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Field reaction of transgenic cotton to sucking insect pest in north India

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ABSTRACT : Eight *Bt* transgenic cotton genotype *viz.,* RCH 134, Sigma and Bioseed 6488 with Cry1Ac, Cry 2Ac along with their respective non *Bt* genotype were evaluated under field conditions in 9 district (2 districts each from Haryana, Rajasthan and 5 districts from Punjab) of north India for their reaction to sucking insect pests in comparison to BG II and their respective non *Bt* hybrids. Differential reaction of *Bt* hybrids over their non *Bt* counterparts was recorded in terms of increased or decreased tolerance or susceptibility to sucking insect pests following *Bt* gene introgression. Higher population of jassid was recorded on BG I as compared to BG II and non *Bt* among all the cotton hybrids. RCH non *Bt* and Sigma non *Bt* hybrids recorded less population of whitefly than RCH and Sigma (BGII and BGI). In all the 3 *Bt* hybrids BGI (RCH, Sigma and 6488) recorded high population of mealybug. Similarly in RCH BGI, 6488 BGI indicates susceptibility to thrips.

Key words: Jassid, mealybug, transgenics cotton, whitefly

Transgenic cotton with *Bt* var. *kurstaki* genes encoding Cry 1AC proteins have been first introduced for commercial cultivation in 1996-1997 in USA with the expectations of reduction in number of insecticides applications, increase in natural enemies, reduction in amount of pesticide residues in food and reduction in farmers exposure to the pesticides. The major reason for the interest on *Bt* cotton in India is attributed to the skewed quantum of insecticides (54% of pesticide share on 55 cropped area) used on the crop, particularly against *Helicoverpa armigera* which is considered as the national pest having a damage potential of 60-80 per cent yield loss and its developed resistance to almost all groups of insecticides. In cotton pest control, transgenic cultivars have been deployed as an ecofriendly pest management tool conferring resistance to insect pests to several conventional insecticides. The impact of *Bt* cotton on the non target insect species may be positive due to elimination of insecticidal use (Arshad *et al.,* 2009).

Many factors are responsible for low productivity, but the magnitude of insect pests is of major concern, which damage crop from sowing till maturity. Cotton crop is substantially afflicted by sucking insect pests *viz.,* jassid (*Amrasca biguttula bigutulla,* Ishida*)*, whitefly (*Bemisia tabaci,* Gennadius), aphids (*Aphis gossypii,* Glover), mealybug (*Phenacoccus solenopsis,* Green) and thrips (*Thrip tabaci*, Lindeman). Therefore, need of any genotype including *Bt* transgenic is to possess high degree of tolerance to all other important insect pests in addition to the target insect. Gaining resistance to *H. armigera* or other bollworms at the cost of susceptibility to sucking pets besides low yield levels must be avoided. But there is lack of resistance against sucking insect pests and hence require continuous use of insecticides and other control tactics for effective management. Keeping in view the changing scenario of insect, different hybrids of *Bt* cotton (BG1 and BG II) alongwith non *Bt* hybrids have been evaluated under field conditions for their reaction to sucking insect pest of cotton.

MATERIALS AND METHODS

Eight *Bt* cotton genotype *viz.,,* RCH 134 BG 1, RCH 134 BG II, RCH 134 Non *Bt*, Sigma BG 1, Sigma BG II, Sigma non *Bt*, 6488 BG I, 6488 BG II were evaluated under field conditions in 5 district of Punjab *viz.,* Mansa, Muktsar, Ludhiana, Ferozepur, Bathinda, 2 districts from Rajasthan (Ganganagar, Hanumangarh) and 2 districts from Haryana (Sirsa and Fatehbad). The field experiments were conducted in a plot size 0.25 ac with spacing 67.5x90 cm having 3 replications in a randomized block design. Weekly observations on the population of sucking insect pests *viz.,* jassid nymphs, whitefly adults, thrips population/3 leaves and number of mealy bug nymphs and adults/10 central shoot were recorded from 15 randomly selected plants for the period between 30 to 180 days of crop. The data obtained was pooled and subjected to analysis of variance (ANOVA) after applying suitable transformation.

RESULTS AND DISCUSSION

Jassid : In Mansa district all the cotton genotype shows no significant results where jassid population ranges from 1.21 to 2.08 (Table 1). In Muktsar district RCH non *Bt* (2.16) have highest population in comparison to Sigma BG II (1.96) and Sigma BG I (1.83). However, the data was statistically non significant. In district Ferozepur significantly higher population of jassid was recorded in Sigma BG I (2.02) followed by RCH BG I (1.88). In Ludhiana and Bathinda districts, cotton shows no significant effect among the 8 cotton genotype with maximum population of jassid in RCH BGI (1.86). The pooled analysis of 5 districts of Punjab showed higher population of jassid nymphs in Sigma BG I (1.84) and RCH BG I (1.74) as compared to all other hybrids. In state Rajasthan, Ganganagar and Hanumangarh districts show no significant effect among the all genotype with population range from 1.10-2.07 jassid nymphs/3 leaves. On an average of Rajasthan state, cotton showed a non significant difference with respect to jassid nymph population. Similarly Sirsa district reported higher population in Sigma non *Bt* (2.22) and RCH non *Bt* (2.13) whereas in Fatehbad, population of jassid reported high in RCH BGI (2.07) hybrid in comparison to other cotton hybrids. Pooled average of 2 districts of Haryana state showed non significant difference among the different cotton hybrids with jassid population ranged from 1.21-2.07/3 leaves. The pooled analysis of 9 districts of north India showed non significant results with respect to jassid population. However, higher population of jassid nymph was recorded in RCH BG I (1.78), Sigma

Table 1. Incidence of jassid on different cotton hybrids in north India

Hybrids	Population of jassid nymphs/3 leaves												
	Punjab						Rajasthan			Haryana			**Pooled**
	Mansa	Muktsar	Ferozpur	Ludh-iana	Bath-inda	**Pooled mean**	Srigan-ganagar	Hanu-mangarh	**Pooled mean**	Sirsa	Fateh-abad	**Pooled mean**	**mean**
RCH BG II	2.02	1.15	0.73(4.47)	1.15	2.15	**1.60**	1.32	1.88	**1.60**	2.02	1.32	**1.67**	**1.52**
RCH BG I	2.08	1.32	1.88(7.16)	1.86	1.55	**1.74**	1.33	1.83	**1.58**	2.07	2.07	**2.07**	**1.78**
RCH NON BT	1.96	2.16	0.74(4.57)	1.10	1.21	**1.43**	2.07	1.36	**1.71**	2.13	1.83	**1.98**	**1.61**
Sigma BGII	1.21	1.96	0.73(4.55)	1.85	2.07	**1.56**	1.96	1.83	**1.89**	1.44	1.71	**1.64**	**1.65**
Sjgma BGI	1.55	1.83	2.02(7.22)	1.71	2.07	**1.84**	1.90	1.36	**1.63**	1.55	1.82	**1.63**	**1.74**
Sigma non *Bt*	2.07	1.32	0.72(4.51)	1.16	1.34	**1.32**	1.36	1.88	**1.62**	2.22	1.32	**2.02**	**1.54**
6488 BG II	1.34	1.08	1.87(7.12)	1.80	2.15	**1.65**	1.10	1.36	**1.23**	1.10	1.96	**1.21**	**1.46**
6488 BG I	1.65	1.36	0.72(4.51)	1.11	2.15	**1.40**	1.11	1.88	**1.49**	1.65	1.83	**1.80**	**1.51**
CD(p=0.05)	NS	NS	1.28	NS	NS	**NS**	NS	NS	**NS**	NS	NS	**NS**	**NS**

Mean of 3 replications, Figures in parentheses are "n+1 transformation

BG I (1.74), Sigma BGII (1.65), RCH non *Bt* (1.61), Sigma non *Bt* (1.54), RCH BGII (1.52), 6488 BGI (1.51) and 6488 BGII (1.46). Results are in corroborate with finding of Dhillon *et al.,* 2012 who reported the population of major non target sucking pests such as *Amrasca bigutulla bigutulla, Bemesia tabaci, Aphis gossypii, Oxycarenus laetus* did not differ significantly between *Bt* and non *Bt* cotton.

Whitefly : Whitefly population was significantly lower in RCH non *Bt* and Sigma non *Bt* (5.55, 6.40) as compared to all others *Bt* hybrids in Mansa districts (Table 2). In Muktsar district whitefly population was significantly lower in Sigma BG I and Sigma BG II (3.88, 4.80) followed by RCH non *Bt* (5.17) in comparison to all others cotton hybrids. The population of whitefly did not differ significantly in Ferozepur and Ludhiana districts. Significant low population of whitefly was recorded in 6488 *Bt* hybrids (4.99) followed by RCH BGII (5.07) in district Bathinda. The pooled analysis of 5 districts of Punjab showed higher population of whitefly in RCH BG I and Sigma BG I 6488 BG II (1.79, 1.78, 1.52) as compared to all other hybrids. There is very less difference in the population recorded on 8 *Bt* and non *Bt* hybrids in district Sriganganagar where its population range from 3.84 to 5.02 whitefly/3 leaves. Similarly for district Hanumangarh significant population was observed with lowest population on 6488BGI (2.57). On an average significant population of whitefly was reported in state Rajasthan with highest in RCH BGI (4.69) in comparison to other hybrids where population ranged from 3.60-4.69. In Sirsa district of Haryana, whitefly population/3 leaves in all the *Bt* and non *Bt* hybrids varied from 4.10 in RCH BGI to 7.31 in Sigma BGI with significant difference. Whereas in district Fatehbad whitefly population was significantly lower in Sigma BGII (3.73) followed by RCH non *Bt* (3.88) and found significantly highest in 6488 BGII (7.51). The pooled analysis of 2 districts of Haryana reported significantly higher population of whitefly in comparison to other 2 states. The pooled analysis of 9 districts of north India showed no significant result with population of whitefly adults ranged from 5.20 (RCH non *Bt*) to 5.91 (RCH BGI).

Mealybug : Mealybug population did not differ significantly in Mansa and Muktsar districts but in Ferozepur districts it was significantly lower in all the hybrids tested except RCH BG I and 6488 BG II (0.74 and 0.91) as observed in Table 3. Based on the observations recorded in Ludhiana during peak activity period, the mean population of mealybug on different *Bt* cotton hybrids ranged from 0.04 (RCH BGII) to 0.08 (RCH non *Bt*)/center shoot as compared to RCH BG I (0.05). Mealy bug population in these *Bt* hybrids varied from 0.28 to 0.81/plant, being highest in 6488 BGII. Significant higher population was recorded in 6488 BG II (0.81), 6488 BGI (0.80) and RCH BG II (0.77) with minimum on Sigma non *Bt* (0.28) in comparison to all other cotton hybrids in Bathinda district. The pooled analysis of 5 districts of Punjab showed significantly lower population of mealy bug in RCH BG II, Sigma BG II followed by RCH non *Bt* and 6488 BG II (0.33, 0.35, 0.44 and 0.47, respectively) in comparison to all other hybrids. In district Sriganganagar of state Rajasthan, significant lower population of mealy bug was recorded in 6488 BG II (0.24), RCH non *Bt* (0.34) and Sigma BGI (0.36) in comparison to all other cotton hybrids. Similar population was recorded in district Hanumangarh but with a slight significant difference. 0.30 mealybug/center shoot was observed in 6488 BGI, 0.34 in RCH BGI, 0.36 in Sigma BGII. On the base of pooled analysis of 2 districts of Rajasthan non significant results obtained with population ranged from 0.34 (RCH BGI) to 0.44 (Sigma non *Bt*). In Haryana districts (Sirsa and Fatehbad) non significant population was recorded with minimum population was observed in RCH BGII (0.30) in Sirsa whereas in district Fatehbad 6488

Table 2. Incidence of whitefly on different cotton hybrids in north India

Hybrids	Population of whitefly/3 leaves												
	Punjab						Rajasthan			Haryana			**Pooled mean**
	Mansa	Muktsar	Ferozpur	Ludh-iana	Bath-inda	**Pooled mean**	Srigan-ganagar	Hanum-angarh	**Pooled mean**	Sirsa	Fatehbad	**Pooled mean**	
RCH BG II	7.22 (13.78)	5.73 (12.58)	10.43	2.03	5.07 (10.81)	**6.02 (12.45)**	5.21 (12.44)	3.99 (10.99)	**4.60 (11.71)**	4.69 (11.35)	7.29 (14.45)	**5.99** (12.90)	**5.70**
RCH BG I	6.55 (12.95)	7.76 (14.85)	10.41	2.30	7.13 (14.56)	**6.84 (13.65)**	4.36 (11.42)	5.02 (12.33)	**4.69 (11.88)**	4.10 (10.53)	5.55 (10.40)	**4.82 (10.46)**	**5.91**
RCH NON *Bt*	5.55 (10.40)	5.17 (11.14)	11.22	2.00	5.78 (13.05)	**5.94 (12.09)**	4.16 (11.19)	4.66 (11.92)	**4.41 (11.56)**	4.41 (11.02)	3.88 (9.68)	**4.15 (10.35)**	**5.20**
Sigma BG II	5.85 (13.12)	4.80 (9.81)	11.00	2.32	6.69 (13.05)	**6.15 (12.45)**	4.39 (11.48)	4.96 (12.28)	**4.67 (11.88)**	5.92 (13.31)	3.73 (9.54)	**4.82 (11.42)**	**5.53**
Sjgma BG I	7.13 (14.62)	3.88 (9.68)	10.67	2.01	5.55 (10.40)	**5.85 (12.05)**	3.98 (10.99)	4.97 (12.29)	**4.48 (11.64)**	7.13 (14.62)	7.44 (14.58	**7.28 (14.62)**	**5.86**
Sigma non *Bt*	6.40 (10.72)	6.75 (14.58)	11.18	2.30	6.35 (13.50)	**6.47 (13.04)**	5.02 (12.33)	3.87 (10.89)	**4.44 (11.59)**	4.36 (10.69)	4.53 (10.40)	**4.44 (10.54)**	**5.57**
6488 BG II	6.30 (13.50)	5.46 (12.72)	10.18	2.07	4.99 (10.77)	**5.82 (12.46)**	3.84 (10.41)	5.02 (12.33)	**4.43 (11.37)**	4.10 (10.45)	7.51 (14.58)	**5.81 (12.51)**	**5.51**
6488 BG I	6.50 (13.95)	6.87 (14.17)	11.04	1.96	4.99 (10.72)	**6.28 (12.90)**	4.63 (11.71)	2.57 (8.66)	**3.60 (10.19)**	5.35 (12.75)	5.39 (11.76)	**5.37 (12.26)**	**5.48**
CD(p=0.05)	2.45	2.61	NS	NS	2.50	**0.92**	1.09	1.14	**0.79**	1.70	3.04	**1.74**	**NS**
C V (%)	31.81	35.14	8.34	26.22	34.49	**27.29**	15.98	16.66	**16.32**	24.10	42.61	**34.68**	**27.36**

Mean of 3 replications, Figures in parentheses are “n+1 transformation

Table 3. Incidence of mealybug on different cotton hybrids in north India

Hybrids	Population of Mealybug/10 central shoot												
	Punjab						Rajasthan			Haryana			**Pooled mean**
	Mansa	Muktsar	Ferozpur	Ludh-iana	Bath-inda	**Pooled mean**	Srigan-ganagar	Hanum-angarh	**Pooled mean**	Sirsa	Fatehbad	**Pooled mean**	
RCH BG II	0.30	0.29	0.27 (1.90)	0.04 (0.52)	0.77 (3.98)	**0.33 (2.14)**	0.43 (2.64)	0.42 (2.74)	**0.42**	0.30	0.84	**0.57 (2.97)**	**0.40 (2.44)**
RCH BG I	0.38	0.84	0.74 (3.74)	0.05 (0.75)	0.65 (3.46)	**0.53 (2.84)**	0.42 (2.76)	0.34 (2.43)	**0.38**	0.38	0.66	**0.52 (2.82)**	**0.50 (2.78)**
RCH NON *Bt*	0.66	0.73	0.41 (2.40)	0.08 (0.98)	0.31 (2.34)	**0.44 (2.58)**	0.34 (2.46)	0.34 (2.06)	**0.34**	0.63	0.84	**0.74 (3.81)**	**0.48 (2.78)**
Sigma BG II	0.28	0.64	0.39 (2.42)	0.05 (0.71)	0.38 (2.41)	**0.35 (2.14)**	0.42 (2.71)	0.36 (2.51)	**0.39**	0.46	0.81	**0.64 (3.67)**	**0.42 (2.61)**
Sjgma BG I	0.62	0.84	0.38 (2.43)	0.07 (0.89)	0.66 (3.23)	**0.52 (2.83)**	0.36 (2.51)	0.50 (3.51)	**0.43**	0.62	0.86	**0.74 (3.87)**	**0.55 (3.10)**
Sigma non *Bt*	0.78	0.88	0.41 (2.46)	0.05 (0.71)	0.28 (2.23)	**0.48 (2.67)**	0.50 (3.36)	0.38 (2.58)	**0.44**	0.80	0.81	**0.80 (4.13)**	**0.54 (3.06)**
6488 BG II	0.28	0.30	0.91 (4.24)	0.04 (0.55)	0.81 (4.20)	**0.47 (2.75)**	0.24 (2.21)	0.58 (3.64)	**0.41**	0.35	0.46	**0.41 (2.66)**	**0.44 (2.77)**
6488 BG I	0.63	0.86	0.40 (2.40)	0.08 (0.89)	0.80 (4.11)	**0.55 (3.01)**	0.54 (3.57)	0.30 (2.31)	**0.42**	0.63	0.70	**0.67 (3.83)**	**0.55 (3.18)**
CD (p=0.05)	NS	NS	1.17	0.31	1.38	**0.56**	0.88	0.89	**NS**	NS	NS	**1.05**	**0.41**

Mean of 3 replications, Figures in parentheses are “n+1 transformation

BG II (0.44) recorded low population of mealybug. On an average of 2 districts of Haryana significant population was observed with minimum on 6488 BG II (0.41), RCH BGI (0.52), RCH BGII (0.57) in comparison to other cotton hybrids. On pooled analysis of 9 districts of North India significantly least population of mealy bug was noticed in RCH BG II (0.40), Sigma BG II (0.42), 6488 BG II (0.44) in comparison with other hybrids.

Thrips : The population of thrips did not differ significantly in the most of the districts except Ferozepur. In district Ferozepur, significantly low population was recorded in RCH BGI and 6488 BG II as compared to all others hybrids. The pooled analysis of five districts of Punjab recorded non significant observations with minimum population recorded in 6488 BG II (1.04), RCH BG I (1.09), Sigma BG I (1.11) in comparison to other *Bt* and non *Bt* hybrids. Significant population of thrips in district Sriganganagar reported, where it was lowest in RCH BGI (0.15) and 6488 BGI (0.17) Sigma non *Bt* (0.17) in comparison to other hybrids. In Hanumangarh district no significant results were obtained where population ranged from 0.78-1.33 thrips/three leaves. On pooled analysis based of two districts of Rajasthan, no significant difference in thrips population was observed on any *Bt* and non *Bt* cotton hybrids. In Haryana state, district Sirsa, maximum population of thrips was recorded on Sigma BGII (1.68) followed by RCH BGI (1.55) and Sigma non *Bt* (1.38) however, the data was statistically non significant. In Fatehbad, significant population of thrips was recorded where population range from 0.32 in RCH BGII to 1.88 in Sigma non *Bt*. Though there were significant differences among the hybrids, there were no significant differences between *Bt* and non *Bt* versions in any of the hybrid which indicated through mean population of thrips (Table 4). The overall mean population of thrips in all eight *Bt* and non *Bt* hybrids in 2 district of Haryana were statistically significant where thrips population ranged from 0.91 in Sigma BG I to 1.23 in Sigma BG II as compared to 1.13 in RCH non *Bt*, 1.08 in 6488 BG I, 1.07 in RCH BG I, 1.00 in RCH BG II and 0.96 in 6488 BG II.

Overall prospects of tested *Bt* and non *Bt* hybrids : *Bt* cotton to be a component of IPM their mandatory tolerance to sucking pests is a must. On the whole, the results of the present study showed that there were not much differences between *Bt* and non *Bt* versions of the same hybrids regarding the incidence of sucking pests which is in accordance with the work of Prasad and Rao, (2008) who reported that the incidence of sucking pests was more or less similar in both *Bt* and non *Bt* hybrids. However, some of the other reports showed that the

Table 4. Incidence of thrips on different cotton hybrids in north India

Hybrids	Population of thrips/ 3 leaves												
	Punjab						Rajasthan			Haryana			**Pooled mean**
	Mansa	Muktsar	Ferozpur	Ludh-iana	Bath-inda	**Pooled mean**	Srigan-ganagar	Hanu-mangarh	**Pooled mean**	Sirsa	Fateh-abad	**Pooled mean**	
RCH BG II	1.34	1.45	1.35(5.70)	0.39	1.33	**1.17**	0.24(1.76)	1.27	**0.75**	1.34	0.32(2.15)	**0.83(3.62)**	**1.00 (4.26)**
RCH BG I	1.57	1.46	0.64(2.82)	0.49	1.31	**1.09**	0.15(1.05)	1.13	**0.64**	1.55	1.33(5.00)	**1.44(5.54)**	**1.07 (4.51)**
RCH NON *Bt*	1.16	1.28	1.70(5.87)	0.38	1.44	**1.19**	0.42(2.95)	1.33	**0.87**	1.16	1.27(5.45)	**1.21(4.82)**	**1.13 (4.59)**
Sigma BG II	1.45	1.07	1.73(5.95)	0.46	1.57	**1.26**	0.84(4.18)	1.12	**0.99**	1.68	1.13(4.76)	**1.40(5.63)**	**1.23 (5.04)**
Sjgma BG I	1.31	1.13	1.58(5.70)	0.36	1.16	**1.11**	0.41(2.98)	0.78	**0.59**	1.31	0.17(1.37)	**0.74(3.41)**	**0.91 (4.07)**
Sigma non *Bt*	1.33	1.31	1.72(5.85)	0.39	1.45	**1.24**	0.17(1.37)	1.27	**0.72**	1.38	1.886.34)	**1.63(5.90)**	**1.21 (4.77)**
6488 BG II	1.45	1.49	0.64(2.82)	0.33	1.31	**1.04**	0.49(3.18)	0.84	**0.67**	1.33	0.76(3.73)	**1.04(4.30)**	**0.96 (4.27)**
6488 BG I	1.21	1.33	1.74(5.98)	0.38	1.33	**1.20**	0.17(1.37)	1.27	**0.72**	1.20	1.12(4.30)	**1.16(4.65)**	**1.08 (4.43)**
CD(p=0.05)	NS	NS	1.77	NS	NS	**NS**	1.27	NS	**NS**	NS	1.66	**1.09**	**0.50**

Mean of three replications, Figures in parentheses are "n+1 transformation

incidence of sucking pests was high in *Bt* hybrids than their non *Bt* counterparts (Abro *et al.,* 2004). Population of jassid was recorded high on BGI as compare to BGII and non *Bt* in all three cotton hybrids. RCH non *Bt* and Sigma non *Bt* hybrids recorded less population of whitefly than RCH and Sigma (BGII and BGI). In all the three *Bt* hybrids BGI (RCH, Sigma and 6488) recorded high population of mealybug. Similarly, in RCH BGI, 6488 BGI indicates susceptibility to thrips. Susceptible reaction of RCH, Sigma and 6488 BGI was recorded in all the sucking pests in comparison to BGII and respective their non *Bt* hybrids. From the above findings it can be concluded that the performance of *Bt* hybrid was variable for sucking insect pests. None of the *Bt* hybrids was tolerant to six BGI and BG II cotton genotype. The present study was corroborate by Vennila *et al.*, 2004 and Vijay *et al.*,2012. So if the *Bt* transgenic cotton hybrids are to be the part of IPM, direct selection for sucking pests is a most right from the first step *Bt* gene introgression breeding for parents.

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