Bt COTTON EVALUATION REPORT

TRANSGENIC COTTON HYBRIDS WITH
DELTA ENDOTOXIN Cry IA(c) GENE

CENTRAL ZONE

Submitted to
INDIAN COUNCIL OF AGRICULTURAL RESEARCH

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Executive Summary

1) The All India Coordinated Cotton Improvement Project (AICCIP) undertook the evaluation of twelve cotton hybrids possessing the Cry 1A(c) gene, expressing delta- endotoxin, an insecticidal protein from the spores of the soil bacterium, *Bacillus thuringiensis var. kurstakii* for the management of cotton bollworms, based on the ICAR letter No. 2(8)/2003-C.C.I. dated 25.4.2003 in the North Zone AICCIP centres. The trials were laid out in accordance with the protocol and following standard package of practices of cotton cultivation, of respective centres, where the evaluations were undertaken. The untreated, acid de-linted seeds of the relevant test hybrids and their non-Bt hybrids were provided by M/S Ankur Seeds Pvt. Ltd., Nagpur, M/S Rasi Seeds Pvt. Ltd., Athur and M/S Maharashtra Hybrid Company (MAHYCO) seeds Pvt. Ltd., Jalna.

2) The Breeding and Plant Protection evaluations of Ankur-09Bt, Ankur-651Bt, Ankur-2534Bt, MRC.6301Bt, MRC.6304Bt, MRC.6160Bt, RCH.2Bt, RCH.118Bt, RCH.138Bt, RCH.144Bt, RCH.335Bt & RCH.359Bt were undertaken along with their non-Bt counterparts and Bt check hybrid (MECH.162Bt) and zonal check hybrid, NHH.44 at the designated five AICCIP centers, viz., Surat, Khandwa, Nanded, Akola and Nagpur. These were evaluated at Gujarat Agricultural University, RARS, Surat, Marathwada Agricultural University, Cotton Research Station, Nanded, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Jawaharlal Krishi Vishwa Vidyalaya, RARS, Khandwa, Central Institute for Cotton Research, Nagpur. The mean value Ginning outturn ranged from 34.0% (NHH. 44) to 39.9% (Ankur-651). The Bt check hybrid MECH. 162 Bt had a Ginning outturn of 36.8 %. At Nagpur, the test hybrids MRC.6301Bt (44.8%) and Ankur-651 (43.7%) had significantly higher GOT than the best check hybrid MECH.162 Bt (36.5%). Between Bt and Non-Bt counterpart hybrids at Nagpur, there were significant differences, in hybrids *viz.*., Ankur-9, Ankur-2534, Ankur-651 and MRC. 6301.

3) American bollworm incidence in central zone began around 90-100 days of crop growth only, unlike its normal appearance of 55-65 days after germination of crop. The Bt hybrids did show their superiority in counteracting this pest, even in the late appearance of this pest. The general observation is that there was not much serious pest build up in various centres due to inclement weather conditions. However, the results provide inference about the gene action to deter bollworm damage. This affirms the fact that these evaluations are to be undertaken for more number of seasons to

get the clear picture about the performance of the test entries, as is practised in AICCIP trials.

4) The seed cotton yield at Surat and Akola was not found to be good due to abnormal climatic conditions at grand growth stage that affected the crop severely. The data on seed cotton harvest provides the best indication about the vagaries of rainfall during 2003-04 season in these centers. While Surat was hit by excess and heavy rainfall, Akola had severe drought at various crop growth periods. Hence, there was wide variability for mean seed cotton yield in the hybrids tested over five locations. The data from the other centers are reasonably good, representing the season's climatic condition of the locations.

5) Under unprotected conditions, the average seed cotton yield registered across four locations of this zone, showed that MRC.6160Bt yielded 1432 Kg/ha, followed by Ankur.09Bt with 1372 Kg/ha and RCH.359Bt with 1351 Kg/ha. It was found that RCH.359 non-Bt hybrid yielded 1332 Kg/ha seed cotton in comparison to 1043 Kg/ha, registered by Check Bt hybrid.

6) The fibre property data of the various test entries from the fibre samples of Nagpur indicate that there is no appreciable difference in the various fibre properties such as staple length, tenacity and micronaire in the test entries. In accordance with the textile requirements and CIRCOT norms, the ratio of tenacity to strength shall be around 0.8 and above. The data show that strength to length ratio for the best hybrids are not crossing beyond 0.74. This is mainly due to adverse climatic conditions.

7) Irrespective of the various degrees of disease intensity, all hybrids (Bt & Non Bt) showed susceptible reaction after 120 days to both bacterial leaf blight and myrothecium leaf spot diseases.

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Introduction

The Central Zone, comprising of Gujarat, Maharashtra, Madhya Pradesh constitute India's 40% cotton area and produce more than 50% fibre, mainly under rainfed conditions. Assured rainfall to dryland conditions prevail in these states. Cotton farmers prefer hybrids over varieties in this area due to their stable productivity. Due to uncertain climatic and edaphic factors, reduction in cost of cultivation is the primary requirement for the growers. Intense bollworm pressure and extensive increase in expenditure to effectively suppress them from cotton crop have caused the cotton growers to struggle to make both ends meet.

During 2003-04, the monsoon rains caused flooding conditions in the early part of the season, especially the western regions such as Surat and drought in centers such as Akola and Khandwa. Erratic rainfall did affect the testing results and the various parameters of evaluation were influenced due to this. However, a realistic picture about the performance of all the test hybrids is given below.

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

Centres involved:

Gujarat Agricultural University, RARS, Surat
Maratwada Agricultral University, Cotton Research Station, Nanded
Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola
Jawaharlal Krishi Vishwa Vidyalaya, RARS, Khandwa
Central Institute for Cotton Research, Nagpur

Test hybrid entries:

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

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

CENTRAL ZONE AICCIP CENTRES: Khandwa, Surat, Nanded, Akola, CICR, Nagpur

M/S Ankur Seeds Pvt. Ltd.	Ankur –09 Bt Ankur – 651 Bt Ankur – 2534 Bt
M/S Rasi Seeds Pvt. Ltd.	RCH.2 Bt RCH.138 Bt RCH.144 Bt RCH. 118 Bt RCH. 335 Bt RCH. 359 Bt
M/S Maharashtra Hybrid Seeds Co. (MAHYCO) Ltd.	MRC. 6301 Bt MRC. 6304 Bt MRC. 6160 Bt
NHH.44 (ZC) MECH.162 Bt (Bt check)	

Test entries (codes 2331-2356)	
Code	Name of entry
2331	RCH. 118 Bt
2332	RCH. 335 Bt
2333	RCH. 359 Bt
2334	Ankur – 651 Bt
2335	Ankur – 09 Bt
2336	Ankur – 2534 Bt
2337	MRC. 6301 Bt
2338	MRC. 6304 Bt
2339	MRC. 6160 Bt
2340	RCH.2 Bt
2341	RCH.138 Bt
2342	RCH.144 Bt
2343	NHH.44 (Zonal check)
2344	MECH.162 Bt (cc)
2345	RCH. 118
2346	RCH. 335
2347	RCH. 359
2348	Ankur – 651
2349	Ankur – 09
2350	Ankur – 2534
2351	MRC. 6301
2352	MRC. 6304
2353	MRC. 6160
2354	RCH.2
2355	RCH.138
2356	RCH.144

BREEDING TRIAL

DESIGN- RBD - No. of treatments :26, 2 REPLICATIONS – 6 ROWS X 6 metre rows

Plots	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
R1	31	52	39	43	33	55	47	49	34	51	46	56	54	37	40	35	41	44	53	36	38	48	42	32	45	50
R2	33	35	45	40	37	39	43	46	42	36	48	51	54	31	52	55	44	34	53	38	32	41	49	47	50	56

PLANT PROTECTION TRIAL

(Unprotected against bollworms and protection against sap sucking pests)

DESIGN-RBD - No. of treatments :26, 2 REPLICATIONS – 6 ROWS X 6 metre rows

Plots	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
R1	31	52	39	43	33	55	47	49	34	51	46	56	54	37	40	35	41	44	53	36	38	48	42	32	45	50
R2	33	35	45	40	37	39	43	46	42	36	48	51	54	31	52	55	44	34	53	38	32	41	49	47	50	56

RESULTS OF EVALUATIONS

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

BREEDING EVALUATION

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

Germination Percentage:

In general, all the hybrids had high germination percentage, as given below. The lowest mean germination percentage was noted in MRC. 6160 (77.3%), whereas, the highest mean value of 86.9% was recorded in MRC. 6301 Bt. However, 100% germination was noted in all the hybrids at CICR, Nagpur.

Germination percentage

Genotype	CRS, NANDED	CICR, NGP	JNKVV, KWA	GAU, SURAT	PDKV, AKOLA	Mean
Ankur - 09 Bt	56.5	100.0	50.8	95.0	92.5	**79.0**
Ankur - 09	49.5	100.0	72.4	100.0	100.0	**84.4**
Ankur - 651 Bt	54.5	100.0	76.7	97.5	97.5	**85.2**
Ankur - 651	38.5	100.0	82.5	98.3	90.0	**81.9**
Ankur - 2534 Bt	54.0	100.0	70.8	95.9	95.8	**83.3**
Ankur – 2534	49.0	100.0	62.5	99.2	100.0	**82.1**
MRC. 6160 Bt	51.0	100.0	74.2	98.4	95.0	**83.7**
MRC. 6160	46.5	100.0	50.8	98.3	90.8	**77.3**
MRC. 6301 Bt	55.5	100.0	82.5	98.4	98.3	**86.9**
MRC. 6301	41.0	100.0	80.0	98.4	94.2	**82.7**
MRC. 6304 Bt	54.0	100.0	73.3	96.7	96.7	**84.1**
MRC. 6304	42.0	100.0	82.5	99.2	100.0	**84.7**
RCH. 2 Bt	52.5	100.0	82.5	99.2	99.2	**86.7**
RCH. 2	41.5	100.0	74.2	98.3	87.5	**80.3**
RCH. 118 Bt	53.5	100.0	80.3	98.3	100.0	**86.4**
RCH. 118	36.5	100.0	78.3	98.4	95.8	**81.8**
RCH. 138 Bt	46.0	100.0	80.8	95.0	91.7	**82.7**
RCH. 138	46.0	100.0	76.7	95.8	99.2	**83.5**
RCH. 144 Bt	46.0	100.0	89.2	95.9	100.0	**86.2**
RCH. 144	46.0	100.0	75.0	95.9	99.2	**83.2**
RCH. 335 Bt	49.5	100.0	74.2	96.7	97.5	**83.6**
RCH. 335	39.0	100.0	65.8	99.2	95.0	**79.8**
RCH. 359 Bt	53.5	100.0	68.3	98.3	100.0	**84.0**
RCH. 359	48.5	100.0	85.1	98.4	100.0	**86.4**
MECH. 162 Bt	34.5	100.0	72.5	98.3	95.0	**80.1**
NHH. 44 (ZC)	47.0	100.0	82.5	98.4	98.3	**85.2**
CD @ 5%	--------	--------	--------	--------	--------	
CV %	--------	--------	--------	--------	--------	

Plant Height (cm):

The tallest hybrid was found to be MRC. 6160 (116.7 cm), while the shortest hybrid was RCH. 335 (73.7 cm). In check hybrids, *viz.*., NHH. 44 and MECH. 162 Bt, the mean plant height recorded was 80.2 cm and 76.5 cm, respectively. There were significant differences between Bt and corresponding Non-Bt counterparts in locations such as Khandwa and Nagpur, except in MRC. 6304, RCH. 2, RCH. 118, RCH.

138, RCH. 144 and RCH. 359. The mean plant height, as given below, shows that the Bt hybrids were generally taller than their non-Bt counterparts.

Plant Height (cm)

Genotype	CICR, NGP	JNKVV, KWA	PDKV, AKOLA	Mean
Ankur - 09 Bt	106.2	117.0	53.8	**92.3**
Ankur - 09	106.3	87.2	61.3	**84.9**
Ankur - 651 Bt	119.0	120.7	67.5	**102.4**
Ankur - 651	101.7	80.0	67.5	**83.1**
Ankur - 2534 Bt	111.1	110.7	57.5	**93.1**
Ankur - 2534	95.1	84.8	65.0	**81.6**
MRC. 6160 Bt	115.3	95.5	60.0	**90.3**
MRC. 6160	154.7	134.2	61.3	**116.7**
MRC. 6301 Bt	120.5	112.8	55.0	**96.1**
MRC. 6301	86.5	80.5	66.3	**77.8**
MRC. 6304 Bt	94.0	91.8	46.3	**77.4**
MRC. 6304	108.3	92.3	58.8	**86.5**
RCH. 2 Bt	98.5	84.7	66.3	**83.1**
RCH. 2	103.6	109.8	36.3	**83.2**
RCH. 118 Bt	117.3	78.5	57.5	**84.4**
RCH. 118	111.9	79.5	61.3	**84.2**
RCH. 138 Bt	101.2	81.5	61.3	**81.3**
RCH. 138	101.8	90.0	71.3	**87.7**
RCH. 144 Bt	144.2	111.8	92.5	**116.2**
RCH. 144	95.0	102.2	85.0	**94.1**
RCH. 335 Bt	88.8	93.5	60.0	**80.8**
RCH. 335	92.8	67.2	61.3	**73.7**
RCH. 359 Bt	99.3	90.2	65.0	**84.8**
RCH. 359	115.6	85.0	75.0	**91.9**
MECH. 162 Bt	101.1	76.0	52.5	**76.5**
NHH. 44 (ZC)	88.9	61.7	90.0	**80.2**
CD @ 5%	18.3	12.2	--------	
CV %	8.3	6.3	---------	

Number of Monopodia per Plant:

All the hybrids tested in the trial had at least one Monopodia and the maximum number was observed in RCH. 2 (with a mean value of 4.7 per plant), whereas, the minimum number was recorded in Ankur-09 Bt (with a mean value of 1.1 per plant). The following table shows

significant difference between Bt and Non-Bt counterpart hybrids were noticed in Ankur-09, MRC. 6304, RCH. 2, RCH. 118, RCH. 138 and RCH. 335 at Nagpur and Khandwa.

Number of Monopodia

Genotype	CICR, NGP	JNKVV, KWA	Mean
Ankur - 09 Bt	1.5	0.7	**1.1**
Ankur – 09	2.8	2.2	**2.5**
Ankur - 651 Bt	2.4	1.2	**1.8**
Ankur – 651	2.2	0.8	**1.5**
Ankur - 2534 Bt	2.6	2.5	**2.6**
Ankur – 2534	3.3	1.5	**2.4**
MRC. 6160 Bt	2.8	1.5	**2.2**
MRC. 6160	2.7	0.5	**1.6**
MRC. 6301 Bt	3.1	0.8	**2.0**
MRC. 6301	2.8	1.5	**2.2**
MRC. 6304 Bt	1.6	3.2	**2.4**
MRC. 6304	2.2	1.2	**1.7**
RCH. 2 Bt	2.0	0.8	**1.4**
RCH. 2	5.5	3.8	**4.7**
RCH. 118 Bt	2.6	0.8	**1.7**
RCH. 118	5.3	1.3	**3.3**
RCH. 138 Bt	5.4	2.8	**4.1**
RCH. 138	2.6	1.2	**1.9**
RCH. 144 Bt	2.9	1.9	**2.4**
RCH. 144	3.3	1.2	**2.3**
RCH. 335 Bt	3.3	1.5	**2.4**
RCH. 335	2.0	1.9	**2.0**
RCH. 359 Bt	2.7	1.7	**2.2**
RCH. 359	2.6	0.2	**1.4**
MECH. 162 Bt (CC)	2.7	0.8	**1.8**
NHH. 44 (ZC)	5.2	0.7	**3.0**
CD @ 5%	0.9	1.1	
CV %	15.3	37.2	

Number of Sympodia per Plant:

The mean number of sympodia per plant over two locations ranged from 13.0 (NHH. 44) to 19.3 (MRC. 6160). The following table shows significant differences between Bt and Non-Bt counterparts in some test

hybrids as in Ankur-651, MRC. 6301, RCH. 2, RCH. 118, RCH. 138, RCH. 335 and RCH. 359 at CICR, Nagpur and Khandwa.

Number of Sympodia

Genotype	CICR, NGP	JNKVV, KWA	Mean
Ankur - 09 Bt	16.5	18.0	**17.3**
Ankur - 09	15.8	15.9	**15.9**
Ankur - 651 Bt	16.7	20.5	**18.6**
Ankur - 651	17.1	13.3	**15.2**
Ankur - 2534 Bt	16.3	16.7	**16.5**
Ankur - 2534	15.8	18.5	**17.2**
MRC. 6160 Bt	17.7	17.7	**17.7**
MRC. 6160	19.7	18.8	**19.3**
MRC. 6301 Bt	15.4	17.7	**16.6**
MRC. 6301	13.1	15.3	**14.2**
MRC. 6304 Bt	14.8	19.5	**17.2**
MRC. 6304	17.4	20.2	**18.8**
RCH. 2 Bt	15.9	17.2	**16.6**
RCH. 2	13.7	24.2	**19.0**
RCH. 118 Bt	15.0	12.7	**13.9**
RCH. 118	15.5	16.8	**16.2**
RCH. 138 Bt	13.4	20.8	**17.1**
RCH. 138	14.1	16.2	**15.2**
RCH. 144 Bt	15.3	20.3	**17.8**
RCH. 144	13.9	19.8	**16.9**
RCH. 335 Bt	13.8	23.7	**18.8**
RCH. 335	15.8	14.2	**15.0**
RCH. 359 Bt	15.3	18.3	**16.8**
RCH. 359	17.6	13.9	**15.8**
MECH. 162 Bt (CC)	16.7	15.8	**16.3**
NHH. 44 (ZC)	12.2	13.7	**13.0**
CD @ 5%	2.6	3.6	
CV %	8.1	9.9	

Length of Sympodia (cm):

The mean length of sympodia, as given below, ranged from 25.9 cm (RCH. 2) to 34.8 cm (RCH. 144 Bt), as compared to 28.9 cm and 33.1 cm, respectively. There were significant differences observed between Bt and Non-Bt counterparts in hybrids *viz.*, Ankur-09, Ankur-651, Ankur-2534, MRC. 6301, MRC. 6304, RCH. 2, RCH. 138, RCH. 144, RCH. 335 and RCH. 359 in one or the other location.

Length of Sympodia

Genotype	CRS, NANDED	CICR, NGP	JNKVV, KWA	GAU, SURAT	PDKV, AKOLA	Mean
Ankur - 09 Bt	29.8	34.7	29.2	39.0	20.8	**30.7**
Ankur - 09	29.6	20.9	23.7	44.0	24.9	**28.6**
Ankur - 651 Bt	31.7	51.7	33.9	32.0	19.1	**33.7**
Ankur - 651	26.6	35.0	25.7	47.0	27.5	**32.4**
Ankur - 2534 Bt	31.5	43.9	30.5	41.0	20.6	**33.5**
Ankur - 2534	26.7	34.4	25.5	35.0	18.6	**28.0**
MRC. 6160 Bt	31.8	37.5	28.6	35.0	19.1	**30.4**
MRC. 6160	29.2	41.7	32.8	39.0	17.3	**32.0**
MRC. 6301 Bt	28.9	45.0	28.0	36.0	26.1	**32.8**
MRC. 6301	24.7	29.7	23.2	38.0	19.0	**26.9**
MRC. 6304 Bt	32.2	40.5	24.7	35.0	20.9	**30.7**
MRC. 6304	32.2	38.8	25.2	41.0	23.4	**32.1**
RCH. 2 Bt	24.3	31.4	27.0	39.0	21.1	**28.6**
RCH. 2	26.0	28.7	26.8	32.0	15.9	**25.9**
RCH. 118 Bt	28.0	39.0	25.3	34.0	20.1	**29.3**
RCH. 118	27.0	34.9	22.8	39.0	18.6	**28.5**
RCH. 138 Bt	29.7	35.2	30.3	77.0	21.9	**38.8**
RCH. 138	26.9	33.1	25.0	45.0	28.3	**31.7**
RCH. 144 Bt	32.4	39.9	29.3	44.0	28.3	**34.8**
RCH. 144	27.5	34.1	27.3	50.0	19.2	**31.6**
RCH. 335 Bt	28.6	36.4	25.2	31.0	18.1	**27.9**
RCH. 335	35.7	36.0	24.8	39.0	27.3	**32.6**
RCH. 359 Bt	32.7	35.3	26.8	31.0	15.1	**28.2**
RCH. 359	26.3	35.6	25.8	45.0	26.3	**31.8**
MECH. 162 Bt (CC)	29.7	33.9	21.8	35.0	24.1	**28.9**
NHH. 44 (ZC)	29.2	31.5	19.3	55.0	30.4	**33.1**
CD @ 5%	--------	10.7	7.4	4.8	--------	
CV %	--------	14.4	13.7	5.9	--------	

Number of fruiting points:

The maximum number of fruiting points, as given below, was recorded in the hybrid Ankur-651 Bt (60.5), whereas, the minimum number was observed in the hybrid RCH. 118 Bt (44.7) as compared to 52.6 and 51.4 recorded in the check hybrids *viz.*., MECH. 162 Bt and NHH. 44, respectively. Ankur-09, Ankur-651, MRC. 6301, MRC. 6304, MRC. 6160,

RCH. 2, RCH.118, RCH.138 and RCH. 335 showed significant difference between Bt and Non-Bt counterpart hybrids.

Number of fruiting points

Genotype	CRS, NANDED	CICR, NGP	JNKVV, KWA	GAU, SURAT	PDKV, AKOLA	Mean
Ankur - 09 Bt	46.7	89.1	27.5	34.0	80.0	**55.5**
Ankur - 09	44.2	56.9	27.5	40.0	72.2	**48.2**
Ankur - 651 Bt	51.3	83.5	29.6	42.0	95.9	**60.5**
Ankur - 651	37.9	55.6	24.8	38.0	109.1	**53.1**
Ankur - 2534 Bt	42.6	75.8	25.3	36.0	67.9	**49.5**
Ankur - 2534	36.4	52.9	26.7	34.0	105.7	**51.1**
MRC. 6160 Bt	46.5	48.7	26.3	36.0	84.1	**48.3**
MRC. 6160	36.9	104.4	32.7	37.0	70.3	**56.3**
MRC. 6301 Bt	44.2	70.1	26.3	45.0	90.7	**55.3**
MRC. 6301	33.0	41.3	21.8	38.0	127.1	**52.2**
MRC. 6304 Bt	44.9	62.9	25.6	39.0	59.4	**46.4**
MRC. 6304	46.3	60.9	29.7	32.0	100.6	**53.9**
RCH. 2 Bt	38.5	55.7	25.3	44.0	108.8	**54.5**
RCH. 2	39.6	44.5	28.2	38.0	115.7	**53.2**
RCH. 118 Bt	40.7	69.8	24.2	40.0	49.1	**44.7**
RCH. 118	40.8	56.6	25.5	34.0	110.4	**53.5**
RCH.138Bt	36.5	51.6	25.8	45.0	86.2	**49.0**
RCH.138	39.5	64.9	29.0	31.0	87.6	**50.4**
RCH. 144 Bt	46.0	81.9	28.7	45.0	60.0	**52.3**
RCH. 144	30.5	47.3	26.9	40.0	90.7	**47.1**
RCH. 335 Bt	55.0	52.4	23.2	44.0	77.9	**50.5**
RCH. 335	40.4	67.2	23.3	38.0	94.1	**52.6**
RCH. 359 Bt	43.2	59.7	25.5	46.0	84.2	**51.7**
RCH. 359	36.7	74.8	24.3	45.0	90.1	**54.2**
MECH. 162 Bt (CC)	43.7	73.5	26.3	38.0	81.4	**52.6**
NHH. 44 (ZC)	47.0	48.8	22.7	31.0	107.7	**51.4**
CD @ 5%	--------	--------	3.3	5.3	--------	
CV %	--------	--------	6.1	6.6	--------	

Number of bolls per plant:

The mean number of bolls per plant ranged from 18.9 (Ankur-651 Bt) to 30.0 (RCH. 359) over five locations as compared to 24.2 and 19.4 recorded respectively in check hybrids *viz.*, MECH. 162 Bt and NHH. 44. All the test hybrids showed significant differences, as given below,

between Bt and Non-Bt counterparts for mean boll number per plant in one or the other locations.

Number of bolls per plant

Genotype	CRS, NANDED	CICR, NGP	JNKVV, KWA	GAU, SURAT	PDKV, AKOLA	Mean
Ankur - 09 Bt	20.5	33.7	29.8	17.0	19.5	**24.1**
Ankur - 09	20.5	16.4	20.3	21.0	28.8	**21.4**
Ankur - 651 Bt	15.5	6.5	23.3	25.0	24.3	**18.9**
Ankur - 651	18.8	30.0	17.2	20.0	43.2	**25.8**
Ankur - 2534 Bt	20.0	14.6	21.8	21.0	27.3	**21.0**
Ankur - 2534	22.0	48.2	22.7	16.0	22.7	**26.3**
MRC. 6160 Bt	24.3	54.4	22.5	21.0	18.3	**28.1**
MRC. 6160	24.0	42.3	24.2	18.0	12.8	**24.3**
MRC. 6301 Bt	19.2	13.8	22.0	27.0	17.5	**19.9**
MRC. 6301	18.0	44.5	18.3	20.0	22.2	**24.6**
MRC. 6304 Bt	17.2	16.2	25.0	22.0	16.3	**19.3**
MRC. 6304	21.4	17.9	28.2	15.0	15.0	**19.5**
RCH. 2 Bt	17.9	16.5	20.3	28.0	21.8	**20.9**
RCH. 2	25.1	56.6	33.3	19.0	6.8	**28.2**
RCH. 118 Bt	18.7	47.4	14.8	25.0	12.7	**23.7**
RCH. 118	25.8	45.5	21.2	18.0	9.3	**24.0**
RCH. 138 Bt	17.5	10.4	25.5	28.0	33.0	**22.9**
RCH. 138	18.3	18.4	21.3	13.0	25.3	**19.3**
RCH. 144 Bt	23.6	13.4	28.5	28.0	26.8	**24.1**
RCH. 144	20.2	15.0	27.3	22.0	26.5	**22.2**
RCH. 335 Bt	18.4	13.9	20.2	29.0	23.5	**21.0**
RCH. 335	27.1	36.7	19.8	21.0	24.0	**25.7**
RCH. 359 Bt	11.6	28.0	22.3	29.0	19.3	**22.1**
RCH. 359	19.8	54.7	18.2	26.0	31.5	**30.0**
MECH. 162 Bt (CC)	25.2	39.9	19.0	20.0	17.0	**24.2**
NHH. 44 (ZC)	21.0	9.3	17.7	14.0	35.0	**19.4**
CD @ 5%	--------	6.4	3.6	4.2	5.7	
CV %	--------	11.0	7.7	9.4	12.5	

Boll Weight :

The maximum boll weight was recorded (as given in Table below) in the hybrids RCH. 118 Bt, RCH. 335 Bt and RCH. 359 Bt (4.3 g/boll), while the minimum boll weight was noted in the hybrid MRC. 6301 Bt (3.6 g/boll) as compared to 3.9 and 3.8 g/ boll recorded in check hybrids *viz.*, MECH. 162 Bt and NHH. 44, respectively. Some hybrids such as Ankur-

09, Ankur-2534, MRC. 6160, MRC. 6301, MRC. 6304, RCH. 2, RCH. 138, RCH. 144, RCH. 335 and RCH. 359 showed significant differences between Bt and Non-Bt counterpart in one or the other location.

Boll weight (g)

Genotype	CRS, NANDED	CICR, NGP	JNKVV, KWA	GAU, SURAT	PDKV, AKOLA	Mean
Ankur - 09 Bt	4.8	4.7	4.6	3.0	3.2	**4.1**
Ankur - 09	4.1	4.3	3.8	3.7	3.2	**3.8**
Ankur - 651 Bt	3.6	4.7	4.2	3.5	3.2	**3.8**
Ankur - 651	4.0	5.2	4.2	3.6	3.2	**4.0**
Ankur - 2534 Bt	4.3	4.3	4.2	3.6	3.6	**4.0**
Ankur - 2534	4.7	4.1	4.5	4.0	3.3	**4.1**
MRC. 6160 Bt	4.1	4.2	3.7	4.3	3.5	**4.0**
MRC. 6160	3.8	4.5	3.7	3.7	3.6	**3.9**
MRC. 6301 Bt	3.4	4.0	3.4	3.6	3.6	**3.6**
MRC. 6301	4.2	4.7	3.6	3.7	3.0	**3.8**
MRC. 6304 Bt	3.9	4.5	3.4	3.9	3.4	**3.8**
MRC. 6304	4.0	4.7	3.6	3.8	2.8	**3.8**
RCH. 2 Bt	4.5	4.4	3.7	4.0	3.5	**4.0**
RCH. 2	3.8	4.2	4.0	4.0	2.4	**3.7**
RCH. 118 Bt	4.8	5.2	4.1	4.0	3.4	**4.3**
RCH. 118	4.4	4.9	4.6	3.9	2.6	**4.1**
RCH. 138 Bt	4.4	4.1	4.2	3.4	3.6	**4.0**
RCH. 138	4.4	4.7	3.8	3.3	3.2	**3.9**
RCH. 144 Bt	3.5	3.8	3.8	3.6	3.6	**3.7**
RCH. 144	4.0	4.2	4.4	3.3	3.0	**3.8**
RCH. 335 Bt	5.6	5.1	3.7	3.7	3.6	**4.3**
RCH. 335	4.6	4.5	3.4	3.7	2.9	**3.8**
RCH. 359 Bt	5.2	4.6	4.0	3.5	4.2	**4.3**
RCH. 359	3.9	4.7	4.1	3.5	3.4	**3.9**
MECH. 162 Bt (CC)	3.6	4.7	4.3	4.0	3.1	**3.9**
NHH. 44 (ZC)	4.4	4.3	3.6	3.5	3.3	**3.8**
CD @ 5%	--------	1.0	0.3	0.6	0.5	
CV %	--------	11.2	4.2	7.5	7.9	

Seed Cotton Yield (Kg/ha):

The data on seed cotton harvest provides the beet indication about the vagaries of rainfall during 2003-04 season in these centers. While Surat was hit by excess and heavy rainfall, Akola had severe drought at various crop growth periods. Hence, there was wide variability for mean seed cotton yield in the hybrids tested over five locations, as given in the following table. The data from the other centers are reasonably good, representing the agro-climatic conditions of the locations.

The yield ranged from 538 kg/ha as in conventional check hybrid (NHH. 44) to 1114 kg/ha (MRC. 6160 Bt). The Bt hybrids *viz.*, Ankur-09, MRC. 6304, RCH. 144 and RCH. 359 showed numerical superiority over their respective Non-Bt hybrids and vice-versa in other test hybrids. At Nanded, no test hybrids was superior over Bt check hybrid i.e., MECH. 162 Bt. At Nagpur, two hybrids (MRC. 6160 and RCH. 359, both Non-Bt hybrids) recorded significantly higher yield over the best check hybrid (MECH. 162 Bt). There seems to be some error in the yield of Ankur-2534Bt at Nagpur when compared to its non-Bt counterpart. Similarly at Khandwa, non-Bt hybrids, viz., MRC. 6160 and RCH. 2, both showed superiority in yield over the best check hybrid (MECH. 162 Bt). Only one hybrid (RCH. 335 Bt) significantly out-yielded the best check hybrid (NHH. 44) at PDKV, Akola. The overall mean of seed cotton yield data of Bt hybrids in the Zone shows that MRC.6160 Bt (1114 kg/ha) is the best in yield under prevailing climatic and testing conditions of 2003-04. It is significant to note that at Khandwa, Nanded and Nagpur, the yield performance of many test hybrids show certain yield advantage over Bt check and Zonal check hybrids. Amongst them significant best yield of

2012 kg/ha is that of Anklur.2534. Ankur-09, MRC.6301, RCH.2 and RCH.118.

Seed cotton yield (Kg/ha)

Genotype	CRS, NANDED	CICR, NGP	JNKVV, KWA	GAU, SURAT	PDKV, AKOLA	Mean
Ankur - 09 Bt	1363	1791	1260	333	581	**1066**
Ankur - 09	959	327	889	492	521	638
Ankur - 651 Bt	898	154	447	585	857	588
Ankur - 651	1168	991	623	497	603	776
Ankur - 2534 Bt	990	416	1125	541	665	747
Ankur - 2534	1233	2012	1131	452	590	**1083**
MRC. 6160 Bt	1293	1791	1348	594	545	**1114**
MRC. 6160	1588	1964	1540	443	363	**1180**
MRC. 6301 Bt	1076	292	896	667	605	707
MRC. 6301	1302	1481	1097	489	640	**1002**
MRC. 6304 Bt	1111	339	867	570	431	664
MRC. 6304	1137	466	770	381	378	627
RCH. 2 Bt	916	373	910	759	536	699
RCH. 2	1194	1789	1370	506	84	989
RCH. 118 Bt	872	1527	1104	665	348	903
RCH. 118	1510	1654	1081	449	102	959
RCH. 138 Bt	781	154	825	651	774	637
RCH. 138	816	261	1354	276	770	695
RCH. 144 Bt	981	246	1055	671	810	752
RCH. 144	881	472	851	469	321	599
RCH. 335 Bt	607	374	447	752	887	613
RCH. 335	1172	1373	840	533	622	908
RCH. 359 Bt	1254	1450	977	701	660	**1008**
RCH. 359	1072	1885	799	644	628	**1006**
MECH. 162 Bt	1298	1641	1227	570	388	**1025**
NHH. 44 (ZC)	812	163	745	312	660	538
CD @ 5%	388.7	160	130	--------	203.9	
CV %	17.3	7.8	6.6	--------	17.9	

Seed Index (g):

The mean seed, as given below, index ranged from 7.2 g (RCH. 335) to 9.2 g (MRC. 6304 Bt and RCH. 2 Bt), while the check hybrids recorded 7.9 g (MECH. 162 Bt) and 8.6 g (NHH. 44). Three test hybrids *viz.*, RCH. 335, RCH. 2 and Ankur-09 showed significant differences between Bt and Non-Bt counterpart hybrids at Nagpur, Surat and Akola, respectively.

Seed index (g)

Genotype	CRS, NANDED	CICR, NGP	GAU, SURAT	PDKV, AKOLA	Mean
Ankur - 09 Bt	8.5	8.4	7.5	6.1	7.6
Ankur - 09	8.5	9.2	8.3	8.1	8.5
Ankur - 651 Bt	7.5	8.9	8.3	8.2	8.2
Ankur - 651	7.7	9.0	8.3	7.8	8.2
Ankur - 2534 Bt	9.4	8.9	8.5	7.1	8.5
Ankur - 2534	7.4	8.2	9.0	7.2	7.9
MRC. 6160 Bt	6.6	8.2	9.8	8.4	8.2
MRC. 6160	7.7	7.7	9.0	7.2	7.9
MRC. 6301 Bt	8.1	9.4	7.8	7.1	8.1
MRC. 6301	8.8	9.6	8.3	7.5	8.5
MRC. 6304 Bt	8.7	10.2	9.0	8.8	9.2
MRC. 6304	8.2	9.3	8.3	8.2	8.5
RCH. 2 Bt	8.2	9.5	10.0	9.3	9.2
RCH. 2	8.1	9.5	8.3	7.8	8.4
RCH. 118 Bt	8.1	9.8	10.0	8.5	9.1
RCH. 118	8.5	9.6	9.0	7.1	8.5
RCH. 138 Bt	7.1	10.4	8.3	7.6	8.3
RCH. 138	8.5	10.3	7.0	7.3	8.3
RCH. 144 Bt	8.6	8.9	8.5	8.3	8.6
RCH. 144	8.5	9.5	7.8	7.7	8.4
RCH. 335 Bt	7.5	9.5	9.0	9.1	8.8
RCH. 335	7.3	4.5	9.3	7.7	7.2
RCH. 359 Bt	9.5	9.1	8.5	8.8	9.0
RCH. 359	7.7	8.2	7.3	7.1	7.6
MECH. 162 Bt	8.2	8.6	8.0	7.0	7.9
NHH. 44 (ZC)	9.1	10.2	7.5	7.6	8.6
CD @ 5%	--------	1.2	1.5	1.8	
CV %	--------	6.3	8.7	11.0	

Lint Index (g):

The range of lint index was between 4.3 g (RCH. 138 Bt) and 5.6 g (Ankur-651 and MRC. 6301 Bt), while the check hybrids recorded 4.9 g (MECH. 162 Bt) and 4.4 g (NHH. 44). The test hybrids *viz.*, Ankur-09, Ankur-651, MRC. 6301, RCH. 118, RCH. 138, RCH. 2 and RCH. 359 showed significant difference (table below) between Bt and Non-Bt counterpart hybrids in one or the other locations. All Bt hybrids that have more than 5.0 Lint index shall be useful for better fibre yield.

Lint Index (g)

Genotype	CRS, NANDED	CICR, NGP	GAU, SURAT	PDKV, AKOLA	Mean
Ankur - 09 Bt	5.4	6.2	3.7	5.0	5.1
Ankur - 09	5.2	4.7	4.4	6.1	5.1
Ankur - 651 Bt	4.2	4.4	3.8	5.1	4.4
Ankur - 651	4.9	7.1	4.1	6.1	5.6
Ankur - 2534 Bt	5.1	5.7	4.2	5.2	5.1
Ankur - 2534	4.4	4.8	4.7	5.5	4.8
MRC. 6160 Bt	4.5	5.9	4.7	5.4	5.1
MRC. 6160	5.0	4.7	4.0	5.4	4.8
MRC. 6301 Bt	5.3	7.9	3.6	5.4	5.6
MRC. 6301	4.5	5.4	4.1	5.4	4.9
MRC. 6304 Bt	5.3	6.2	4.5	5.9	5.5
MRC. 6304	5.0	5.2	4.0	6.0	5.1
RCH. 2 Bt	4.8	5.3	4.4	5.7	5.0
RCH. 2	4.8	5.6	3.7	5.1	4.8
RCH. 118 Bt	4.5	5.9	4.8	5.6	5.2
RCH. 118	4.6	5.2	3.9	4.9	4.6
RCH. 138 Bt	3.9	5.6	3.8	4.2	4.3
RCH. 138	4.7	5.5	3.5	6.0	4.9
RCH. 144 Bt	5.3	5.8	4.2	5.0	5.0
RCH. 144	5.3	5.3	3.7	4.8	4.8
RCH. 335 Bt	4.0	4.9	4.3	5.5	4.7
RCH. 335	4.4	5.2	4.6	5.4	4.9
RCH. 359 Bt	5.5	5.0	5.2	6.3	5.5
RCH. 359	4.0	4.2	4.3	5.3	4.4
MECH. 162 Bt	4.6	4.9	4.3	5.6	4.9
NHH. 44 (ZC)	4.6	5.0	3.6	4.5	4.4
CD @ 5%	--------	2.1	0.8	0.6	
CV %	--------	18.6	9.0	5.2	

Ginning Outturn (GOT) (%):

The mean value ranged from 34.0 % (NHH. 44) to 39.9% (Ankur-651). The Bt check hybrid MECH. 162 Bt had a ginning outturn of 36.8 %. At Nagpur, the test hybrids MRC.6301Bt (44.8%) and Ankur-651 (43.7%) had significantly higher GOT than the best check hybrid MECH.162 Bt (36.5%). Between Bt and Non-Bt counterpart hybrids at Nagpur, there were significant differences, as given below, in hybrids *viz.*., Ankur-9, Ankur-2534, Ankur-651 and MRC. 6301.

Ginning outturn (%)

Genotype	CRS, NANDED	CICR, NGP	GAU, SURAT	PDKV, AKOLA	Mean
Ankur - 09 Bt	38.4	42.5	33.2	44.8	**39.7**
Ankur - 09	38.0	33.1	34.4	43.2	**37.2**
Ankur - 651 Bt	36.0	33.8	31.6	38.2	34.9
Ankur - 651	39.0	43.7	32.8	44.0	**39.9**
Ankur - 2534 Bt	35.2	38.8	32.9	42.7	**37.4**
Ankur - 2534	37.5	31.6	34.2	43.3	36.7
MRC. 6160 Bt	37.2	41.2	32.6	39.2	**37.6**
MRC. 6160	39.5	37.6	30.7	43.0	**37.7**
MRC. 6301 Bt	39.5	44.8	31.8	43.6	**39.9**
MRC. 6301	35.0	36.2	32.9	41.9	**36.5**
MRC. 6304 Bt	38.0	37.8	33.4	40.1	**37.3**
MRC. 6304	38.0	35.9	32.7	42.2	**37.2**
RCH. 2 Bt	37.0	35.7	30.7	37.9	35.3
RCH. 2	37.1	36.8	30.9	39.6	36.1
RCH. 118 Bt	39.5	37.6	32.3	39.7	**37.3**
RCH. 118	34.7	35.1	30.0	40.9	35.2
RCH. 138 Bt	35.2	34.9	31.3	35.5	34.2
RCH. 138	35.5	34.9	33.1	44.9	**37.1**
RCH. 144 Bt	38.1	39.3	33.1	37.5	**37.0**
RCH. 144	38.5	35.9	32.3	38.4	36.3
RCH. 335 Bt	34.6	33.1	32.2	37.6	34.4
RCH. 335	37.5	38.0	32.9	41.2	**37.4**
RCH. 359 Bt	36.6	35.6	37.7	41.9	**38.0**
RCH. 359	34.3	33.7	37.2	42.7	**37.0**
MECH. 162 Bt	31.0	36.5	34.7	44.8	36.8
NHH. 44 (ZC)	33.8	33.2	32.1	37.0	34.0
CD @ 5%	--------	6.4	--------	--------	
CV %	--------	8.4	--------	--------	

Fibre property data

The fibre property data of the various test entries from the fibre samples of Nagpur 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. Data from other centers are to yet to be obtained. In accordance with the textile requirements and CIRCOT norms, the ratio of tenacity to strength shall be around 0.8 and above. The data given below shows that strength to length (S/L) ratio for the best hybrids are not crossing beyond 0.74. The hybrids with good fibre length had S/L ratio of 0.70 to 0.74 only. This seems to be mainly due to adverse climatic conditions.

Fibre Properties – Nagpur

Name of Genotype	2.5% SL Length in (mm)	Uniformity Ratio (%)	Fineness Micronaire 10^{-6} g/in	Bundle Strength Tenacity (g/tex) at 3.2 mm gauge
Ankur – 09 Bt	27.00	49.00	5.00	19.10
Ankur – 09	**28.95**	**49.00**	**3.80**	**21.35**
Ankur – 651 Bt	23.40	50.00	4.45	19.45
Ankur – 651	27.70	52.50	4.70	19.65
Ankur – 2534 Bt	**28.75**	**51.00**	**3.65**	**21.00**
Ankur – 2534	28.35	50.00	3.80	20.50
MRC. 6301 Bt	27.35	51.00	4.85	20.05
MRC. 6301	**28.30**	**50.00**	**4.20**	**20.35**
MRC. 6304 Bt	28.65	50.50	4.95	20.20
MRC. 6304	28.45	48.50	4.60	20.30
MRC. 6160 Bt	27.60	50.00	4.30	19.80
MRC. 6160	26.00	50.00	4.45	18.45
RCH.2 Bt	28.00	51.50	4.55	20.35
RCH.2	27.35	53.00	4.55	20.85
RCH. 118 Bt	28.25	50.00	4.50	19.15
RCH. 118	28.85	51.50	4.35	20.65
RCH.138 Bt	27.25	51.00	4.60	19.45
RCH.138	30.00	48.50	4.10	19.95
RCH.144 Bt	26.65	53.00	4.60	19.55
RCH.144	**29.60**	**52.50**	**4.00**	**21.35**
RCH. 335 Bt	**28.65**	**52.00**	**4.00**	**21.15**
RCH. 335	26.95	48.50	4.60	19.75
RCH. 359 Bt	28.85	50.00	4.30	21.00
RCH. 359	27.90	50.00	3.70	20.90
MECH.162 Bt	26.65	50.00	4.45	20.00
NHH.44	29.00	49.00	4.10	20.30
CD	2.08	2.91	0.36	1.57
CV%	3.63	2.80	4.04	3.77

PLANT PROTECTION EVALUATION

PLANT PROTECTION EVALUATION

The FIVE AICCIP CENTRES in central zone evaluated the performance of the twelve Bt hybrid entries along with their non-Bt counterparts and Bt check hybrid and non-Bt check hybrid for reaction to all the prevailing pests and diseases along with their non-Bt counterparts as well as with the Bt check and local check hybrid. Data were recorded on the incidence and damage due to various pests and diseases prevalent during the season. The evaluation was undertaken in experimental plots which were sprayed with recommended insecticides of each location against sap sucking pests as and when they crossed threshold levels. The response of test hybrids against prominent pests such as leaf hoppers (jassids) and whitefly amongst sap sucking insects and all the bollworm species was evaluated. Amongst diseases, the Bacterial blight, Grey mildew, Myrothecium leaf spot and Para Wilt syndrome were considered as the most important ones in this zone.

Entomology Evaluation

The Entomology evaluation was targeted primarily to test the action of Cry IA (c) gene in twelve Bt trial hybrids, viz., Ankur-09Bt, Ankur-651Bt, Ankur-2534Bt, MRC.6301Bt, MRC.6304Bt, MRC.6160Bt, RCH.2Bt, RCH.118Bt, RCH.138Bt, RCH.144Bt, RCH.335Bt & RCH.359Bt against the following bollworms.

SPOTTED BOLLWORM- *Earias vittella* Fabricius
SPINY BOLLWORM – *Earias insulana* Boisdual
AMERICAN BOLLWORM – *Heicoverpa armigera* Hubner
PINK BOLLWORM – *Pectinophora gosyypiella* (Saunders)

This was undertaken in all the five locations in plots without any plant protection against bollworms. The insecticides sprayings were done

based on the threshold levels only against sap sucking pest species 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 aphids and jassids infestation of the concerned entry.

The experiments were sown between 23rd June to 7th July, as given in the table below. The dates of harvest are also provide therein.

Dates	Surat	Khandwa	Nanded	Akola	Nagpur
Date of sowing	26.6.03	28.06.03	02.07.03	07.07.03	23.06.03
Date of germination	01.07.03	5.07.03	05.07.03	19.07.03	27.06.03

The centre-wise results are given below. General observation is that there was not much serious pest build up in various centres due to inclement weather conditions. However, the results provide inference about the gene action to deter bollworm incidence and damage. This affirms the fact that these evaluations are to be undertaken for more number of seasons to get the clear picture about the performance of the test entries, as is practised in AICCIP trials.

SURAT

The appearance of the American bollworm, in terms of first appearance of bollworm eggs, was by 75th day of crop growth, based on the data given below. Spotted bollworm was observed by 82nd day after germination. It is significant to find that there was no larvae of any bollworm on any hybrids till 15th August, when the first eggs of American bollworm was noticed on NHH.44 and certain other hybrids. There was no incidence of *Helicoverpa armigera* on Bt hybrids, while this pest was seen on all other hybrids.

First appearance record of bollworms

Entry	First egg seen	First 2nd instar larvae seen	
	ABW	SBW	ABW
RCH. 118 Bt	29/9	*--	--
RCH. 335 Bt	6/10	--	--
RCH. 359 Bt	6/10	29/9	--
Ankur – 651 Bt	29/9	29/9	--
Ankur – 09 Bt	6/10	--	13/10
Ankur – 2534 Bt	29/9	--	--
MRC. 6301 Bt	29/9	--	--
MRC. 6304 Bt	6/10	29/9	--
MRC. 6160 Bt	6/10	29/9	--
RCH.2 Bt	29/9	--	--
RCH.138 Bt	--	15/9	--
RCH.144 Bt	29/9	--	--
NHH.44 (Zonal check)	15/9	29/9	22/9
MECH.162 Bt (cc)	22/9	--	29/9
RCH. 118	6/10	17/11	--
RCH. 335	22/9	29/9	29/9
RCH. 359	15/9	22/9	22/9
Ankur – 651	6/10	6/10	13/10
Ankur – 09	15/9	20/10	22/9
Ankur – 2534	29/9	29/9	--
MRC. 6301	--	15/9	13/10
MRC. 6304	29/9	20/10	--
MRC. 6160	22/9	29/9	29/9
RCH.2	6/10	15/9	--
RCH.138	15/9	15/9	22/9
RCH.144	22/9	17/11	29/9

*---- not appeared

The bollworms were not seen to cross threshold in Bt hybrids except Ankur.09Bt for American bollworm, while for Spotted bollworm, it crossed in MRC.6301Bt, MRC.6304Bt, RCH.138Bt, RCH.359Bt and Ankur-651Bt by 29th September as much as in the case of Bt check hybrid.

With regard to percent boll damage by bollworms, it is found that all Bt hybrids had low to very low level of damage in comparison to non-Bt hybrids and Bt check hybrid. The combined boll damage due to Spotted and American bollworms ranged between 6 to 12% on non-Bt hybrids and zonal check hybrid, the Pink bollworm damage was seen to go up to 57% in certain non-Bt hybrids. Pink bollworm damage in Bt hybrid, RCH.335Bt and MRC. 6304Bt was maximum(11.48%), while in MRC.6160Bt was 18.78%. There appears to be poor presence of expressed endotoxin in these hybrids by the time Pink bollworm infestation appeared, as given below.

Mean percent green boll damage

Treatment	Mean Per cent green boll damage by			
	Earias	*Helicoverpa*	Combine *(Earias+Helicoverpa)*	Pink bollworm
RCH. 118 Bt	6.36 (0.73)	4.37 (0.1)	6.55 (0.80)	4.05(0.0)
RCH. 335 Bt	4.32 (0.07)	5.21 (0.3)	5.39 (0.38)	11.48(3.46)
RCH. 359 Bt	4.05 (0.0)	4.69 (0.1)	4.69 (0.17)	4.05(0.0)
Ankur – 651 Bt	5.26 (0.34)	4.05 (0.0)	5.26 (0.39)	4.05(0.0)
Ankur – 09 Bt	7.57 (1.24)	4.05 (0.0)	7.55 (1.23)	4.05(0.0)
Ankur – 2534 Bt	5.56 (0.44)	4.75 (0.1)	6.26 (0.69)	4.05(0.0)
MRC. 6301 Bt	6.02 (0.60)	5.11 (0.2)	6.83 (0.91)	4.05(0.0)
MRC. 6304 Bt	4.05 (0.0)	5.68 (0.4)	5.68 (0.48)	11.48(3.46)
MRC. 6160 Bt	4.62 (0.15)	4.55 (0.1)	4.62 (0.15)	18.78(9.86)
RCH.2 Bt	4.73 (0.18)	4.38 (0.1)	4.93 (0.24)	4.05(0.0)
RCH.138 Bt	4.51 (0.16)	4.92 (0.2)	5.38 (0.38)	4.05(0.0)
RCH.144 Bt	4.71(0.17)	5.22 (0.3)	5.77 (0.51)	4.05(0.0)
NHH.44 (Zonal check)	6.55 (0.80)	4.05 (0.0)	6.55 (0.80)	42.39(44.95)
MECH.162 Bt (cc)	4.05 (0.0)	4.05 (0.0)	4.79 (0.20)	4.05(0.0)
RCH. 118	9.23 (2.07)	6.94 (1.00)	10.51 (2.83)	52.76(62.88)
RCH. 335	8.12 (1.50)	8.51 (1.7)	11.69 (3.61)	57.08(69.96)
RCH. 359	8.60 (1.74)	8.65 (1.8)	12.08 (3.88)	37.99(37.39)
Ankur – 651	9.21 (2.06)	5.70 (0.4)	12.39 (4.10)	42.0(44.27)
Ankur – 09	9.78 (2.39)	8.32 (1.6)	10.60 (2.88)	48.29(55.23)
Ankur – 2534	7.35 (1.14)	6.42 (0.8)	9.11 (2.01)	15.48(6.62)
MRC. 6301	5.23 (0.33)	10.28 (2.7)	11.46 (3.45)	33.21(29.50)
MRC. 6304	7.52 (1.21)	7.46 (1.2)	9.81 (2.40)	45.27(49.97)
MRC. 6160	8.05 (1.46)	9.54 (2.2)	12.30 (4.04)	51.17(60.19)
RCH.2	4.79 (0.20)	6.31 (0.7)	6.71 (0.87)	57.08(69.96)
RCH.138	7.88 (1.38)	7.46 (1.2)	9.82 (2.41)	33.51(29.98)
RCH.144	6.22 (0.67)	5.50 (0.4)	7.66 (1.28)	38.98(39.07)
C.D.@ 5%	4.15	3.99	5.60	24.13
C.V. %	59.01	46.42	54.91	46.40

Figures in parenthesis are retransformed values after Arcsinee transformation

While considering the data on open boll damage, as mentioned in the following table, there was approximately 20% reduction in most of the Bt hybrids over the damage in their respective non-Bt hybrids. Similarly, the locule damage also was low in Bt hybrids. The reduction was between 60-75%. In Ankur-09Bt, the reduction in locule damage was 88%.

Percent bollworm damage to open boll and locules

Hybrids	% damage to open boll	% damage to locules
RCH. 118 Bt	15.18(6.36)	13.44(4.90)
RCH. 335 Bt	10.83(3.03)	8.16(1.51)
RCH. 359 Bt	16.94(7.99)	13.56(5.0)
Ankur – 651 Bt	18.19(9.24)	13.71(5.12)
Ankur – 09 Bt	4.05(0.0)	4.05(0.0)
Ankur – 2534 Bt	9.94(2.48)	7.58(1.24)
MRC. 6301 Bt	14.97(6.17)	12.60(4.26)
MRC. 6304 Bt	12.60(4.26)	8.23(1.55)
MRC. 6160 Bt	13.45(4.91)	9.88(2.43)
RCH.2 Bt	12.90(4.48)	9.56(2.26)
RCH.138 Bt	11.08(3.19)	8.36(1.61)
RCH.144 Bt	14.11(5.44)	8.63(1.75)
NHH.44	54.41(65.62)	39.57(40.08)
MECH.162 Bt (cc)	19.06(10.16)	14.48(5.75)
RCH. 118	47.91(54.57)	36.50(34.88)
RCH. 335	40.28(41.23)	32.81(28.86)
RCH. 359	55.98(68.20)	43.26(46.46)
Ankur – 651	48.31(55.26)	35.81(33.73)
Ankur – 09	47.26(53.44)	37.47(36.51)
Ankur – 2534	49.36(57.08)	37.16(36.02)
MRC. 6301	47.22(53.37)	37.54(36.63)
MRC. 6304	53.84(64.69)	42.11(44.46)
MRC. 6160	48.50(55.59)	39.47(39.91)
RCH.2	65.50(82.30)	53.02(63.32)
RCH.138	51.36(60.51)	36.24(34.45)
RCH.144	58.38(72.01)	46.27(51.72)
C.D. @ 5%	13.70	11.28
C.V. %	20.16	21.50

Figures in parenthesis are retransformed values after Arcsine transformation

The threshold level of sucking pests was found to cross by 74 to 85 days after germination. Aphids infested few Bt hybrids, as seen from the table below.

Jassid damage was seen in most hybrids, however, it was low in Bt hybrids of Ankur-651, Ankur-2534 and RCH.144 in comparison to other Bt and non-Bt hybrids.

Days after sowing (DAS) at which threshold of sucking pests was crossed

Entry	Sucking pests DAS					
	Aphid		Jassid		Whitefly	
	Bt	NBt	Bt	NBt	Bt	NBt
RCH. 118	56	-	84	84	-	-
RCH. 335	-	56	84	119	-	77
RCH. 359	64	-	84	77	77	84
Ankur – 651	64	161	112	140	77	84
Ankur – 09	161	-	84	119	77	77
Ankur – 2534	161	-	84	84	84	91
MRC. 6301	-	56	84	-	91	91
MRC. 6304	-	56	84	77	-	-
MRC. 6160	56	-	84	84	91	-
RCH.2	-	-	84	84	-	-
RCH.138	-	161	112	84	77	-
RCH.144	-	-	112	91	77	84
NHH.44		-		91		91
MECH.162 Bt (cc)	-		56		-	

The seed cotton yield was not found to be good and the abnormal climatic conditions prevailing during grand growth stage has affected the crop severely, as seen from the table below.

Picking-wise seed cotton yield(Kg/ha)

Sr. No.	Treatment	Yield (Kg/ha)		
		1st Picking	2nd Picking	Total
1.	RCH. 118 Bt	556	128	684
2.	RCH. 335 Bt	737	299	1035
3.	RCH. 359 Bt	351	274	625
4.	Ankur – 651 Bt	543	128	671
5.	Ankur – 09 Bt	227	69	297
6.	Ankur – 2534 Bt	715	55	770
7.	MRC. 6301 Bt	581	97	678
8.	MRC. 6304 Bt	370	65	436
9.	MRC. 6160 Bt	607	122	629
10.	RCH.2 Bt	551	242	793
11.	RCH.138 Bt	505	38	543
12.	RCH.144 Bt	450	183	633
13.	NHH.44(Zonal check)	004	50	54
14.	MECH.162 Bt (cc)	215	34	248
15.	RCH. 118	78	48	126
16.	RCH. 335	133	42	175
17.	RCH. 359	90	93	183
18.	Ankur – 651	202	29	231
19.	Ankur – 09	143	19	162
20	Ankur – 2534	156	53	208

21.	MRC. 6301	147	34	181
22.	MRC. 6304	162	36	198
23.	MRC. 6160	145	23	168
24.	RCH.2	135	61	196
25.	RCH.138	135	25	160
26.	RCH.144	80	21	101
	C.D.@ 5%	297	102	245
	C.V. %	43.09	56.97	30.45

Khandwa

There was minor incidence of Spotted bollworm, as top shoot borer. Their build up did not become high in all the test hybrids. However, the square damage due to American bollworm was significant between 72nd to 100th day after germination, as given below. The hybrids, such as Ankur-09, RCH.118, RCH.359, MRC.6301 were found to be least affected till 100th day.

Percentage Square damage

Entry name	Days after sowing				
	72	79	86	93	100
RCH. 118 Bt	1.8	2.0	2.0	1.2	1.1
RCH. 335 Bt	16.70	17.10	17.0	17.0	16.70
RCH. 359 Bt	2.40	2.40	2.0	1.70	1.30
Ankur – 651 Bt	12.80	12.80	12.80	12.30	11.80
Ankur – 09 Bt	1.90	2.1	1.9	1.5	1.0
Ankur – 2534 Bt	18.0	16.10	16.1	15.10	14.80
MRC. 6301 Bt	17.10	18.0	17.80	16.10	14.10
MRC. 6304 Bt	15.10	15.20	15.10	14.80	13.80
MRC. 6160 Bt	2.1	2.5	2.2	1.8	1.1
RCH.2 Bt	16.10	16.70	16.70	16.0	15.70
RCH.138 Bt	16.80	17.80	16.80	15.10	14.20
RCH.144 Bt	17.10	17.10	16.80	15.0	15.0
NHH.44	17.40	17.40	16.10	16.0	14.20
MECH.162 Bt (cc)	16.80	16.90	15.90	14.0	13.10
RCH. 118	15.10	15.0	14.80	11.0	11.10
RCH. 335	2.3	2.8	2.7	2.0	2.0
RCH. 359	1.85	2.10	2.0	1.50	1.20
Ankur – 651	2.20	2.20	2.20	2.20	1.50
Ankur – 09	14.80	16.90	16.90	14.10	11.20
Ankur – 2534	2.0	2.2	2.2	2.0	1.80
MRC. 6301	16.0	16.0	15.0	15.0	13.10
MRC. 6304	17.0	17.10	16.0	15.70	14.60
MRC. 6160	14.30	16.20	16.10	15.80	14.0
RCH.2	1.5	2.2	2.2	1.5	1.0

RCH.138	2.3	2.3	2.3	2.0	1.84
RCH.144	14.50	17.10	17.0	15.10	12.10

The damage to open bolls and locules were seen to be low and apparently, there seems to be a low pest pressure at this center. The maximum damage was seen up to 12% only in check hybrids for open boll damage while 14% damage was seen in locules.

The plant protection measures taken up at this center show that 3 sprays were given for sap sucking management.

Nanded

The peak damage to squares at this center is given below. It is found that all Bt hybrids have a fairly low level of damage in comparison to non-Bt counterparts, which recorded a maximum of 23.95% (RCH.118) or 17.42% as in Ankur-2534. The check hybrid also had more damage than the test Bt hybrids.

SQUARE DAMAGE IN TEST HYBRIDS

Entry name	12.09.03	22.09.03
RCH. 118 Bt	0.00 (0.00)	0.00 (0.00)
RCH. 335 Bt	4.31 (10.95)	2.50 (9.05)
RCH. 359 Bt	2.96 (9.55)	3.63 (10.93)
Ankur – 651 Bt	0.00 (0.00)	3.75(10.85)
Ankur – 09 Bt	3.40 (10.41)	1.95 (8.03)
Ankur – 2534 Bt	2.67 (8.92)	2.88 (9.74)
MRC. 6301 Bt	1.00 (4.07)	4.88 (12.75)
MRC. 6304 Bt	0.00 (0.00)	2.50 (9.05)
MRC. 6160 Bt	0.00 (0.00)	3.15 (9.84)
RCH.2 Bt	0.00 (0.00)	1.75 (7.58)
RCH.138 Bt	2.15 (8.30)	4.40 (12.07)
RCH.144 Bt	4.46 (12.16)	4.75 (12.55)
NHH.44	4.88 (12.51)	7.63 (16.02)
MECH.162 Bt (cc)	6.13 (13.87)	1.50 (4.99)
RCH. 118	23.95 (29.22)	6.50 (13.99)
RCH. 335	7.47 (14.75)	6.21 (14.20)
RCH. 359	14.17 (21.84)	9.80 (18.18)
Ankur – 651	14.75 (21.60)	10.79 (19.06)
Ankur – 09	13.65 (20.57)	8.59 (16.60)
Ankur – 2534	17.42 (24.45)	6.25 (14.29)
MRC. 6301	13.48 (21.21)	12.49 (20.47)
MRC. 6304	10.01 (18.44)	8.15 (15.04)
MRC. 6160	8.95 (17.37)	5.38 (12.89)
RCH.2	10.18 (18.41)	5.25 (13.24)
RCH.138	19.66 (26.03)	8.25 (15.53)
RCH.144	14.79 (22.61)	4.13 (11.55)

CD	10.33	8.50

Figures in parenthesis are angular transformed values

The open boll damage in Bt entries was the least amongst all entries. While a maximum of 56% was recorded in MRC.6301 in October, there was significant damage to open bolls in other non-Bt entries too, as given below.

Open boll damage in October and November, 2003

Entry name	Open boll damage	
	7.10.2003	04.11.03
RCH. 118 Bt	2.50 (6.45)	2.14 (7.94)
RCH. 335 Bt	0.00 (0.00)	3.55 (10.72)
RCH. 359 Bt	0.00 (0.00)	2.85 (9.60)
Ankur – 651 Bt	0.00 (0.00)	4.10 (11.43)
Ankur – 09 Bt	2.50 (6.45)	6.42 (14.45)
Ankur – 2534 Bt	0.00 (0.00)	4.47 (12.07)
MRC. 6301 Bt	0.00 (0.00)	4.15 (11.74)
MRC. 6304 Bt	0.00 (0.00)	4.50 (11.93)
MRC. 6160 Bt	0.00 (0.00)	5.12 (12.96)
RCH.2 Bt	0.00 (0.00)	3.55 (10.81)
RCH.138 Bt	0.00 (0.00)	6.56 (14.84)
RCH.144 Bt	2.50 (6.45)	3.61 (10.81)
NHH.44	5.00 (12.91)	7.56 (15.91)
MECH.162 Bt (cc)	0.00 (0.00)	2.56 (9.15)
RCH. 118	7.50 (15.67)	14.23 (21.98)
RCH. 335	27.50 (31.60)	6.54 (14.72)
RCH. 359	26.79 (31.15)	7.37 (15.71)
Ankur – 651	7.94 (15.87)	8.38 (16.24)
Ankur – 09	30.92 (33.76)	9.44 (16.78)
Ankur – 2534	0.00 (0.00)	13.67 (21.70)
MRC. 6301	56.06 (49.05)	9.24 (17.57)
MRC. 6304	3.95 (9.77)	9.76 (17.81)
MRC. 6160	5.26 (9.46)	9.09 (17.51)
RCH.2	16.67 (23.85)	6.87 (14.59)
RCH.138	6.70 (14.98)	9.76 (17.75)
RCH.144	14.50 (22.37)	9.42 (17.84)
CD	13.02	7.62

Figures in parenthesis are angular transformed values

While the sap sucking pests invaded the test hybrids in the early part of the season, with one to two insecticide applications, they were

suppressed. There was no significant damage due to jassids and whitefly during the season.

AKOLA

The square damage due to Spotted bollworm is given below. This bollworm was not significant in population or damage in the crop up to 105 days in this AICCIP center. It is found that while NHH.44 suffered 4% damage at 105 days after sowing, the Bt hybrids were free from this damage. In no-Bt hybrids, the damage ranged between 3 to 9%. The gene action seems to be there in Bt hybrids to ward off this bollworm damage up to 105 days.

Infestation of Spotted bollworms in squares

Entry name	105 days after sowing
RCH. 118 Bt	0.00(0.00)
RCH. 335 Bt	0.45(0.47)
RCH. 359 Bt	1.11(1.02)
Ankur – 651 Bt	0.54(0.52)
Ankur – 09 Bt	0.72(0.60)
Ankur – 2534 Bt	0.78(0.63)
MRC. 6301 Bt	0.00(0.00)
MRC. 6304 Bt	0.00(0.00)
MRC. 6160 Bt	0.00(0.00)
RCH.2 Bt	0.45(0.48)
RCH.138 Bt	0.00(0.00)
RCH.144 Bt	0.00(0.00)
NHH.44	3.90(1.94)
MECH.162 Bt (cc)	1.22(0.78)
RCH. 118	3.07(1.67)
RCH. 335	3.95(1.83)
RCH. 359	2.75(1.54)
Ankur – 651	2.40(1.44)
Ankur – 09	5.60(2.26)
Ankur – 2534	3.24(1.78)
MRC. 6301	3.28(1.71)
MRC. 6304	8.83(2.77)
MRC. 6160	3.63(1.89)
RCH.2	7.15(2.67)

RCH.138	4.28(2.01)
RCH.144	1.68(1.28)
CD 5%	1.38

Fig. in (-) are corresponding (x + 1) log values.

The square damage due to American bollworm is given below. It is found that while NHH.44 was had 9 to 15% damage between 60 and 90 days after sowing, the Bt hybrids were free from this damage. In no-Bt hybrids, the damage ranged between 7 to 23%. The gene action was explicit in Bt hybrids to ward off American bollworm damage.

Infestation of *H.armigera* in squares

Entry name	60 days after sowing	75 days after sowing	90 days after sowing
RCH. 118 Bt	0.00(0.00)	0.00(0.00)	0.00(0.00)
RCH. 335 Bt	0.00(0.00)	0.00(0.00)	0.00(0.00)
RCH. 359 Bt	0.00(0.00)	0.00(0.00)	0.00(0.00)
Ankur – 651 Bt	0.00(0.00)	0.5(0.71)	0.00(0.00)
Ankur – 09 Bt	0.00(0.00)	1.43(1.17)	0.00(0.00)
Ankur – 2534 Bt	0.00(0.00)	2.45(1.46)	0.00(0.00)
MRC. 6301 Bt	0.65(0.57)	0.00(0.00)	0.00(0.00)
MRC. 6304 Bt	2.06(1.02)	0.00(0.00)	0.00(0.00)
MRC. 6160 Bt	0.82(0.64)	0.95(0.69)	0.00(0.00)
RCH.2 Bt	0.00(0.00)	0.84(0.65)	0.00(0.00)
RCH.138 Bt	2.52(1.55)	0.0(0.00)	0.00(0.00)
RCH.144 Bt	0.0(0.0)	0.00(0.00)	0.00(0.00)
NHH.44	15.18(3.88)	11.88(3.39)	9.36(3.05)
MECH.162 Bt (cc)	8.91(2.95)	2.41(1.50)	0.00(0.0)
RCH. 118	23.59(4.80)	9.97(3.14)	5.15(1.60)
RCH. 335	18.85(4.33)	5.36(2.30)	4.98(2.13)
RCH. 359	7.83(2.80)	6.51(2.37)	5.74(2.30)
Ankur – 651	19.35(4.40)	12.21(3.48)	4.59(2.12)
Ankur – 09	5.76(2.33)	2.96(1.71)	9.34(2.96)
Ankur – 2534	10.72(3.27)	4.89(2.03)	0.51(0.71)
MRC. 6301	20.89(4.56)	4.43(2.02)	13.69(3.66)
MRC. 6304	13.47(3.64)	6.03(1.74)	4.21(1.76)
MRC. 6160	21.32(4.58)	5.51(2.35)	9.45(3.05)
RCH.2	12.61(3.53)	4.95(2.20)	3.93(1.40)

RCH.138	15.60(3.93)	9.30(2.16)	9.75(3.09)
RCH.144	27.30(4.87)	10.82(3.29)	2.00(1.38)
CD 5%	1.62	1.87	1.52

Fig. in (-) are corresponding (x + 1) log values.

The test hybrids were infested with jassids. The observations at 45 and 60 days after sowing provide the impression that there is no significant incidence, especially as in this center, which is well known for this pest pressure.

Jassid damage in the test hybrids

Entry names	45 days after sowing	60 days after sowing
RCH. 118 Bt	3.07(0.59)	6.27(0.86)
RCH. 335 Bt	1.93(0.47)	2.67(0.55)
RCH. 359 Bt	1.30(0.35)	1.90(0.45)
Ankur – 651 Bt	1.50(0.40)	2.63(0.56)
Ankur – 09 Bt	2.07(0.49)	2.03(0.46)
Ankur – 2534 Bt	1.07(0.32)	1.27(0.35)
MRC. 6301 Bt	1.10(0.32)	2.00(0.48)
MRC. 6304 Bt	2.23(0.49)	3.77(0.68)
MRC. 6160 Bt	2.20(0.50)	3.37(0.52)
RCH.2 Bt	2.03(0.46)	2.23(0.51)
RCH.138 Bt	1.60(0.41)	2.10(0.49)
RCH.144 Bt	2.13(0.48)	3.20(0.62)
NHH.44	0.97(0.28)	2.20(0.51)
MECH.162 Bt (cc)	1.83(0.41)	6.33(0.87)
RCH. 118	5.40(0.80)	5.33(0.80)
RCH. 335	1.03(0.30)	1.43(0.38)
RCH. 359	2.10(0.48)	1.07(0.31)
Ankur – 651	1.37(0.37)	1.37(0.37)
Ankur – 09	1.17(0.33)	1.20(0.32)
Ankur – 2534	0.77(0.23)	1.37(0.35)
MRC. 6301	0.87(0.27)	2.63(0.54)
MRC. 6304	1.93(0.45)	2.63(0.56)
MRC. 6160	1.23(0.34)	4.40(0.73)
RCH.2	1.47(0.39)	5.47(0.81)

RCH.138	2.27(0.51)	3.40(0.64)
RCH.144	1.77(0.43)	0.67(0.20)
CD 5%	0.23	0.20

Fig. in (-) are corresponding (x + 1) log values.

Nagpur

The experiment, conducted at CICR farm did not have appreciable bollworm damage during the entire season. The sap sucking due to leaf hoppers was present in severe form in most entries and appropriate measures for their suppression was taken.

First appearance of life stages of bollworms

Entry	American bollworm eggs DAS		American bollworm larvae DAS	
	Bt	NBt	Bt	NBt
RCH. 118	73	73	87	80
RCH. 335	80	80	-	87
RCH. 359	80	73	-	80
Ankur – 651	80	73	98	87
Ankur – 09	59	80	59	80
Ankur – 2534	59	80	121	80
MRC. 6301	80	59	114	59
MRC. 6304	80	80	87	-
MRC. 6160	80	73	-	80
RCH.2	80	59	-	87
RCH.138	80	73	-	59
RCH.144	59	59	114	114
NHH.44		73		80
MECH.162 Bt (cc)	80		87	

Days after sowing (DAS) at which ETL exceeded

Entry	Jassid	
	Bt	NBt
RCH. 118	42	42
RCH. 335	-	42
RCH. 359	42	42
Ankur – 651	42	42
Ankur – 09	42	42
Ankur – 2534	42	42
MRC. 6301	42	42
MRC. 6304	42	42
MRC. 6160	42	42

RCH.2	42	42
RCH.138	42	42
RCH.144	42	42
NHH.44	42	42
MECH.162 Bt (cc)	42	42

The average seed cotton yield of the central zone is given below. It is found that Surat trial has been vitiated by excess rainfall during peak growth of the crop. Omitting this centre's data the mean has been computed and it is found that the Bt hybrids such as MRC.6160 topped with 1432 Kg/ha, while Ankur-09, RCH.359, RCH.144 & RCH.118 had given better yield over Bt check hybrid. Amongst non-Bt hybrids, RCH.359 topped with 1332 Kg/ha seed cotton yield.

Average Seed cotton yield (Kg/ha

Genotype	CRS, NANDED	CICR, NGP	JNKVV, KWA	PDKV, AKOLA	Mean
RCH. 118 Bt	1189	1774	1360	608	**1233**
RCH. 335 Bt	972	685	740	1137	883
RCH. 359 Bt	1324	1663	1387	1030	1351
Ankur – 651 Bt	677	996	567	1031	818
Ankur – 09 Bt	938	2007	1896	648	**1372**
Ankur – 2534 Bt	790	926	1360	916	998
MRC. 6301 Bt	1367	992	1068	1036	1116
MRC. 6304 Bt	938	874	1057	681	888
MRC. 6160 Bt	1400	2098	1590	641	**1432**
RCH.2 Bt	1319	926	979	1094	1080
RCH.138 Bt	1098	718	1068	1042	981
RCH.144 Bt	1428	933	1207	1233	1200
NHH.44	473	502	823	696	624
MECH.162 Bt	1011	1882	1005	276	***1043***
RCH. 118	334	2211	708	172	856
RCH. 335	629	1600	2109	633	1243
RCH. 359	703	2055	1512	1058	**1332**
Ankur – 651	677	1359	1470	887	1098
Ankur – 09	777	784	1896	779	1059
Ankur – 2534	647	2331	1293	795	1266
MRC. 6301	595	1750	1207	586	1035
MRC. 6304	623	899	729	473	681
MRC. 6160	313	2249	1095	361	1005

RCH.2	694	2214	1564	358	1207
RCH.138	686	558	1820	1029	1023
RCH.144	616	908	1970	784	1070
CD @ 5%	286			345	

The Entomology evaluations of Central Zone could be summed up as follows.

Average population of American Bollworms was nearly 5 times higher in non-Bt entries as compared to Bt entries (Fig.I). It ranged from 0.1 to 0.2 larva/ plant as against 0.25 to 1.00 in their non-Bt counterparts. The check entries MECH 162 Bt and NHH 44 recorded 0.1 and 0.61 larva / plant respectively.

All the Bt entries registered higher yield over their non-Bt counterparts (Table; Fig.II). The average increase in yield was 56.9 percent in Bt entries over non-Bt entries. In **Surat** centre, all the Bt entries except Ankur 09 and MRC 6304 recorded significantly higher yield over the best check MECH 162 Bt. In **Khandwa,** all the Bt entries recorded significantly higher yield over to the best check MECH 162 Bt. In **Akola,** three Bt entries viz., RCH 335, RCH 2 and RCH 138 recorded significantly higher yield over the best check, NHH 44. In **Nanded,** five Bt hybrids RCH 144, RCH 359, RCH 2, MRC 6160 and MRC 6301 recorded significantly higher yield over the best check, MECH 162 Bt. In **Nagpur,** all the Bt entries except RCH 118, RCH 359, MRC 6304 and MRC 6160 recorded significantly higher yield over the best check, NHH 44.

PLANT PATHOLOGY EVALUATION

The experimental plots of the Entomology Evaluation was also utilized for observations on the major diseases that infected all the entries.

With regard to the incidence of new wilt, among the Bt hybrids RCH 118 Bt had the highest incidence of 15% after 150 days followed RCH 359 Bt (10%). Five other Bt hybrids (RCH 138 Bt, RCH 2 Bt, MRC 6304 Bt, MRC 6160 Bt and RCH 144 Bt) had varying wilt incidence ranging from 1.70 to 8.30%. All Non Bt hybrids including checks have showed para wilt incidence ranging from 1.70 to 41.70%. Even though four Bt hybrids viz. Ankur 651 Bt, Ankur 09 Bt, Ankur 2534 Bt and MRC 6301 Bt did not show any wilting, their non Bt hybrids had a wilt incidence ranging from 3.30% (Ankur 09) to 15.00 % (Ankur 651).

Observations on New Wilt at different intervals - KHNADWA

Entry code	90 Days	120 days	135 Days	150 Days
	Incidence %	Incidence %	Incidence %	Incidence %
Ankur – 09 Bt	0.00	0.00	0.00	0.00
Ankur – 09	0.00	0.00	0.00	3.30
Ankur – 651 Bt	0.00	0.00	0.00	0.00
Ankur – 651	0.00	1.70	10.00	15.00
Ankur – 2534 Bt	0.00	0.00	0.00	0.00
Ankur – 2534	0.00	0.00	3.30	5.00
MRC. 6160 Bt	0.00	0.00	0.00	6.70
MRC. 6160	0.00	1.70	3.30	5.00
MRC. 6301 Bt	0.00	0.00	0.00	0.00
MRC. 6301	0.00	0.00	3.30	5.0
MRC. 6304 Bt	0.00	0.00	3.30	5.00
MRC. 6304	0.00	3.30	5.00	8.30
RCH.2 Bt	0.00	0.00	1.70	3.30
RCH.2	0.00	0.00	1.70	3.30
RCH. 118 Bt	0.00	0.00	10.00	15.00
RCH. 118	0.00	0.00	10.00	15.00
RCH.138 Bt	0.00	0.00	0.00	1.70
RCH.138	0.00	1.70	1.70	3.30
RCH.144 Bt	0.00	0.00	5.00	8.30
RCH.144	0.00	0.00	0.00	1.70

RCH. 335 Bt	0.00	0.00	0.00	0.00
RCH. 335	0.00	3.30	16.70	21.70
RCH. 359 Bt	0.00	3.30	6.70	10.00
RCH. 359	0.00	5.00	31.70	41.70
MECH.162 Bt	0.00	6.70	15.00	23.30
NHH.44)	0.00	0.00	0.00	1.70

At Khandwa, the incidences of Bacterial blight and Myrothecium leaf spot disease were recorded. Irrespective of the various degrees of disease intensity, all hybrids (Bt & Non Bt) showed susceptible reaction after 120 days to both bacterial leaf blight and myrothecium leaf spot diseases.

Observations on Bacterial Leaf Blight at different intervals.

Entry code	30 Days		60 days		90 Days		120 Days	
	Grade	Incidence	Grade	Incidence	Grade	Incidence	Grade	Incidence
Ankur – 09 Bt	0	0.00	2	13.30	3	16.70	4	33.30
Ankur – 09	0	0.00	2	11.70	4	25.00	4	33.30
Ankur – 651 Bt	0	0.00	0	0.00	3	20.00	4	31.70
Ankur – 651	0	0.00	0	0.00	3	30.00	3	46.70
Ankur – 2534 Bt	0	0.00	2	16.70	3	25.00	4	30.00
Ankur – 2534	0	0.00	0	0.00	4	18.30	4	35.00
MRC. 6160 Bt	0	0.00	3	16.70	4	30.00	4	38.30
MRC. 6160	0	0.00	0	0.00	4	25.00	4	30.00
MRC. 6301 Bt	0	0.00	0	0.00	3	20.00	4	35.00
MRC. 6301	0	0.00	2	6.70	4	13.30	4	45.00
MRC. 6304 Bt	0	0.00	2	16.70	3	25.00	4	40.00
MRC. 6304	0	0.00	0	0.00	3	16.70	4	35.00
RCH.2 Bt	0	0.00	0	0.00	3	28.30	3	40.00
RCH.2	0	0.00	2	5.00	4	25.00	4	35.00
RCH. 118 Bt	0	0.00	0	0.00	3	25.00	4	38.30

RCH. 118	0	0.00	0	0.00	3	20.00	4	38.30
RCH.138 Bt	0	0.00	2	8.30	3	16.70	3	46.70
RCH.138	0	0.00	2	11.70	4	26.70	4	40.00
RCH.144 Bt	0	0.00	2	11.70	4	18.30	4	35.00
RCH.144	0	0.00	0	0.00	4	20.00	4	28.30
RCH. 335 Bt	0	0.00	0	0.00	3	16.70	4	35.00
RCH. 335	0	0.00	2	8.30	3	16.70	3	38.30
RCH. 359 Bt	0	0.00	2	8.30	3	20.00	4	33.30
RCH. 359	0	0.00	2	8.30	3	25.00	4	30.00
MECH.162 Bt	0	0.00	0	0.00	3	20.00	4	36.70
NHH.44	0	0.00	0	0.00	4	25.00	4	45.00

At Nanded, the major disease was Grey mildew and infected all the hybrids at moderate levels. At Akola and Surat, there was no serious disease development due to inclement weather. At Nagpur, moderate levels of foliar diseases were encountered in all entries.

CONCLUSIONS:

1. The Bollgard I Bt hybrids under evaluations had good deterrence to bollworms. The reduction in number of insecticide spraying based on larval-population threshold for American bollworm is expected to be around 1-2, in comparison to non-Bt hybrids, where a minimum of 3-5 sprays shall be warranted.

2. Mild infestation of Spotted bollworms was observed in Surat and Khandwa. The Bt hybrids were superior over non-Bt counterparts in reducing their damage. Pink bollworm was quite low in population in most of the centres. Moderate population appeared at Akola and Khandwa. The Bt hybrids did well to reduce the boll damage over non-Bt hybrids.

3. Under unprotected conditions, the average seed cotton yield registered across four locations of this zone, showed that MRC.6160Bt yielded 1432 Kg/ha, followed by Ankur.09Bt with 1372 Kg/ha and RCH.359Bt with 1351 Kg/ha. It was found that RCH.359 non-Bt hybrid yielded 1332 Kg/ha seed cotton in comparison to 1043 Kg/ha, registered by Check Bt hybrid.

4. The evaluations were done under extreme agroclimatic conditions due to which the actual pest population and its pressure on test hybrids cold not be fully realized. Under this circumstance, it is suggested to repeat the evaluations of those entries that have undergone only one year's evaluation so far.

5. There was no serious outbreak of any diseases or maladies in the various centers where evaluations were conducted.

6. 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.