

# EVALUATION REPORT

Ankur.651Bt	MRC.6304Bt
Ankur.2226Bt	RCH.134Bt
Ankur.2534Bt	RCH.138Bt
MRC.6301Bt	RCH.317Bt

**&**

**Combined report for first &  
Second year  
(8 Bt hybrids)**

**NORTH ZONE**

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

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2004 *kharif season***

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# Executive Summary

## Second year evaluation

- ❖ The Bt cotton evaluation of eight Bt hybrids, viz., Ankur-651, Ankur-2226, Ankur-2534, MRC.6301, MRC.6304, RCH.134, RCH.138 and RCH.317 was undertaken by the All India Cotton Improvement Project (AICCIP) during 2004 *Kharif* season to test their suitability in North Zone states for the second year in succession (vide ICAR letter No.2(8)/2003-C.C.I. dated 25.4.2003). AICCIP undertook this evaluation at five centres, viz., PAU, Faridkot; PAU, Ludhiana; CCSHAU, Hisar; RAU, Sriganaganagar and CICR Regional Station, Sirsa. The incidence of three bollworm species in these centres was low during this year also. The natural conditions did not allow their build up during this season too. The general response of the test Bt hybrids showed superiority in terms of the number of bolls as well as the seed cotton yield.
- ❖ Sap sucking pests such as jassids were low except in Sriganaganagar, Ludhiana and Hisar. There was also an incidence of *Spodoptera litura* in Hisar in the latter half of the crop season and this did not affect the crop growth or boll retention due to defoliation. The whitefly population was seen to be high in Sriganaganagar. It was over seventeen times that of the population in other centres.
- ❖ Amongst various diseases, the CLCuV was the most dominant issue for growing healthy crop to yield good quality lint in the North Zone. At Sriganaganagar, the check hybrid Om Shankar had 14.63 per cent plants infected by CLCuV. All other hybrids (Both Bt and Non-Bt) had no incidence (Ankur-651 Bt) to 7.89 per cent (MRC.6304 Non-Bt) plants infected by CLCuV. The vector population did not build up appreciably in all centres except at Sriganaganagar. The early August population of Sriganaganagar was noticed to be at a range between to 15 to 19 per three leaves and it continued to build up a maximum range of 20 to 42 within next 40 days in the unsprayed plots. Triazophos spraying to contain

- whitefly in the test entries of protected plots was begun from the second spray schedule in August. The increased whitefly population, with higher proportion of viruliferous insects, seems to have led to increased incidence of Cotton leaf curl virus in the test entries at this centre.
- ❖ Yet another dimension that emerged in Pathological observations was of the incidence of Parawilt at Ludhiana in almost all entries due to abnormal climatic conditions. The seed cotton yield was seen to be reduced due to this syndrome in most of the entries. RCH.134 and RCH.138 Bt hybrids were found to suffer less and hence yielded the best at this centre.
  - ❖ The pattern of insecticides used for protecting the breeding evaluation was directed towards reducing jassid and whitefly population. The bollworm incidence was in the months of August and September in a mild way and the conventional insecticides reduced their population. In the absence of Spotted and American bollworms pressure, the best yielding hybrids showed better adaptability to this region. The Pink bollworm damage, as measured through open boll damage assessment at Ludhiana and Sriganagar, indicates that these Bt hybrids may necessitate special plant protection attention against this pest.
  - ❖ The overall mean seed cotton yield across protected and unprotected evaluation indicate that there has been consistency in the performance of the best yielding Bt hybrids such as RCH.134, RCH.138 and MRC.6301 under protected and unprotected environment. Under bollworm protection, the highest yield was for RCH.138 Bt (3369 kg/ha). The exclusion of Ludhiana yield data further brings this up to 3508 kg/ha, followed by RCH.134Bt and MRC. 6301Bt. The highest yield of RCH.134Bt under unprotected condition and its overall performance at all locations of the zone testifies that this hybrid is very much adapted and has adequate bollworm-tolerance to retain bolls for realising the highest seed cotton yield. Stability of seed cotton yield of the candidate entries during second year was analysed by the given formula:  $\text{mean} - \text{SD} / \text{max.value} \times 100$ . This measures the effect of environment (location) on the genotypes.

RCH.134 (87.69%), RCH.138 (76.56%), RCH.317 (76.34%), MRC.6301 (70.3%) and Ankur.651 (64.34%) Bt hybrids showed the best stability, as seen in the following table. These hybrids seem to be more adapted than the others in the North zone.

- ❖ The fibre property data shows that the various parameters such as fibre length, tenacity and micronaire values of various entries were within approved and acceptable limits. The tenacity to strength ratio of the RCH.138Bt as well as of MRC.6301Bt is found to be above 0.80 and their micronaire values are good. Given normal growing conditions, these hybrids seem to produce quality lint.

### **Two years' evaluation analysis**

The eight Bt hybrids, vide ICAR letter No.2(8)/2003-C.C.I. dated 25.4.2003 were evaluated in the North Zone AICCIP centers. The combined report of 2003 and 2004 seasons in regard to these eight Bt hybrids is provided below.

- ❖ Out of the eight hybrids that have been tested during the last two years, potential Bt genotypes seem to be MRC.6301, RCH.134, RCH.138, Ankur- 2534 and Ankur-651, including the yield and quality of lint, considering all the facets of cotton cultivation of North Zone. The seed cotton yield superiority of RCH.134 and 138 Bt hybrids over the rest of the test hybrids was consistent. The fibre properties also showed consistency during the two years in these two hybrids. In general, 2004 season was more favourable for stable fibre tenacity values and consequently, the ratio between tenacity and length was near 0.80 in most of the cases, unlike last year. It is also seen that there is a reduction of micronaire value in Bt entries in comparison to their non-Bt counterparts.
- ❖ The susceptibility to CLCuV disease depends on the whitefly vector population and effective monitoring and in built advisory service to contain their population shall be vested with the recommendation to cultivate these hybrids widely, especially in those districts where the notoriety of disease spread is currently high. When the two years' data on the incidence of CLCuV disease on the eight Bt hybrids were examined, all

hybrids except Ankur-651Bt, showed a range of susceptibility to CLCuV at Sriganagar. All non-Bt hybrids, including Ankur-651, showed susceptibility to this disease at Sriganagar centre. Even though most of the Bt plants had shown the maximum grade of 4 (four), the seed cotton yield was not affected due to the low incidence of the disease. However, the hybrids showing grade 3 to 4 could encounter severe yield loss under heavy disease pressure, when the disease infection appears in the early stage of the crop.

- ❖ It is important that the North Zone states cultivate cotton hybrids just in order to produce 50s cotton that has always been a far-cry in spite of all the best natural resources that are at the command of the farmers. The current lint production is only for the share of 20s and 30s cotton and these are better produced in resource-constrained regions of the country. The factor productivity of cotton shall be increased if only such hybrids are targeted that could produce 50s, high quality fibre at low biotic pressure.

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# EVALUATION REPORT FOR SECOND YEAR (2004 season)

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## Introduction

The All India Coordinated Cotton Improvement Project (AICCIP) undertook the evaluation of **eight cotton hybrids** possessing the Cry 1 A(c) gene expressing delta-endotoxin in five North Zone centres, viz., CCSHAU, Hisar; PAU, Ludhiana and Faridkot, RAU, Sriganaganagar and Regional Station, Sirsa for the second year in succession (vide ICAR letter No.2(8)/2003-C.C.I. dated 25.4.2003). The trials were laid out in accordance with 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 hybrids and their non-Bt counterparts were provided by the above seed companies. The relevant Bt check, local checks were included for comparison and results are furnished below:

## Test hybrid entries:

The eight Bt hybrids, viz., ANKUR-651Bt, ANKUR-2226 Bt, ANKUR-2534 Bt, MRC.6301 Bt, MRC.6304 Bt, RCH.134 Bt, RCH.138 Bt and RCH.317 Bt were evaluated with MECH.162Bt as check, LHH.144 & OMSHANKAR as zonal hybrid checks and respective variety checks, viz., F.1861 (Faridkot/Ludhiana), H.1117 (Hisar), RS.2013 (Sriganaganagar). These entries were evaluated at these centres with the same protocol observed during 2003 *kharif* season.

## Date of sowing and final harvest

Dates	Faridkot	Ludhiana	Hisar	Sriganaganagar	Sirsa
Date of sowing	8.5.2004	12.5.2004	31.5.2004	20.5.2004	11.5.2004
Date of final harvesting	10.11.2004	13.11.2004	15.11.2004	18.11.2004	19.11.2004

## **BREEDING TRIAL**

DESIGN: Randomised Block Design 3 Replications – 6 ROWS X 6 metre rows with plant protection, based on recommended package of practices of the respective centres with plant protection against all pests and diseases at the prescribed economic threshold levels for each of those biotic stresses in the concerned entries from time to time, based on close monitoring for their incidence and damage.

## **PLANT PROTECTION TRIAL**

DESIGN: Randomised Block design 3 Replications – 6 ROWS X 6 metre rows with no plant protection measures against prevalent bollworms and diseases. However, protection against sap sucking pests in respective entries, based on the recommended practices of respective centres was made.



# 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.

## Germination Data

The germination of the various entries in the centres is seen to be quite satisfactory and the percentage ranged from 87 to 91. The details of Centre-wise, individual entries are given below.

**Germination % (Plant Stand )**

<b>Entry</b>	<b>FKT</b>	<b>LDH</b>	<b>SGNR</b>	<b>HSR</b>	<b>SIRSA</b>	<b>Mean</b>
Ankur.651Bt	100.0	93.0	80.8	85.3	98.0	<b>91.4</b>
Ankur.2226Bt	97.5	96.0	81.8	82.9	92.4	<b>90.1</b>
Ankur.2534Bt	95.1	93.0	82.8	71.2	81.8	<b>84.8</b>
MRC.6301Bt	92.0	83.0	77.8	83.3	90.4	<b>85.3</b>
MRC.6304Bt	93.8	60.0	80.8	73.2	69.2	<b>75.4</b>
RCH.134Bt	95.1	93.0	77.3	87.4	92.9	<b>89.1</b>
RCH.138Bt	98.8	96.0	78.8	85.3	98.5	<b>91.5</b>
RCH.317Bt	95.7	93.0	81.3	72.7	95.5	<b>87.6</b>
LHH.144	98.1	93.0	80.3	78.8	83.3	<b>86.7</b>
OM Shankar	93.8	88.0	76.3	85.3	88.9	<b>86.5</b>
MECH.162Bt check	97.5	92.0	80.8	86.8	91.4	<b>89.7</b>
Ankur.651	97.5	87.0	81.8	88.3	91.4	<b>89.2</b>
Ankur.2226	98.8	92.0	80.3	82.9	97.5	<b>90.3</b>
Ankur.2534	98.1	95.0	82.3	88.3	94.4	<b>91.6</b>
MRC.6301	94.4	91.0	81.3	79.2	84.3	<b>86.1</b>
MRC.6304	98.1	93.0	82.3	95.5	87.9	<b>91.4</b>
RCH.134	98.1	97.0	80.3	85.3	92.9	<b>90.7</b>
RCH.138	97.5	92.0	83.8	83.8	93.9	<b>90.2</b>
RCH.317	98.8	90.0	74.2	83.8	95.0	<b>88.4</b>
Variety Check	94.1	89.0	89.1	84.4	80.7	<b>87.4</b>

### FIRST SYMPODIAL NODE:

The first sympodial node ranged from 4.8 to 5.3 in Bt hybrids and was comparable with non-Bt hybrids. However, at Faridkot all genotypes showed the longest sympodial node, as given in the table below.

Nodes of 1st Sympodia				
Entry	Faridkot	Ludhiana	Sirsa	Mean
Ankur.651Bt	8.6	3.0	3.3	4.9
Ankur.2226Bt	8.3	3.5	2.6	4.8
Ankur.2534Bt	8.3	3.1	2.7	4.7
MRC.6301Bt	8.4	3.0	3.0	4.8
MRC.6304Bt	9.3	3.6	3.0	5.3
RCH.134Bt	8.7	3.4	2.7	4.9
RCH.138Bt	9.0	3.9	3.1	5.3
RCH.317Bt	7.8	3.2	2.8	4.6
LHH.144	9.3	4.2	3.1	5.5
OM Shankar	9.9	3.3	3.6	5.6
MECH.162Bt check	9.1	3.6	3.1	5.3
Ankur.651	7.7	3.7	3.1	4.8
Ankur.2226	8.3	3.5	3.2	5.0
Ankur.2534	7.9	3.4	2.9	4.7
MRC.6301	8.1	3.6	3.2	5.0
MRC.6304	8.4	3.3	3.1	4.9
RCH.134	8.6	3.4	3.3	5.1
RCH.138	8.8	3.6	4.0	5.5
RCH.317	9.3	3.7	2.8	5.3
Variety Check	10.1	3.5	3.1	5.6
CD at 5%	NS	0.3	0.7	
CV %	10.4	11.8	14.5	

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

The mean length of the first sympodium in test hybrids ranged between 22.2 to 25 and was comparable to the Bt check hybrids, as given below.

Length of 1st Sympodia				
Entry	Faridkot	Ludhiana	Sirsa	Mean
Ankur.651Bt	18.9	30.5	25.6	25.0
Ankur.2226Bt	18.9	22.2	25.4	22.2
Ankur.2534Bt	20.4	21.8	24.5	22.2
MRC.6301Bt	23.3	24.6	28.0	25.3
MRC.6304Bt	21.2	20.5	27.0	22.9
RCH.134Bt	24.7	22.8	26.7	24.7
RCH.138Bt	18.8	21.6	30.2	23.5
RCH.317Bt	27.1	21.0	26.7	24.9
LHH.144	20.9	27.9	31.3	26.7

OM Shankar	18.3	30.6	29.5	26.1
MECH.162Bt check	20.9	26.1	29.0	25.3
Ankur.651	18.3	20.0	26.2	21.5
Ankur.2226	19.1	26.8	31.1	25.7
Ankur.2534	20.7	26.2	26.3	24.4
MRC.6301	25.0	24.6	33.5	27.7
MRC.6304	22.1	32.2	29.6	28.0
RCH.134	25.3	27.0	29.4	27.2
RCH.138	41.9	24.1	38.5	34.8
RCH.317	20.4	24.8	26.8	24.0
Variety Check	18.7	24.3	30.5	24.5
CD at 5%	4.2	7.6	4.1	
CV %	11.5	18.6	8.7	

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

The mean fruiting points, as given in the table below shows that the fruiting points varied from 64 to 87 in Bt hybrids while in non-Bt counterparts, it ranged from 61 to 79.

#### Mean fruiting points on first sympodium

Entry	Faridkot	Ludhiana	Hisar	Mean
Ankur.651Bt	54.0	53.1	118.0	75.0
Ankur.2226Bt	55.4	44.2	92.0	63.9
Ankur.2534Bt	45.9	47.7	139.4	77.7
MRC.6301Bt	52.6	68.4	147.1	89.4
MRC.6304Bt	58.6	61.3	94.3	71.4
RCH.134Bt	56.4	59.3	89.8	68.5
RCH.138Bt	53.1	64.2	144.4	87.2
RCH.317Bt	57.1	58.8	115.0	77.0
LHH.144	64.1	61.8	142.4	89.5
OM Shankar	59.3	62.8	86.8	69.7
MECH.162Bt check	75.0	61.0	106.7	80.9
Ankur.651	49.0	62.4	81.8	64.4
Ankur.2226	50.9	53.0	77.6	60.5
Ankur.2534	53.4	53.5	99.0	68.6
MRC.6301	67.1	67.7	104.3	79.7
MRC.6304	54.1	61.9	98.1	71.4
RCH.134	70.2	64.3	83.0	72.5
RCH.138	65.9	67.1	102.4	78.5
RCH.317	53.8	58.7	89.9	67.4
Variety Check	52.2	64.9	158.1	91.7
CD at 5%	10.1	12.0		
CV %	10.6	12.5		

**TOTAL BOLLS/PLANT:**

The total bolls of test hybrids were statistically similar in the zone. Bt hybrids had more number of bolls over their non-Bt counterparts.

**Total number of bolls/plant**

Entry	Faridkot	Ludhiana	Sriganga nagar	Hisar	Sirsa	Mean
ANKUR-651Bt	46.3	33.0	45.8	41.0	57.5	44.7
ANKUR-2226 Bt	48.9	23.0	50.9	39.3	60.3	44.5
ANKUR-2534 Bt	34.4	26.0	49.1	61.6	63.5	46.9
MRC.6301 Bt	43.7	47.0	45.3	47.6	52.5	47.2
MRC.6304 Bt	42.1	20.0	40.9	38.8	61.4	40.6
RCH.134 Bt	36.5	42.0	43.8	29.6	53.2	41.0
RCH.138 Bt	28.7	46.0	50.9	45.7	57.9	45.8
RCH.317 Bt	47.8	58.0	47.9	41.5	64.1	51.9
RCH.2Bt (Bt check)	40.1	12.0	42.7	28.2	53.0	35.2
MECH.162Bt (Bt check)	33.2	32.0	44.4	38.3	55.8	40.7
LHH.144	36.7	17.0	46.6	23.0	63.7	37.4
Omshankar	31.3	17.0	54.5	30.5	55.1	37.7
ANKUR-651	-	-	40.9	50.1	46.7	45.9
ANKUR-2226	31.9	19.0	59.8	26.6	55.5	38.6
ANKUR-2534	36.5	14.0	54.5	22.2	57.5	36.9
MRC.6301	28.0	11.0	51.9	28.3	51.3	34.1
MRC.6304	45.1	10.0	49.3	29.5	59.1	38.6
RCH.134	42.4	16.0	49.1	22.7	54.0	36.9
RCH.138	36.7	10.0	38.4	23.2	60.3	33.7
RCH.317	35.8	15.0	49.1	31.6	69.8	40.2
F 1861	21.5	7.0				14.3

**BOLL WEIGHT (g):**

The mean boll weight was ranging from 3.4 to 4.3 in test hybrids. The non-Bt hybrids and check hybrids also had similar boll weight. The zonal average was the highest in MRC.6301Bt and MRC.6304Bt. RCH. Bt hybrids, viz., 134 and 138 also were the next best in this regard.

### Boll weight (g)

Entry	Faridkot	Ludhiana	Sriganganagar	Hisar	Sirsa	Mean
Ankur.651Bt	3.7	3.8	2.5	4.0	2.8	3.4
Ankur.2226Bt	4.4	3.5	2.7	3.7	3.6	3.6
Ankur.2534Bt	4.1	3.6	2.9	4.1	3.3	3.6
MRC.6301Bt	4.3	4.7	3.5	4.7	4.2	4.3
MRC.6304Bt	5.1	4.1	3.1	5.0	3.5	4.2
RCH.134Bt	4.3	4.4	3.1	4.3	3.3	3.9
RCH.138Bt	3.6	4.3	3.6	4.2	3.7	3.9
RCH.317Bt	3.6	3.5	3.3	4.1	3.2	3.5
LHH.144	4.9	4.6	4.3	4.7	4.2	4.5
Om Shankar	3.4	3.8	3.5	4.2	3.2	3.6
MECH.162Bt check	4.0	3.8	3.5	3.9	3.3	3.7
Ankur.651	3.5	3.8	3.2	4.1	3.2	3.6
Ankur.2226	4.2	4.5	4.5	4.2	3.9	4.2
Ankur.2534	4.2	3.8	3.0	4.4	3.3	3.7
MRC.6301	4.3	4.2	3.5	3.9	3.9	4.0
MRC.6304	3.7	3.4	2.5	3.5	3.3	3.3
RCH.134	4.1	4.5	3.8	5.0	3.7	4.2
RCH.138	3.9	3.9	3.4	4.0	3.2	3.7
RCH.317	3.6	3.6	2.8	3.3	3.1	3.3
Variety Check	3.9	3.4	1.9	2.8	3.2	3.0
CD at 5%	0.1	0.3			0.5	
CV %	0.9	4.1			7.9	

### PERCENT GINNING OUTTURN:

The percentage Ginning outturn (GOT) was ranging between 32 to 36 in Bt test entries, as seen in the following table. The highest GOT was seen in MRC.6301 Bt (35.8%) and RCH. 134 Bt (35.1%) and Ankur 2226 **non-Bt** (35.4%) hybrids at Sriganganagar and Sirsa. The test Bt hybrids except RCH.138Bt and MRC..6304Bt gave 34-36% GOT in the zone.

### Ginning out turn (%)

Entry	Faridkot	Ludhiana	Sriganganagar	Hisar	Sirsa	Mean
Ankur.651Bt	33.0	34.1	36.3	33.2	35.2	34.4
Ankur.2226Bt	33.4	34.7	36.6	33.6	35.4	34.7
Ankur.2534Bt	33.3	33.1	35.9	32.7	35.0	34.0
MRC.6301Bt	35.8	33.6	36.1	35.9	37.5	<b>35.8</b>
MRC.6304Bt	32.5	32.4	34.8	29.8	33.0	32.5

RCH.134Bt	33.3	33.8	37.9	34.7	37.6	<b>35.5</b>
RCH.138Bt	32.5	32.3	32.7	32.4	33.5	32.7
RCH.317Bt	34.2	34.5	34.6	34.6	35.1	34.6
LHH.144	31.2	32.6	32.9	31.9	31.1	31.9
Om Shankar	33.5	33.2	35.8	34.7	36.5	34.8
MECH.162Bt check	33.9	33.2	37.0	34.9	35.5	34.9
Ankur.651	35.3	34.4	34.9	33.7	34.7	34.6
Ankur.2226	36.4	34.6	38.0	34.1	33.8	<b>35.4</b>
Ankur.2534	33.0	35.3	35.2	32.5	36.3	34.5
MRC.6301	32.0	33.4	36.7	34.0	35.6	34.3
MRC.6304	34.9	33.7	35.8	33.3	35.6	34.7
RCH.134	36.6	34.0	33.7	34.1	37.3	<b>35.1</b>
RCH.138	31.5	33.2	35.6	31.6	32.8	32.9
RCH.317	32.6	34.2	37.6	32.2	34.2	34.1
Variety Check	33.5	32.4	35.0	33.6	37.5	34.4
CD at 5%	0.8	0.4				
CV %	1.5	0.8				

### MEAN LINT INDEX (g)

The lint index was the highest in MRC.6301 Bt (5.3), RCH. 134 Bt (4.9 g) Ankur **non-Bt** 2226 (4.9 g) hybrids and did not vary much amongst the test Bt hybrids.

### MEAN LINT INDEX (g)

Entry	Faridkot	Ludhiana	Hisar	Sirsa	Mean
Ankur.651Bt	4.1	4.3	4.1	4.3	4.2
Ankur.2226Bt	4.6	4.1	4.5	4.6	4.4
Ankur.2534Bt	4.9	4.7	4.1	4.4	4.5
MRC.6301Bt	5.6	5.1	5.3	5.1	<b>5.3</b>
MRC.6304Bt	4.4	4.8	4.2	4.2	4.4
RCH.134Bt	4.7	5.0	4.8	5.1	<b>4.9</b>
RCH.138Bt	4.3	4.6	4.3	3.6	4.2
RCH.317Bt	4.8	4.5	4.6	4.4	4.6
LHH.144	4.9	5.0	5.0	4.4	4.8
Om Shankar	4.1	4.4	4.0	3.6	4.0
MECH.162Bt check	4.7	4.8	4.9	4.1	4.6
Ankur.651	4.2	4.5	4.3	3.5	4.1
Ankur.2226	5.5	5.3	4.7	4.3	<b>4.9</b>
Ankur.2534	4.6	4.9	4.2	4.3	4.5
MRC.6301	4.8	4.8	4.9	4.5	4.7
MRC.6304	4.5	4.6	4.7	4.0	4.4
RCH.134	5.7	5.2	5.1	4.1	<b>5.0</b>
RCH.138	4.4	4.8	4.5	3.8	4.4
RCH.317	4.6	4.5	4.4	4.3	4.5
Variety Check	4.3	4.1	4.1	3.7	4.0
CD at 5%	0.2	0.6		0.5	
CV %	2.3	8.3		6.8	

## MEAN SEED INDEX (g)

The seed index ranged from 8.2 to 9.4 in test hybrids. The check hybrids recorded more than 9 g, as given in the table below. Some of the test entries have a good combination of high lint index and good seed index as in RCH.134Bt hybrid.

### MEAN SEED INDEX (g)

Entry	Faridkot	Ludhiana	Sriganganagar	Hisar	Sirsa	Mean
Ankur.651Bt	8.4	8.4	8.1	8.2	7.8	8.2
Ankur.2226Bt	9.1	7.7	8.4	8.9	8.3	8.5
Ankur.2534Bt	9.9	9.4	8.6	8.4	8.1	8.9
MRC.6301Bt	10.1	10.0	9.0	9.5	8.4	9.4
MRC.6304Bt	9.2	9.9	8.7	9.9	8.4	9.2
RCH.134Bt	9.5	9.7	9.2	9.0	8.4	9.1
RCH.138Bt	9.0	9.5	9.4	9.0	7.2	8.8
RCH.317Bt	9.3	8.6	9.5	8.8	8.1	8.8
LHH.144	10.7	10.4	10.3	10.6	9.8	10.4
Om Shankar	8.2	8.8	7.8	7.5	6.2	7.7
MECH.162Bt check	9.1	9.6	9.6	9.1	7.5	9.0
Ankur.651	7.7	8.6	9.2	8.5	6.6	8.1
Ankur.2226	9.6	10.0	8.0	9.1	8.4	9.0
Ankur.2534	9.4	8.9	8.7	8.7	7.6	8.7
MRC.6301	10.2	9.5	8.7	9.5	8.1	9.2
MRC.6304	8.4	9.1	10.1	9.3	7.1	8.8
RCH.134	9.9	10.2	10.5	9.8	6.9	9.4
RCH.138	9.7	9.6	9.9	9.6	7.8	9.3
RCH.317	9.6	8.6	10.6	9.4	8.2	9.3
Variety Check	8.6	8.6	7.1	8.1	6.1	7.7
CD at 5%	0.1	1.3			0.5	
CV %	0.8	8.3			3.7	

## SEED COTTON YIELD

The seed cotton yield of Bt test hybrids was significantly superior to their non-Bt counterparts as well as to check hybrids. In Plant Breeding evaluation, the highest yield was recorded in RCH.138 Bt (3369 kg/ha) plots followed by RCH.134 Bt (3208 kg/ha) and MRC. 6301 Bt (3001 kg/ha) in this zone. RCH.134 and RCH.138 Bt hybrids were found to perform the best at Ludhiana even in spite of a bad season in general in this evaluation. Considering the poor crop conditions of the experimental plots of Ludhiana, if we exclude the yield data of this centre, it is found that RCH.138 Bt (3508 kg/ha) plots followed by RCH.134 Bt (3451 /ha) and MRC. 6301 Bt (3254kg/ha) and Ankur-2226Bt (3217 kg/ha)in this zone.

In general, the Bt test hybrids seem to have performed well under protected conditions in all centres except at Ludhiana, where the experiment suffered mortality due to “parawilt” syndrome.

### SEED COTTON YIELD (kg/ha)

Entry	Faridkot	Ludhiana	Sri ganganagar	Hisar	Sirsa	Mean	Mean without Ludhiana data
Ankur.651Bt	3776	1641	2222	2785	2933	2671	2929
<b>Ankur.2226Bt</b>	3739	581	2802	2771	3556	2690	<b>3217</b>
Ankur.2534Bt	3055	770	2630	2469	3090	2403	2811
<b>MRC.6301Bt</b>	<b>3476</b>	<b>1993</b>	<b>2457</b>	<b>3443</b>	<b>3638</b>	<b>3001</b>	<b>3254</b>
MRC.6304Bt	3707	608	2599	1893	2424	2246	2656
<b>RCH.134Bt</b>	<b>3814</b>	<b>2236</b>	<b>3173</b>	<b>3416</b>	<b>3400</b>	<b>3208</b>	<b>3451</b>
<b>RCH.138Bt</b>	<b>3644</b>	<b>2810</b>	<b>3407</b>	<b>3484</b>	<b>3498</b>	<b>3369</b>	<b>3508</b>
RCH.317Bt	3159	1821	2611	2634	3250	2695	2913
LHH.144	3306	577	1420	1303	2632	1848	2165
Om Shankar	3583	669	1105	1468	2447	1854	2151
MECH.162Bt check	2801	918	1130	1193	2123	1633	1812
Ankur.651	3295	517	1278	1646	2477	1843	2174
Ankur.2226	3557	692	1580	1674	2853	2071	2416
Ankur.2534	3048	695	1475	1468	2842	1906	2208
MRC.6301	3155	709	1438	1303	2512	1823	2102
MRC.6304	3276	521	586	1193	2661	1648	1929
RCH.134	3473	831	877	1660	2770	1922	2195
RCH.138	3004	1025	1111	1331	2776	1849	2056
RCH.317	3385	441	698	1413	2687	1725	2046
Variety Check	3297	446	2000	1975	2185	1981	2364
CD at 5%	389	243	351	230	469		
CV %	6.97	14.6	11.55	12.5	10		

Stability of seed cotton yield of the second year trial of the candidate entries was analysed by the given formula:  $\text{mean} - \text{SD} / \text{max.value} \times 100$ . This measures the effect of environment (location) on the genotypes. RCH.138 (87.69%), RCH.134 (76.56%), RCH.317 (76.34%), MRC.6301 (70.3%) and Ankur.651 (64.34%) Bt hybrids showed the best stability, as seen in the following table. These hybrids seem to be more adapted than the others in the North zone.



### Stability Parameter of Bt hybrids over five locations

Genotypes	Sirsa	Faridkot	Ludhiana	Hisar	Sriganganagar	Mean	Mean Square	Stability Parameter (%)
RCH.138Bt	3498	3644	2810	3484	3407	<b>3369</b>	34091	87.39
RCH.134Bt	3400	3814	2236	3416	3173	<b>3208</b>	82893	76.56
RCH.317Bt	3250	3159	1821	2634	2611	<b>2695</b>	45733	76.34
MRC.6301Bt	3638	3476	1993	3443	2457	<b>3001</b>	196574*	70.30
Ankur.651Bt	2933	3776	1641	2785	2222	<b>2671</b>	58399	64.34
Ankur.2534Bt	3090	3055	770	2469	2630	<b>2403</b>	290673*	60.32
Ankur.2226Bt	3555	3739	581	2771	2802	<b>2689</b>	336522*	56.40
Ankur.2534	2842	3048	695	1468	1475	<b>1906</b>	47574	55.38
Ankur.2226	2853	3557	692	1673	1580	<b>2071</b>	12658	55.06
Ankur.651	2478	3295	517	1646	1278	<b>1843</b>	11735	52.65
MRC.6301	2512	3155	708	1303	1438	<b>1823</b>	44917	51.06
LHH.144	2632	3307	577	1303	1420	<b>1848</b>	43893	49.55
RCH.138	2776	3004	1025	1330	1111	<b>1849</b>	152951	48.53
MECH.162Bt check	2123	2801	918	1193	1130	<b>1633</b>	76635	48.42
Variety Check	2185	3297	447	1975	2000	<b>1981</b>	169462*	47.60
MRC.6304Bt	2423	3707	608	1893	2599	<b>2246</b>	340889*	44.84
RCH.134	2770	3473	831	1660	877	<b>1922</b>	162327*	43.74
Om Shankar	2447	3583	669	1468	1105	<b>1854</b>	98636	42.98
RCH.317	2687	3385	441	1413	698	<b>1725</b>	129034	40.35
MRC.6304	2661	3276	520	1193	586	<b>1647</b>	196564*	36.74

### Fibre quality

The fibre quality data of the various test entries are provided in the following table. 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 and accepted by the industry, the ratio of tenacity to length shall be 0.8 and above. RCH.134Bt, RCH. 138Bt and Ankur.651 stand

superior over others in terms of ratio of fibre tenacity to span length as well as micronaire values.

### Fibre quality parameters of the test Bt hybrids

Entry	2.5 SPAN LENGTH (L) (mm)	Tenacity (T) (g/tex)	T/L	Micronaire	Uniformity ratio (%)
<b>Ankur.651Bt</b>	<b>27.9</b>	<b>22.2</b>	<b>0.80</b>	<b>4.2</b>	<b>46</b>
Ankur.2226Bt	27.2	21.5	0.79	4.2	48
ANkur.2534Bt	27.9	21.8	0.78	3.8	46
MRC.6301Bt	27.6	21.4	0.78	4.9	49
MRC.6304Bt	29.6	23.0	0.78	3.9	46
<b>RCH.134Bt</b>	<b>26.9</b>	<b>22.0</b>	<b>0.82</b>	<b>4.6</b>	<b>49</b>
<b>RCH.138Bt</b>	<b>27.7</b>	<b>22.9</b>	<b>0.83</b>	<b>4.2</b>	<b>49</b>
RCH.317Bt	29.3	22.9	0.78	4.3	47
LHH.144	28.1	22.8	0.81	4.6	49
Om Shankar	27.2	21.3	0.78	4.8	49
MECH.162Bt check	25.5	20.2	0.79	5.0	50
Ankur.651	28.2	21.7	0.77	4.6	46
Ankur.2226	27.9	20.8	0.75	4.6	46
Ankur.2534	28.5	22.3	0.78	4.2	47
<b>RCH.134</b>	<b>27.2</b>	<b>21.7</b>	<b>0.80</b>	<b>4.6</b>	<b>49</b>
RCH.138	28.4	22.2	0.78	4.0	49
RCH.317	29.2	22.9	0.78	4.2	48
MRC.6301	28.0	21.9	0.78	4.4	48
Variety Check	26.0	20.0	0.77	4.9	49

### Details of 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 as and when they crossed economic injury level are provided herein.

The general pressure of pests seemed to be low, since it can be seen that the sprayings of insecticides in any hybrid was taken up only up to 70-80 days. Both sap sucking pests and bollworms built up even on non-Bt hybrids and check varieties at later stages only. 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 critically the exact effectiveness of gene action of these genetically modified hybrids in north zone under the pest-free season.

The Bt test entries were not sprayed at Faridkot with any insecticides for bollworm management through out the experimental duration as the damage did not cross ETL. However, at Ludhiana, there was high incidence of sap sucking insects and all Bt test

entries were subjected to two applications of Imidachloprid 200 SL in June and July followed by Methyl demeton in September. The Bt entries were sprayed on a weekly basis for ETL based damage due to bollworms with Thiodan 35 EC in the end of August, Quinalphos 25 EC in the first week of September followed by Indoxacarb 15 EC for MRC.6301Bt, MRC.6304 Bt, RCH.317Bt and Ankur-651Bt on 13<sup>th</sup> September.

At Hisar, Quinalphos 25 EC was applied in MRC.6304Bt, RCH.317Bt, Ankur-651Bt (which also had a spray of Fenvalerate on 13<sup>th</sup> September) in the last week of September. The details are given in the table. The Bt entries were affected by Tobacco caterpillar (*Spodoptera litura*) against which there is no protection from Cry 1 A(c) protein. While Bt entries had one round of spray against this pest, there was no need for any insecticide for their protection against bollworms, due to their low incidence in these entries. However, non-Bt entries had to be protected with four rounds of fenvalerate, quinalphos, endosulfan, chlorpyrifos were the insecticides that were used at hisar for bollworm management at recommended doses, according to their incidence and damage above economic threshold.

At Sriganagar, the sap sucking pest management was the first round of spray followed by Acetamiprid + Neem or Endosulfan in the second round of spray in Bt entries. The third and fourth rounds of sprayings were only for non-Bt and check hybrids.

At Sirsa, the plant protection measures were carried out only against bollworms based on the fruiting bodies damage (either square or bolls) when crossed the ETL of 5% in any one of the replication. The entries RCH.2Bt, RCH.138 (non-Bt) and RCH.134 (non-Bt) crossed ETL two times, needing two sprays of insecticides against bollworms. In most of the entries only one spray against bollworms was given except RCH.134Bt, RCH.317Bt, MRC.6301Bt, Ankur-2543Bt, RCH.138Bt and the local check H.1117, which received no spray throughout the crop season. No spray has been done for management of sucking pests as they did not cross ETL at Sirsa.

The details of the spraying pattern in each centre on test entries as well as consolidated picture of plant protection during 2004 *kharif* season is given below. There was variation in the incidence of sap sucking insects and bollworms that crossed threshold levels. It is seen that the RCH.134Bt and Ankur.2226Bt had only one spraying against bollworms in this zone. However, the Bt hybrids that were susceptible to sap sucking pests had to be sprayed with suitable insecticides, as given below. However, in Sirsa there was no need of spraying against sap sucking insects.

**Number of sprayings undertaken in different Bt and non Bt genotypes under PROTECTED conditions**

Entry	Faridkot			Ludhiana			Sri ganganagar			Hisar			Sirsa		
	SP	BW	total	SP	BW	total	SP	BW	total	S P	BW	total	S P	BW	total
Ankur-651Bt	1	1	2	1	4	5	1	1	2	1	1	2	-	1	1
Ankur-2226Bt	1	1	2	1	2	3	2		2	1	0	1	-	-	-
Ankur-2534Bt	1	0	1	1	3	4	1		1	1	2	3	-	-	-
MRC.6301Bt	1	1	2	2	4	6	1	1	2	3	0	3	-	-	-
MRC.6304Bt	1	1	2	1	4	5	1		1	1	1	2	-	1	1
RCH.134Bt	1	1	2	2	2	4	1	1*	2	3	0	3	-	-	-
RCH.138Bt	1	1	2	2	3	5	2		2	2	1	3	-	-	-
RCH.317Bt	1	1	2	2	4	6	2		2	2	1	3	-	-	-
LHH.144	2	5	7	1	4	5	1#	1	2	2	3	5	-	1	1
Omshankar	3	5	8	2	3	5	2		2	1	4	5	-	1	1
MECH.162Bt check	1	5	6	2	3	5		2	2	3	4	7	-	1	1
Ankur-651	2	5	7	1	4	5	-	-	-	2	4	6	-	2	2
Ankur-2226	1	5	6	1	5	6	3*#	1	4	2	3	5	-	-	-
Ankur-2534	1	5	6	2	5	7	1#	1	2	1	4	5	-	-	-
MRC.6301	1	5	6	1	4	5	1#		1	1	3	4	-	1	1
MRC.6304	3	5	8	2	4	6		2	2	2	4	6	-	1	1
RCH.134	2	5	7	1	2	3	-	-	-	1	3	4	-	1	1
RCH.138	3	5	8	1	4	5	2*		2	1	4	5	-	1	1
RCH.317	2	5	7	2	4	6	1#	1	2	1	3	4	-	1	1
Variety Check	2	5	7	2	5	7	-	-	-	2	4	6	-	-	-

#- spraying for whitefly (Triazophos), \* - spraying of 10% neem seed kernel extract

**Mean number of sprays in the zone in all entries in second year**

Entry	Sap sucking pests	Bollworms	Total
Ankur-651Bt	0.83	1.60	2.40
Ankur-2226Bt	1.00	1.00	2.00
Ankur-2534Bt	0.83	1.70	2.25
MRC.6301Bt	1.70	1.50	3.25
MRC.6304Bt	0.83	1.75	2.20
RCH.134Bt	1.70	1.00	2.75
RCH.138Bt	1.50	1.70	3.00
RCH.317Bt	1.50	2.00	3.25
LHH.144	1.40	2.80	4.00
Omshankar	1.50	3.25	4.20
MECH.162Bt check	1.80	3.00	4.20
Ankur-651	1.40	3.75	5.00
Ankur-2226	1.20	3.50	5.25
Ankur-2534	1.00	3.75	5.00
MRC.6301	0.80	3.25	3.40
MRC.6304	1.80	3.20	4.60
RCH.134	1.00	2.75	3.75
RCH.138	1.20	3.50	4.20
RCH.317	1.20	2.80	4.00
Variety Check	1.60	4.67	6.667

# PLANT PROTECTION EVALUATION

In this evaluation, the eight test Bt hybrids were tested under **unprotected conditions for bollworms and other lepidopterous insects** so as to find out the performance of the Cry 1 A(c) gene action in them. In general, bollworm pressure was low in this zone during this season. However, the presence of *Spodoptera litura* (Tobacco caterpillar) in certain centres such as Hisar was seen, although this gene product does not have any toxic effect on this species of pest. Sap sucking pests were found to be at the high in Ludhiana followed by Hisar, Sriganagar and Faridkot. The least population was seen in Sirsa. Whitefly population was quite high (17-18 times that of other centres) at Sriganagar. Incidentally, the Cotton leaf curl virus disease was also in full expression in this centre only during this season. The role of viruliferous whitefly population that was built up in this centre seems to have direct relationship with the epidemiology of the virus disease in these entries.

Under protected (Breeding evaluation) and unprotected conditions (Plant Protection evaluation), the performance of test hybrids against prominent pests such as leaf hoppers (jassids), whitefly amongst sap sucking insects and all the bollworm species was evaluated by the Entomologists of these centres. The incidence of diseases in the test hybrids was recorded and interpreted by the Plant Pathologists. 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 impact of this disease in hirsutum cotton cultivation has been under constant review and monitoring in this zone.

## Entomology Evaluation

The Entomology evaluation was targeted primarily to test the action of Cry IA (c) gene in eight Bt 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* Boisduval**

**AMERICAN BOLLWORM – *Helicoverpa armigera* Hubner**

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

There was only minor incidence of bollworms, in general. The Pink bollworm, in particular, was low in population during *Kharif* 2004 season too. 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.

At Faridkot, the open boll damage, an indicator of Pink bollworm infestation, in non-Bt hybrids was below 1% in Bt test hybrids. However, in MECH.132 Bt, it was 7.76%. Similar trend was seen at Hisar and Sirsa too (see Table on Page 24). However, the picture at Sriganaganagar and Ludhiana was different. The entire test Bt hybrids had a range between 14-42% open boll damage at Ludhiana while that at Sriganaganagar was of the range 7 to 30%. The check Bt hybrids had a range between 25-60% open boll damage. Averaging out of the damage data across the zone is not logical under different population levels of Pink bollworm in the five test locations. However, the damage due to other bollworms was well below 5% at all the centers in test Bt entries, as seen from the damage data on squares, green bolls and loculi, while Check Bt hybrids suffered due to these bollworms above 10% in this respect (Table on Page 24).

### Bollworm damage in test entries

Entry	Faridkot				Ludhiana				SNGR				Hisar				Sirsa			
	% Square damage	% Green boll damage	% Locule damage	% Open boll damage	% Square damage	% Green boll damage	% Locule damage	% Open boll damage	% Square damage	% Green boll damage	% Locule damage	% square damage	% Open boll damage	% Green boll damage	% Locule damage	% Open boll damage	% Square damage	% Green boll damage	% Locule damage	% Open boll damage
Ankur-651Bt	0.9	0.0	0.2	0.5	0.3	0.0	12.4	30.2	1.32	30.83	6.5	-	13.7	2.4	1.4	4.0	1.1	0.9	0.5	1.4
Ankur-651	15.2	1.1	6.8	16.5	2.0	0.8	26.0	52.8	3.33	27.49	15.8	-	28.3	6.5	8.3	19.2	0.7	2.0	3.8	2.7
Ankur-2226Bt	3.6	0.0	0.7	1.7	0.8	0.0	9.4	14.0	1.24	12.49	6.0	-	11.7	2.1	1.6	3.9	0.7	2.2	0.5	1.5
Ankur-2226	8.4	3.3	5.9	12.4	1.4	0.8	33.3	59.4	5.63	31.66	22.5	-	61.7	7.6	9.8	20.8	1.3	2.4	4.2	3.7
Ankur-2534Bt	4.4	0.0	0.8	2.0	1.0	0.0	10.2	20.2	1.25	33.46	2.0	-	6.7	1.7	2.8	4.7	0.5	1.1	0.5	0.5
ANkur-2534	8.8	0.0	4.4	13.1	1.7	0.0	28.4	49.6	3.96	38.33	21.3	-	59.3	6.4	5.7	16.0	1.1	2.0	2.1	2.3
MRC.6301Bt	0.0	1.1	0.9	2.1	0.9	4.2	16.5	42.1	1.11	19.16	11.9	-	18.3	1.9	1.5	4.1	0.7	2.4	0.5	0.5
MRC.6301	12.8	4.5	6.5	19.7	1.7	0.0	28.2	52.4	5.23	49.99	17.0	-	35.0	6.5	8.2	13.2	1.1	2.1	3.6	2.9
MRC.6304Bt	1.4	0.0	0.2	0.7	0.2	0.0	9.4	23.9	1.8	31.66	9.2	-	23.3	1.9	1.3	3.9	1.0	1.3	0.5	1.3
MRC.6304	10.5	2.2	5.5	15.7	1.0	0.0	29.7	58.0	4.16	38.43	17.7	-	51.7	7.8	6.5	13.9	1.3	2.2	2.9	3.0
RCH.134Bt	1.6	0.0	0.4	0.9	1.9	0.0	16.0	37.5	0.88	14.66	3.7	-	11.7	2.6	1.0	2.6	0.7	1.6	0.5	1.4
RCH.134	6.4	0.0	7.2	17.7	1.9	0.0	34.8	68.6	2.23	54.16	22.4	-	55.0	6.6	9.7	23.8	0.9	2.1	5.3	2.7
RCH.138Bt	8.7	0.0	0.3	0.8	2.3	0.0	10.0	25.5	1.5	21.34	13.3	-	30.0	1.4	1.7	5.4	1.4	1.2	0.5	1.8
RCH.138	10.6	1.1	4.8	12.0	2.0	0.8	28.7	55.1	6.23	41.26	20.6	-	60.1	7.0	8.1	19.1	1.1	2.2	2.8	0.9
RCH.317Bt	0.0	2.2	0.3	0.6	1.0	0.0	17.5	40.3	1.8	22.25	8.3	-	15.0	2.3	1.3	4.0	0.6	1.4	0.5	1.1
RCH.317	4.9	0.0	5.6	13.5	1.8	0.8	30.4	60.3	4.53	18.49	18.7	-	41.7	6.7	9.2	14.4	0.9	2.0	1.3	3.7
LHH.144	7.3	3.3	5.0	13.3	3.8	0.8	36.2	58.7	8.07	72.49	9.6	-	26.7	6.6	8.4	19.0	1.2	2.3	1.2	1.3
Omshankar	9.4	0.0	6.3	12.2	1.8	0.8	24.7	55.4	5.88	29.99	24.2	-	66.7	8.0	8.4	21.9	1.2	1.8	0.5	3.3
MECH.162Bt check	11.9	0.0	2.9	6.8	1.8	0.0	20.7	50.1	2.34	34.99	10.2	-	25.0	7.8	6.7	18.9	1.2	1.4	3.9	2.4
Variety Check	21.8	3.3	13.0	22.0	1.3	0.8.3	37.3	62.9	5.31	74.16	15.1	-	48.3	6.1	9.5	19.9	0.9	2.0	4.7	4.4
CD at 5%					6.1	3.9	3.8	4.9	2.0	6.9	(4.2)		(7.1)	2.7	4.3					
CV %										8.2	7.1		12.3		11.3	11.3				

The sap sucking pests were quite severe in Ludhiana in all the test entries. However, in general, the jassid population was low in other centres and with adequate protection with suitable insecticides, their damage was restricted. However, the whitefly population of Sriganaganagar was seen to be quite high in all the test entries. There seems to be a good correlation between this data and Cotton leaf curl virus disease in this centre and the low profile of the disease in other centres seems to be due to low population of viruliferous whitefly population in adequate numbers. This discussion shall be further seen in Plant Pathology section.

### Sap sucking insects population (Unprotected)

Entry	Faridkot		Ludhiana		Sriganaganagar		Hisar	Sirsa	
	Jassid	Whitefly	Jassid	Whitefly	Jassid	Whitefly	Jassid	Jassid	Whitefly
Ankur-651Bt	0.6	1.1	2.0	2.6	0.7	17.8	1.3	0.5	1.1
Ankur-2226Bt	0.8	1.0	1.8	2.5	0.9	14.7	1.4	0.6	1.1
Ankur-2534Bt	0.5	1.0	2.1	3.0	0.7	16.4	1.2	0.8	1.2
MRC.6301Bt	0.5	1.1	2.2	2.9	0.8	13.9	1.2	0.5	1.2
MRC.6304Bt	0.4	0.8	1.9	3.0	0.5	15.2	1.3	0.5	1.2
RCH.134Bt	1.0	0.6	2.8	3.3	0.5	16.7	1.3	0.6	1.4
RCH.138Bt	0.6	0.9	2.1	3.0	0.8	19.7	1.3	0.5	1.3
RCH.317Bt	0.9	0.9	2.5	2.9	0.9	18.1	1.4	0.5	1.2
LHH.144	0.4	0.8	2.2	2.9	1.0	11.9	1.2	0.5	1.2
Om Shankar	0.7	1.2	2.4	3.1	0.7	17.0	1.1	0.5	1.2
MECH.162Bt check	1.0	1.2	2.3	2.9	0.7	14.1	1.4	0.6	1.3
Ankur-651	0.7	1.1	2.3	3.1	0.7	18.3	1.3	0.5	1.5
Ankur-2226	0.6	0.8	2.5	3.3	0.7	14.5	1.7	0.5	1.4
Ankur-2534	0.6	1.1	2.3	2.9	0.7	11.7	1.2	0.6	1.3
MRC.6301	0.7	1.0	2.3	2.7	1.1	17.1	1.2	0.7	1.3
MRC.6304	0.6	0.9	2.4	3.0	0.6	17.5	1.3	0.5	1.1
RCH.134	0.6	0.7	2.5	3.1	0.6	16.1	1.0	0.6	1.3
RCH.138	0.6	0.8	2.2	3.0	1.0	13.8	0.9	0.5	1.3
RCH.317	0.7	1.0	2.3	3.1	0.8	13.1	1.4	0.6	1.4
Variety Check	0.4	0.9	2.3	3.2	0.5	15.2	1.4	0.6	1.4
CD at 5%			0.3	NS					

Under unprotected condition, the highest seed cotton yield was recorded in RCH.134 Bt (2847 kg/ha) & RCH.138 (2795 kg/ha) hybrids followed by RCH.317 (2474 kg/ha). The significant point to be noticed was that all the non-Bt hybrids



as well as Bt check hybrid yielded between 1265 to 1747 kg/ha, much below the seed cotton yield from Bt test hybrids.

The Bt check hybrids yielded poor under unprotected conditions with 1173 kg/ha for MECH.162Bt. When the Ludhiana yield data is excluded and seen, the yield levels rise up to 2997 kg/ha followed by RCH.138Bt (2928 kg/ha) and RCH.317Bt (2687 kg/ha) and MRC.6301Bt (2724 kg/ha).

### Seed cotton yield (Kg/ha) (Unprotected)

	Entry	Faridkot	Ludhiana	Sri ganganagar	Hisar	Sirsa	Mean	Mean without Ludhiana data
1	Ankur-651Bt	3466	1058	2172	2359	2014	2214	2503
2	Ankur-2534Bt	2872	949	2345	1756	2517	2088	2372
3	Ankur-2226Bt	3356	742	2142	2222	2688	2230	2602
4	<b>MRC.6301Bt</b>	3283	1334	2530	2305	2778	2446	<b>2724</b>
5	MRC.6304Bt	3323	852	1827	1632	1320	1791	2026
6	<b>RCH.134Bt</b>	3582	2251	2678	3237	2489	<b>2847</b>	<b>2997</b>
7	<b>RCH.138Bt</b>	3374	2260	2839	2730	2771	<b>2795</b>	<b>2928</b>
8	<b>RCH.317Bt</b>	3021	1619	2617	2222	2889	<b>2474</b>	<b>2687</b>
9	MECH.162Bt check	2009	808	888	960	1202	1173	1265
10	LHH.144	2292	492	1703	1193	1799	1496	1747
11	Om Shankar	2277	508	728	1385	1736	1327	1532
12	Ankur-651	2356	322	709	905	2025	1263	1499
13	Ankur-2226	2676	449	734	1344	1556	1352	1578
14	Ankur-2534	2344	386	839	1331	1688	1318	1550
15	MRC.6301	2186	243	975	1139	2167	1342	1617
16	MRC.6304	2426	332	561	905	1254	1096	1287
17	RCH.134	2207	428	919	1550	2181	1457	1714
18	RCH.138	2146	533	1074	1139	1813	1341	1543
19	RCH.317	2225	423	703	1166	1834	1270	1482
20	Variety Check	1774	432	722	1303	1618	1170	1354
	CD at 5%	568			269			
	CV %	12.91						

# PLANT PATHOLOGY EVALUATION

## Performance of Bt hybrids against diseases

The Bt hybrids grown under both protected (Breeding evaluation) and unprotected (Entomology evaluation) conditions were assessed for their performance against various diseases prevalent in the five North zone centres.

### Cotton Leaf Curl Virus (CLCuV) Disease

Even though cotton leaf curl virus disease has been a major source of concern for cotton cultivation in this zone for the past many years, during this year there was very little damage due to this disease in most of the centres.

In the second year trial with eight Bt hybrids only at Sriganaganagar, the check hybrid Om Shankar had 14.63 per cent plants infected by CLCuV. All other hybrids (Both Bt and Non-Bt) had 0.0 per cent (Ankur-651 Bt) to 7.89 per cent (MRC.6304 Non-Bt) plants infected by CLCuV. Even though most of the Bt plants had shown the maximum grade of 4 (four), the seed cotton yield was not affected due to the low incidence of the disease. However, the hybrids showing grade 3 to 4 may encounter severe yield loss due to heavy disease pressure.

When the two years data on the incidence of CLCuV disease on the eight Bt hybrids viz., Ankur-651 Bt, Ankur-2226 Bt, Ankur-2534 Bt, MRC.6301 Bt, MRC.6304 Bt, RCH.134 Bt, RCH.138 Bt and RCH.317 Bt were examined, except Ankur-651 Bt the rest showed susceptibility to CLCuV at Sriganaganagar. **However, all non-Bt hybrids including Ankur-651 showed susceptibility to this disease.**

**Cotton Leaf Curl disease infection in test hybrids**

Test entry	Faridkot		Ludhiana	SGNR		Hisar		Sirsa
	Plant infected %	Grade	Plant infected %	Plant infected %	Grade	Plant infected %	Grade	Plant infected %
ANKUR-651Bt	0	0	0	0.00	0	0	-	0
ANKUR-2226 Bt	0	0	0	0.92	2	0	-	0
ANKUR-2534 Bt	1.85	3	0	2.17	3	0	-	0
MRC.6301 Bt	0	0	0	2.64	4	1.79	3	0
MRC.6304 Bt	2.08	3	0	1.29	4	1.03	3	0
RCH.134 Bt	0	0	0	4.84	4	1.92	2	0
RCH.138 Bt	0	0	0	2.27	4	0	-	0
RCH.317 Bt	0	0	0	1.57	4	0	-	0
MECH.162Bt (Bt check)	1.92	3	6.3	4.01	4	3.7	1	0
LHH.144	0	0	0	0.64	2	0	-	0

OMSHANKAR	4.49	3	0	14.63	4	10.05	3	0
ANKUR-651	0	0	0	0.66	2	0	-	0
ANKUR-2226	0	0	0	2.72	4	1.89	3	0
ANKUR-2534	0	0	11	2.16	3	2.3	1	0
MRC.6301	0	0	0	2.72	4	0	-	0
MRC.6304	3.85	3	0	7.89	4	4.82	3	0
RCH.134	1.85	3	0	3.69	4	0	-	0
RCH.138	0	0	0	2.87	3	0	-	0
RCH.317	0	0	0	0.66	4	0	-	0
F 1861/H11117/RS2013	0	0	0	0.88	4	0	2	0

All entries had grade 2 infection to **bacterial blight** only at Faridkot.

## Parawilt Syndrome

Parawilt was observed on the hybrids only at the Ludhiana centre. Due to this phenomenon, the seed cotton yields of all hybrids were very much reduced in both protected and unprotected trials.

In the second year trial, Ankur-2534 Bt had maximum wilting (54.4 % in protected and 45.3 % in unprotected) followed by Ankur-2226 Bt (39.9% and 40.3 %) and the least in RCH-138 Bt (4.4 % and 3.2 %) among the Bt hybrids.

Parawilt incidence and seed cotton yield at PAU, Ludhiana

Entry	Protected		Unprotected	
	Wilt (%)	Seed Cotton Yield (Kg/ha)	Wilt (%)	Seed Cotton Yield (Kg/ha)
ANKUR-651Bt	26.0	1641	31.2	1058
ANKUR-2226 Bt	39.9	581	40.3	742
ANKUR-2534 Bt	54.4	770	45.3	949
MRC.6301 Bt	27.0	1993	28.5	1334
MRC.6304 Bt	22.1	608	30.2	852
RCH.134 Bt	10.9	2236	7.7	2251
RCH.138 Bt	4.4	2810	3.2	2260
RCH.317 Bt	11.2	1821	12.6	1619
MECH.162 Bt (Check)	8.4	918	9.9	808
LHH.144	9.2	577	9.1	492
OMSHANKAR	5.1	669	3.8	508
ANKUR-651	9.8	517	12.9	322
ANKUR-2226	9.2	692	10.8	449
ANKUR-2534	14.2	695	15.4	386
MRC.6301	9.5	709	12.7	243
MRC.6304	11.6	521	11.8	332
RCH.134	1.1	831	3.7	428
RCH.138	0.6	1025	2.2	533

RCH.317	29.3	441	7.7	423
F 1861	1.0	446	0.0	432
CD at 5%		243		205
CV (%)		14.6		15.5

## OVERALL ASSESSMENT

The Bt test hybrids have performed well in this season in the North zone. In the absence of Spotted and American bollworms pressure, there appears to be better adaptability of the best yielding hybrids in this region. The following table indicates the overall mean seed cotton yield across protected and unprotected evaluation. It indicates that there has been consistency for yield in the Bt hybrids such as RCH.134, RCH.138, MRC.6301 and Ankur-2226 Bt over their non-Bt counterparts and zonal check hybrids a variety. It is also seen that there is a reduction of micronaire value in Bt entries in comparison to their non-Bt counterparts.

### Comparative seed cotton yield of test hybrids under Protected and unprotected conditions

Entry	Plant breeding evaluation		Plant protection evaluation	
	Mean	Mean without Ludhiana data	Mean	Mean without Ludhiana data
Ankur-651Bt	2671	2929	2214	2503
Ankur-2534Bt	2690	<b>3217</b>	2088	2372
Ankur-2226Bt	2403	2811	2230	2602
<b>MRC.6301Bt</b>	<b>3001</b>	<b>3254</b>	2446	<b>2724</b>
MRC.6304Bt	2246	2656	1791	2026
<b>RCH.134Bt</b>	<b>3208</b>	<b>3451</b>	<b>2847</b>	<b>2997</b>
<b>RCH.138Bt</b>	<b>3369</b>	<b>3508</b>	<b>2795</b>	<b>2928</b>
<b>RCH.317Bt</b>	2695	2913	<b>2474</b>	<b>2687</b>
MECH.162Bt check	1848	2165	1173	1265
LHH.144	1854	2151	1496	1747
Om Shankar	1633	1812	1327	1532
Ankur-651	1843	2174	1263	1499
Ankur-2226	2071	2416	1352	1578
Ankur-2534	1906	2208	1318	1550
MRC.6301	1823	2102	1342	1617
MRC.6304	1648	1929	1096	1287
RCH.134	1922	2195	1457	1714
RCH.138	1849	2056	1341	1543
RCH.317	1725	2046	1270	1482
Variety Check	1981	2364	1170	1354

Under bollworm protection, the highest yield was for RCH.138 Bt (3369 kg/ha). The exclusion of Ludhiana yield data further brings this up to 3508 kg/ha, followed by

RCH.134Bt and MRC. 6301Bt. The highest yield of RCH.134Bt under unprotected condition and its overall performance at all locations of the zone testifies that this hybrid is very much adapted and has adequate bollworm-tolerance to retain bolls for realising the highest seed cotton yield.

The following table provides the comparative damage to fruiting forms in test hybrids as well as check entries. It is clear that there is gene action of Cry 1 A (c) in the test Bt hybrids during this season in North zone. Hybrids such as Ankur.651Bt, MRC.6301Bt and RCH.317Bt offered the best protection for the fruiting forms.

Average Boll damage in test entries during 2004 season in North zone

Entry	Mean% square damage	Mean % green boll damage	Mean % locule damage	Mean % Open boll damage
<b>Ankur-651Bt</b>	<b>0.9</b>	<b>6.8</b>	<b>4.2</b>	<b>9.9</b>
Ankur-651	5.3	7.6	12.1	23.9
Ankur-2226Bt	1.6	3.3	3.6	6.6
Ankur-2226	4.2	9.2	15.1	31.6
Ankur-2534Bt	1.8	7.3	3.3	6.8
ANKur-2534	3.9	9.3	12.4	28.1
<b>MRC.6301Bt</b>	<b>0.7</b>	<b>5.8</b>	<b>6.3</b>	<b>13.4</b>
MRC.6301	5.2	12.6	12.7	24.6
MRC.6304Bt	1.1	7.0	4.1	10.6
MRC.6304	4.2	10.1	12.4	28.5
RCH.134Bt	1.5	3.8	4.3	10.8
RCH.134	2.8	12.6	15.9	33.5
RCH.138Bt	3.5	4.8	5.1	12.7
RCH.138	5.0	10.5	13.0	29.4
<b>RCH.317Bt</b>	<b>0.9</b>	<b>5.6</b>	<b>5.6</b>	<b>12.2</b>
RCH.317	3.0	5.6	13.0	26.7
MECH.162Bt check	4.3	8.9	8.9	20.6
LHH.144	5.1	17.1	12.1	23.8
Om Shankar	4.6	8.1	12.8	31.9
Variety Check	7.3	21.4	15.9	31.5

The Pink bollworm damage, as measured through open boll damage assessment, shows that there is substantial reduction of their damage in bolls in test Bt hybrids. The check hybrids and variety had 23-31 per cent damage from this insect. The check Bt hybrid also recorded 20.6% damage.

The incidence of Cotton Leaf curl virus disease was very expressive during this season only at Sriganganagar. The significantly higher whitefly population that was recorded here in comparison to other four centres also indicates that the disease epidemiology has to be regulated right from early season for the suppression of whitefly build up. The

disease could be appropriately managed in case there is an effective planning to contain the vector population in the crop under normal conditions.

Yet another dimension that emerged in Pathological observations was of the incidence of Parawilt at Ludhiana in almost all entries due to abnormal climatic conditions. The seed cotton yield was seen to be reduced due to this syndrome in most of the entries. RCH.134 and 138 Bt hybrids were found to suffer less and hence yielded the best at this centre.

# **Combined report for first & Second year (8 Bt hybrids)**

## Combined report for two seasons-2003 & 2004 *kharif*

The significant points that emerged during the two year evaluations of the eight Bt hybrids from M/S Ankur Seeds Ltd., Mahyco Seeds Ltd. and M/S Rasi Seeds Ltd. (vide ICAR letter No.2(8)/2003-C.C.I. dated 25.4.2003) in the North Zone AICCIP centers, are given below.

The yield determining parameters of the test Bt hybrids show that there is consistency in most of the parameters that were subjected to analysis. The number of nodes on the first sympode, its mean length, mean number of fruiting points, total boll number per plant, boll weight, Ginning put turn, Lint and seed index as well as Seed Cotton yield were compared for two years and are given in Tables below. The RCH.134Bt and RCH.138Bt hybrids were found to be consistent in seed cotton yield in both in unprotected and protected conditions in North zone, as seen in the table on Page.36.

The data shows that there is no variation between the two seasons in most of these parameters in the eight test hybrids. It was significant to note that the seed cotton yield of the current season was quite superior to that of the last year. The seed cotton yield superiority of RCH.134 and RCH.138 Bt hybrids over the rest of the test hybrids was consistent. The fibre properties also showed consistency during the two years in these two hybrids. In general, 2004 season was more favourable for stable fibre tenacity values and consequently, the ratio between tenacity and length was near 0.80 in most of the cases, unlike last year.

Comparative fibre properties of two years

Name of entry	2.5% Span length in mm (L)		Tenacity (g/tex) (T)		Ratio of T/L		Micronaire
	2003	2004	2003	2004	2003	2004	2004
Ankur-651 Bt	28.6	28.0	20.9	22.2	0.73	0.79	4.2
Ankur-2226 Bt	27.3	27.1	20.3	21.3	0.74	0.79	4.3
Ankur-2534 Bt	28.6	27.8	21.6	21.7	0.76	0.78	3.9
<b>RCH.134 Bt</b>	<b>27.6</b>	<b>28.0</b>	<b>22.3</b>	<b>21.7</b>	<b>0.81</b>	0.78	4.7
<b>RCH.138 Bt</b>	<b>27.8</b>	<b>29.3</b>	<b>22.6</b>	<b>22.9</b>	<b>0.81</b>	<b>0.81</b>	<b>4.1</b>
RCH.317 Bt	28.8	27.6	21.1	22.0	0.71	0.79	4.5
MRC.6301 Bt	28.8	27.7	21.4	22.9	0.74	<b>0.83</b>	<b>4.2</b>
MRC.6304 Bt	29.1	28.6	22.3	22.9	0.76	<b>0.80</b>	4.5
RCH.2 Bt	-	28.4	-	22.3	-	0.79	4.4
MECH.162	26.8	28.4	21.1	20.7	0.78	0.79	4.9
LHH.144	28.0	26.2	21.1	22.0	0.75	0.84	4.6
Om Shankar	27.7	27.8	20.3	22.1	0.73	0.79	4.7
F.1861(Fdkt/Ludh/Sirsa)	26.9	-	21.4	-	0.80	0.79	-
H.1117(Hisar)	24.0		19.2		0.80		
RS.2013(Sriganganagar)	25.3		20.3		0.80		



The consistent performance over two years of MRC.6304, RCH.134, RCH.138, Ankur-2534 and Ankur-651 in terms of yield influencing characters as well as seed cotton yield and fibre quality shows that these hybrids are more or less stabilized for cultivation in North zone (Tables of Page 35 & 36).

**Comparative performance of Bt hybrids over the last two years for various characters**

Entry	Germination % (Plant stand)			Number of nodes in first sympodium			Mean length of first sympodium (cm)			Mean number of fruiting points/plant			Total number of bolls/plant		
	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean
ANKUR-651Bt		91.4	91.4	7.1	4.9	6.0	34.7	25.0	29.8	122.0	75.0	98.5	58.0	47.7	52.8
ANKUR-2226 Bt		90.1	90.1	8.6	4.8	6.7	40.2	22.2	31.2	100.0	63.9	81.9	50.0	49.8	49.9
ANKUR-2534 Bt		84.8	84.8	7.5	4.7	6.1	32.3	22.2	27.3	134.0	77.7	105.8	60.0	52.1	56.1
MRC.6301 Bt		85.3	85.3	8.8	4.8	6.8	31.1	25.3	28.2	134.0	89.4	111.7	51.0	47.3	49.1
MRC.6304 Bt		75.4	75.4	8.8	5.3	7.1	30.5	22.9	26.7	140.0	71.4	105.7	45.0	45.8	45.4
RCH.134 Bt		89.1	89.1	9.6	4.9	7.3	34.4	24.7	29.6	104.0	68.5	86.3	42.0	40.8	41.4
RCH.138 Bt		91.5	91.5	9.6	5.3	7.5	35.9	23.5	29.7	136.0	87.2	111.6	48.0	45.8	46.9
RCH.317 Bt		87.6	87.6	9.9	4.6	7.2	36.2	24.9	30.6	129.0	77.0	103.0	51.0	50.3	50.7
LHH.144		86.7	86.7	9.1	5.5	7.3	49.5	26.7	38.1	150.0	89.5	119.7	40.0	42.5	41.2
OMSHANKAR		86.5	86.5	9.6	5.6	7.6	39.2	26.1	32.7	138.0	69.7	103.8	42.0	42.8	42.4
MECH.162Bt (Bt check)		89.7	89.7	9.3	5.3	7.3	34.1	25.3	29.7		80.9	80.9		42.9	42.9
ANKUR-651		89.2	89.2	7.8	4.8	6.3	40.8	21.5	31.2	149.0	64.4	106.7	49.0	42.1	45.5
ANKUR-2226		90.3	90.3	8.8	5.0	6.9	37.4	25.7	31.5	127.0	60.5	93.7	43.0	39.7	41.3
ANKUR-2534		91.6	91.6	7.2	4.7	6.0	33.1	24.4	28.7	112.0	68.6	90.3	54.0	45.8	49.9
MRC.6301		86.1	86.1	8.8	5.0	6.9	40.0	27.7	33.8	133.0	79.7	106.4	36.0	43.4	39.7
MRC.6304		91.4	91.4	8.6	4.9	6.8	38.2	28.0	33.1	143.0	71.4	107.2	61.0	46.6	53.8
RCH.134		90.7	90.7	9.4	5.1	7.2	42.1	27.2	34.7	157.0	72.5	114.7	41.0	39.9	40.4
RCH.138		90.2	90.2	9.6	5.5	7.5	48.5	34.8	41.7	170.0	78.5	124.2	37.0	42.7	39.8
RCH.317		88.4	88.4	7.4	5.3	6.3	45.9	24.0	35.0	153.0	67.4	110.2	41.0	41.0	41.0

### Comparative performance of Bt hybrids over the last two years for various characters

Entry	Boll weight (g/boll)			Ginning Out Turn (%)			Lint Index (g)			Seed Index (g)			Seed Cotton Yield(Kg/ha)			Seed Cotton Yield(Kg/ha)		
	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean	Protected			Unprotected		
													2003-04	2004-05*	Mean	2003-04	2004-05*	Mean
ANKUR-651Bt	3.4	3.4	3.4	35.7	34.4	35.0	4.3	4.2	4.2	8.0	8.2	8.1	1941	2671	2306	1939	2214	2076
ANKUR-2226 Bt	4.3	3.6	4.0	34.6	34.7	34.7	4.7	4.4	4.6	8.8	8.5	8.6	2142	2690	2416	2162	2230	2196
ANKUR-2534 Bt	3.5	3.6	3.5	33.9	34.0	33.9	4.5	4.5	4.5	8.7	8.9	8.8	1945	2403	2174	1979	2088	2033
<b>MRC.6301 Bt</b>	<b>4.0</b>	<b>4.3</b>	<b>4.1</b>	<b>35.1</b>	<b>35.8</b>	<b>35.4</b>	<b>5.2</b>	<b>5.3</b>	<b>5.2</b>	<b>9.4</b>	<b>9.4</b>	<b>9.4</b>	<b>2830</b>	<b>3001</b>	<b>2916</b>	<b>2479</b>	<b>2446</b>	<b>2462</b>
MRC.6304 Bt	3.9	4.2	4.0	35.3	32.5	33.9	5.5	4.4	4.9	10.0	9.2	9.6	2103	2246	2175	2423	1791	2107
<b>RCH.134 Bt</b>	<b>3.7</b>	<b>3.9</b>	<b>3.8</b>	<b>35.3</b>	<b>35.5</b>	<b>35.4</b>	<b>4.9</b>	<b>4.9</b>	<b>4.9</b>	<b>9.0</b>	<b>9.1</b>	<b>9.1</b>	<b>3077</b>	<b>3208</b>	<b>3142</b>	<b>2440</b>	<b>2847</b>	<b>2644</b>
<b>RCH.138 Bt</b>	<b>3.4</b>	<b>3.9</b>	<b>3.6</b>	<b>32.7</b>	<b>32.7</b>	<b>32.7</b>	<b>4.4</b>	<b>4.2</b>	<b>4.3</b>	<b>9.1</b>	<b>8.8</b>	<b>9.0</b>	<b>2989</b>	<b>3369</b>	<b>3179</b>	<b>1881</b>	<b>2795</b>	<b>2338</b>
<b>RCH.317 Bt</b>	<b>3.6</b>	<b>3.5</b>	<b>3.6</b>	<b>34.4</b>	<b>34.6</b>	<b>34.5</b>	<b>4.5</b>	<b>4.6</b>	<b>4.5</b>	<b>6.5</b>	<b>8.8</b>	<b>7.7</b>	<b>2922</b>	<b>2695</b>	<b>2808</b>	<b>2652</b>	<b>2474</b>	<b>2563</b>
LHH.144	4.5	4.5	4.5	31.6	31.9	31.8	4.8	4.8	4.8	10.5	10.4	10.4	1574	1848	1711	1190	1496	1343
OMSHANKAR	3.1	3.6	3.3	33.8	34.8	34.3	4.0	4.0	4.0	8.0	7.7	7.8	1683	1854	1769	1234	1327	1280
MECH.162Bt (Bt check)	4.0	3.7	3.8	36.1	34.9	35.5	-	4.6	4.6	-	9.0	9.0	2016	1633	1825	1747	1173	1460
ANKUR-651	3.4	3.6	3.5	34.0	34.6	34.3	4.6	4.1	4.4	8.8	8.1	8.5	1869	1843	1856	1825	1263	1544
ANKUR-2226	4.3	4.2	4.3	33.2	35.4	34.3	4.8	4.9	4.9	9.3	9.0	9.2	1866	2071	1969	1746	1352	1549
ANKUR-2534	3.7	3.7	3.7	33.8	34.5	34.1	4.7	4.5	4.6	9.2	8.7	8.9	1775	1906	1840	1615	1318	1466
MRC.6301	3.7	4.0	3.8	34.5	34.3	34.4	4.3	4.7	4.5	9.2	9.2	9.2	1537	1823	1680	1380	1342	1361
MRC.6304	3.5	3.3	3.4	34.0	34.7	34.3	5.2	4.4	4.8	10.1	8.8	9.5	1140	1648	1394	1491	1096	1293
RCH.134	3.8	4.2	4.0	34.6	35.1	34.9	5.0	5.0	5.0	9.6	9.4	9.5	1866	1922	1894	1435	1457	1446
RCH.138	3.5	3.7	3.6	33.0	32.9	33.0	4.3	4.4	4.3	8.8	9.3	9.1	1630	1849	1740	907	1341	1124
RCH.317	3.3	3.3	3.3	32.5	34.1	33.3	4.5	4.5	4.5	9.2	9.3	9.2	1667	1725	1696	1406	1270	1338

\* Inclusive of Ludhiana Data

### **Plant Protection evaluation under unprotected condition for bollworms**

The various observations on the influence of sap sucking pests and bollworms on the test Bt entries were recorded in both 2003 and 2004 seasons at these five centres of North Zone. However, many of the entries are noted to be susceptible to jassids. Their build up in the initial phase as well as in the latter half of the crop season, makes plant protection imperative to contain their population. This could reduce the bollworms' natural enemy complex to build up in the crop to offer better protection of the plants against them. The conventional insecticides seem to work well of early stage pest spectrum than target specific molecules that may suppress one species and thereby may give way for the build up of other insect species such as thrips, whitefly etc.

The general bollworm population pressure was low in these centres. Within the available population during crop season, the damage due to *Earias* Spp. and *Helicoverpa* bollworms was minimal. Monitoring of effective gene action under good population pressure was not possible. However, indications from the bolls retained by the test entries *vis-à-vis* that in non-Bt as well as check hybrids definitely indicate that there is an effective protection from these bollworms due to the expression of the gene and the gene product deters damage as well as build up of these bollworms in the entries. The Pink bollworm population is not appreciable in the last quinquinum in the north zone, as was seen in earlier decades. During this testing period also, their population was quite low and did not effectively reduce the quality of lint or damage the locules to leave behind bad seed cotton. The test hybrids seemed superior in terms of the low damage to fruiting forms in comparison with their non-Bt counterparts as well as zonal and local check entries.

The appreciable build up of whitefly population at Sriganaganagar during the last season in the entries show that the viruliferous vector could build up Cotton Leaf Curl virus disease. However, the most important observation was that in cases of Grade 4 and 3 infection also, the plants infected were below 5%. This meant that the higher virulence of the virus alone is not a condition, but it has to be coupled with the plant phenology at infection.

### Cotton Leaf curl disease incidence on Bt cotton hybrids over two year period

Entry	Faridkot			Ludhiana		Sriganganagar			Hisar				Sirsa	
	2003-04	2004-05		2003-04	2004-05	2003-04	2004-05		2003-04		2004-05		2003-04	2004-05
	Plant infected %	Plant infected %	Grade	Plant infected %	Plant infected %	Plant infected %	Plant infected %	Grade	Plant infected %	Grade	Plant infected %	Grade	Plant infected %	Plant infected %
ANKUR-651Bt	0	0	0	0	0	0	0.00	0	0	-	0	-	0	0
<b>ANKUR-2226 Bt</b>	0	0	0	0	0	0	<b>0.92</b>	2	0	-	0	-	0	0
ANKUR-2534 Bt	0.9	1.85	3	0	0	0.33	2.17	3	0	-	0	-	0	0
MRC.6301 Bt	0	0	0	0	0	0	2.64	4	0	-	1.79	3	0	0
MRC.6304 Bt	0	2.08	3	0	0	0	1.29	4	0	2	1.03	3	0	0
RCH.134 Bt	0	0	0	0	0	0	4.84	4	-	2	1.92	2	0	0
RCH.138 Bt	0	0	0	0	0	0	2.27	4	-	2	0	-	0	0
RCH.317 Bt	0	0	0	0	0	0	1.57	4	0	-	0	-	0	0
MECH.162Bt (Bt chk)	0	1.92	3	0	6.3	0	4.01	4	0	-	3.7	1	0	0
<b>LHH.144</b>	0	0	0	0	0	0	<b>0.64</b>	2	0	-	0	-	0	0
OMSHANKAR	39	4.49	3	S	0	12.33	14.63	4	22.0	-	10.05	3	11.9	0
<b>ANKUR-651</b>	0	0	0	0	0	0.67	<b>0.66</b>	2	0	-	0	-	0	0
ANKUR-2226	0	0	0	0	0	0	2.72	4	0	-	1.89	3	-	0
ANKUR-2534	0	0	0	0	11	0	2.16	3	34.0	-	2.3	1	G1	0
MRC.6301	0	0	0	0	0	0	2.72	4	0	-	0	-	0	0
MRC.6304	0	3.85	3	0	0	0	7.89	4	0	-	4.82	3	0	0
RCH.134	0	1.85	3	0	0	0	3.69	4	0	-	0	-	0	0
RCH.138	0	0	0	0	0	0	2.87	3	0	-	0	-	0	0
RCH.317	0	0	0	0	0	0	0.66	4	0	-	0	-	0	0
F 1861/H1117/RS2013	0	0	0	0	0	0	0.88	4	0	-	0	2	2.63	0

The salient data of 2003 season sets regarding boll damage of the eight test entries as well as their non-Bt counterparts and check hybrids are given below to prove the point that these Bt test entries were able to resist the damage to the fruiting forms during 2003. The difference in the response of Bt hybrids to the bollworm incidence amongst the eight genotypes is visible in comparison to their non-Bt counterparts as well as check hybrids.

Shoot damage by Spotted Bollworm - 2003  
(figures in parenthesis are transformed values)

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

Mean Percent Bollworms incidence in open bolls in first pick - 2003  
(Note: Figures in parentheses are n+1 arc sine transformations)

Entry 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)
<b>ANKUR---651</b>	<b>14.17 (22.10)</b>	<b>42.33 (40.56)</b>	<b>7.77 (16.17)</b>	<b>27.63 (31.62)</b>
ANKUR---2226 Bt	6.70 (14.91)	12.82 (20.96)	4.65 (12.45)	7.03 (15.32)
<b>ANKUR---2226</b>	<b>14.41 (22.25)</b>	<b>35.03 (36.26)</b>	<b>8.26 (16.68)</b>	<b>20.76 (27.09)</b>
ANKUR---2534 Bt	8.68 (17.11)	13.10 (21.10)	5.36 (13.35)	6.81 (15.04)
<b>ANKUR---2534</b>	<b>10.59 (18.95)</b>	<b>36.71 (37.23)</b>	<b>6.74 (15.03)</b>	<b>24.29 (29.49)</b>
MRC..6301 Bt	6.58 (14.79)	11.35 (19.66)	4.06 (11.60)	6.00 (14.16)
<b>MRC..6301</b>	<b>15.20 (22.85)</b>	<b>41.30 (39.90)</b>	<b>7.36 (15.69)</b>	<b>28.33 (32.01)</b>
MRC..6304 Bt	8.29 (16.68)	11.39 (19.64)	5.17 (13.12)	7.01 (15.35)
<b>MRC..6304</b>	<b>16.45 (23.89)</b>	<b>47.08 (43.31)</b>	<b>9.72 (18.15)</b>	<b>32.55 (34.74)</b>
RCH.134 Bt	6.02 (14.19)	7.99 (16.31)	3.58 (10.89)	4.29 (11.91)
<b>RCH.134</b>	<b>12.31 (20.51)</b>	<b>41.95 (40.30)</b>	<b>6.73 (15.00)</b>	<b>25.15 (30.02)</b>
RCH.138 Bt	6.36 (14.58)	7.54 (15.79)	3.97 (11.47)	4.55 (12.22)
<b>RCH.138</b>	<b>13.90 (21.86)</b>	<b>41.78 (40.13)</b>	<b>8.00 (16.40)</b>	<b>27.45 (31.29)</b>
RCH.317 Bt	6.77 (15.06)	9.12 (17.49)	4.06 (11.61)	5.33 (13.31)
<b>RCH.317</b>	<b>11.92 (20.16)</b>	<b>38.00 (38.55)</b>	<b>7.02 (15.36)</b>	<b>24.21 (29.33)</b>
MECH.162 Bt	8.04 (16.45)	10.32 (18.67)	4.95 (12.85)	6.23 (14.43)
<b>LHH.144</b>	<b>18.95 (25.71)</b>	<b>51.41 (45.79)</b>	<b>10.78 (19.11)</b>	<b>33.02 (35.01)</b>
<b>OMSHANKAR</b>	<b>14.36 (22.25)</b>	<b>39.23 (38.75)</b>	<b>7.63 (16.03)</b>	<b>29.94 (33.15)</b>
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

Damage on open boll-basis Bt and non-Bt genotypes to bollworms-2004

Hybrid entry	Unsprayed plots		Sprayed plots for sucking and bollworm pests at ET	
	% open boll damage	% Locule damage	% open boll damage	% Locule damage
ANKUR-651Bt	0.74	0.70	3.51	1.34
<b>ANKUR-651</b>	<b>27.55</b>	<b>11.25</b>	<b>7.21</b>	<b>3.30</b>
ANKUR-2226 Bt	1.56	0.38	2.27	0.67
<b>ANKUR-2226</b>	<b>22.36</b>	<b>10.15</b>	<b>6.55</b>	<b>2.63</b>
ANKUR-2534 Bt	0.73	0.17	2.72	1.20
<b>ANKUR-2534</b>	<b>12.85</b>	<b>5.36</b>	<b>13.95</b>	<b>5.47</b>
MRC.6301 Bt	0.74	0.25	1.48	0.40
<b>MRC.6301</b>	<b>20.00</b>	<b>7.85</b>	<b>8.45</b>	<b>4.21</b>
MRC.6304 Bt	3.84	2.49	2.86	1.03
<b>MRC.6304</b>	<b>12.28</b>	<b>6.57</b>	<b>9.55</b>	<b>3.58</b>
RCH.134 Bt	4.83	1.91	3.64	2.08
<b>RCH.134</b>	<b>25.85</b>	<b>10.19</b>	<b>8.45</b>	<b>4.21</b>
RCH.138 Bt	4.22	1.72	1.18	0.29
<b>RCH.138</b>	<b>29.70</b>	<b>15.23</b>	<b>7.51</b>	<b>2.91</b>
RCH.317 Bt	0.73	0.12	3.84	2.23
<b>RCH.317</b>	<b>22.29</b>	<b>10.17</b>	<b>14.21</b>	<b>6.60</b>
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 (variety check)	21.88	10.43	10.33	4.27

**Recommendation:**

1. Out of the eight Bt hybrids that have been evaluated during the last two years, RCH.134Bt, RCH.138Bt, MRC. 6301Bt and Ankur-2226Bt, appears to be high yielding and adapted for cultivation in North Zone. The fibre quality parameters of these hybrids satisfy the industry norms. It is to be noted that AICCIP released Ankur.651Bt for being cultivated in central Zone. The Ankur.651Bt hybrid was found to have minimum Cotton leaf curl disease during the two years. This hybrid is ranked sixth in seed cotton yield in the zone.
2. The susceptibility to CLCuV disease depends on the whitefly vector population and effective monitoring and in built advisory service to contain their population shall be vested with the recommendation to cultivate these hybrids widely, especially in those districts where the notoriety of disease spread is currently high. The onus to effectively suppress whitefly build up during the early season in cotton growers' fields shall be built in along while cultivating these hybrids.

Presently the varieties and hybrids that are recommended for cultivation in this zone spins only for 20s and 30s cotton. The best natural resources that are available in this zone have to be harnessed properly for achieving the maximum productivity of 50s cotton. This could be achieved only by promoting hybrids with least damage by bollworms and combined with tolerance to CLCuV. The factor productivity of cotton shall be increased, if only such hybrids with high quality fibre are cultivated at low pest and disease pressure.

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