Central Institute for Cotton Research, Regional Station, Sirsa**

The trials were sown on 8.5.2003 and 9.5.2003, as per the protocol. The entries ANKUR-2226Bt, RCH.138Bt, MRC.6304Bt and 2320 had less plant stand as compared to others. One spray for sucking pests was given and one spray for bollworms in entries ANKUR-2226Bt, RCH.138Bt, MRC.6304, ANKUR-2534 and ANKUR-651 was given. The entries MRC.6304Bt, MECH.162Bt (Bt Check hybrid), MRC.6304 were found to be more susceptible to jassid compared to others. The mixtures were observed in Test hybrids Nos. ANKUR-651Bt, ANKUR-2226Bt, MRC.6304 & ANKUR-651.

The good boll retention was observed in entries ANKUR-651Bt, ANKUR-2226Bt, RCH.138Bt, OMSHANKAR, MECH.162Bt (Bt Check hybrid), ANKUR-2534, ANKUR-2226, MRC.6301 and ANKUR-651. The plant population in unprotected entomology trial was comparatively low in ANKUR-651Bt, ANKUR-2226Bt, RCH.138Bt, ANKUR-2534 and ANKUR-2226 and may vitiate the yield.

The entries RCH.138, ANKUR-2226 and OMSHANKAR in unprotected plot and OMSHANKAR, 2320 in protected plant showed incidence of leaf curl disease and the rest were found free from disease. No other foliar diseases were observed.

The entries ANKUR-2226Bt, MRC.6304Bt, OMSHANKAR, MECH.162Bt (Bt Check hybrid), MRC.6304, ANKUR-2226 exhibited more than 2 grade for jassid incidence.

In general, the trials were maintained properly and good results were expected, except unprotected entomology trial where plant stand was observed to be very poor in some entries necessitating to disqualify for analysis.

#### **5. CCS Haryana Agricultural University, Hisar**

The trials were laid out as per the protocol. The plant stand was very poor in entries ANKUR-651Bt, ANKUR-2226Bt, RCH.138Bt, MRC.6304Bt, MRC.6304 in Breeding trials. In Entomology trials, the entries ANKUR-651Bt, ANKUR-2226Bt, RCH.138Bt, MRC.6304Bt, MRC.6304, H.1117 had very poor plant population of less than 50%. The sprays were given for control of jassid while one spray for control of spotted bollworm was given in entries except ANKUR-651Bt, RCH.134Bt, ANKUR-2226Bt, RCH.138Bt, MRC.6304Bt, MECH.162Bt (Bt Check hybrid), RCH.317 and ANKUR-651, which showed less than 5% bollworm damage.

The Test hybrids OMSHANKAR exhibited the incidence of leaf curl virus in all the trials. The Test hybrids RCH.134 in breeding and RCH.138Bt, H.1117 and MRC.6304 in entomology trials showed incidence of leaf curl virus.



In general, all the leaf curl infected plants showed 2 or 3 grades symptoms of incidence.

In total, the crop stands of 7 to 8 entries were found below normal, which may lead to vitiation of the trials.

### General:

Cotton crop of North Zone is excellent and normal sowing rainfall received. The incidence of pests till now is minimal. In the beginning, Jassid and later spotted bollworm induces were observed. Egg laying of *Helicoverpa* started by 1<sup>st</sup> week of September in the entire zone.

The sowing of Bt cotton trials have been taken by all the centres during the second fortnight of May, 2003. In general, the trials have been laid out properly as per the protocol. However, the following observations were made by the team for consideration while computing the results of the trials.

- i. In general, the plant population was less in entries ANKUR-651Bt, ANKUR-2226Bt, RCH.138Bt and MRC.6304Bt while seems to be due to low germination percentage of the seeds supplied by the firms.
- ii. At all locations, the entries MRC.6304Bt, MECH.162Bt (Bt Check hybrid), MRC.6304 have been found susceptible to jassids and the Test hybrids OMSHANKAR for Cotton Leaf Curl virus disease.
- iii. The mixtures/off types have been observed in the entries, ANKUR-651Bt, ANKUR-2226Bt, RCH.138Bt, MRC.6304, ANKUR-651 at all locations.
- iv. Upto 110 to 120 days crop, only attack by jassid and spotted bollworm was observed and egg laying of *Heliothis* was seen from 1<sup>st</sup> week of September in all the locations.
- v. Whichever the Test hybrids recorded poor germination, the concerned firm may be requested to ensure supply of good quality seeds in future, so that conducting of trials will have a true meaning with out loss of time and man hour.