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Research Article

ASSESSMENT OF BT COTTON HYBRIDS AGAINST BROWN MIRID BUG, *CREONTIADES BISERATENSE* DISTANT (HEMIPTERA: MIRIDAE)

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ABSTRACT

The field study was conducted to evaluate the *Bt* cotton hybrids against mirid bug, *Creontiades biseratense* Distant (Hemiptera:Miridae) at Cotton field of Perambalur district during 2015-2016 and 2016-2017 with 17 BG II *Bt* hybrids and 2 varieties. The data revealed that Ankur Jai BG II *Bt* and VICH 303 BG II *Bt* hybrids recorded lowest mirid bug population (8.68 bugs/plant, 9.09 bugs/plant), lowest per cent square damage (10.18& 12.73), poor per cent parrot beak bolls (2.27& 3.5) and highest seed cotton yield (1773.2 kg/ha & 1788 kg/ha)among the tested hybrids during 2015-2016. Whereas Ankur Jai BG II Bt alone recorded lowest mirid bug population (7.84 bugs/plant), lowest per cent square damage (7.83) and lowest per cent parrot beak bolls (2.69) during 2016-2017. But VICH 303 BG II Bt hybrid recorded highest seed cotton yield (1786 kg/ha) than Ankur Jai BG II *Bt* (1752 Kg/ha) during 2016-2017.This study concluded that, none of the *Bt* hybrids were not resistant to mirid bugs but Ankur Jai & VICH 303 BG II *Bt* hybrids recorded lowest mirid bug population, poor fruiting bodies damage and highest yield. Use of these two genotypes should be an important component while formulating the IPM strategies for the management of mirid bug, *C.biseratense* in *Bt* cotton.

INTRODUCTION

Cotton is one of the most important fiber crop in the world and plays a pivotal role in social and economic development of India. The data from Cotton corporation of India indicates that during 2015-16, cotton was planted in an area of 118.81 lakh ha, which produced 352 lakh bales with the productivity of 504 kg/ha. Arthropod pests have likely affected cotton since it was domesticated at least 3,000 years ago (Lee and Fang, 2015). A large number of arthropod species have been described as cotton pests, but only less than 40 of them are considered key pests of the crop (Wilson *et al.,* 2013). They directly decrease yield or reduce fiber quality and their management is a key challenge for cotton growers worldwide. Potential losses up to 40% occur from invertebrate pests alone in cotton (Oerke, 2006).

The introduction and successful implementation of transgenic *Bt* cotton not only solved the problem of bollworm complex but also cut down the number of insecticidal spray which probably leads sever incidence of sucking pest and occupied major pest status and cause considerable damage in traditional and *Bt* cotton in India at present (Zala *et al.,* 2014). This is consistent with Indian *Bt* farmers' perceptions, who attributed a total of 77% of cotton damage to aphids and other sucking pests and only 23% to the primary Lepidopteran pests, leading to 99% of the famers spraying against secondary pests (Stone, 2011). Adopting farmers are either still using significant numbers of insecticide applications to control secondary pests, or the damage caused by these pests has increased. The reduction in the use of insecticides in *Bt* cotton can increase the population of sucking insect pests (Men *et al.,* 2004) and hence sucking pests have become a more significant part of insect pest complex in *Bt* cotton. This is fact that genetically engineered cotton crop has successfully controlled bollworms but, it has adversely affected the sucking complex of cotton crop (Wu *et al.,* 2002).

Saravanan *et al*., (2014) reported that the incidence of *C.biseratense and C.livida* in Perambalur district of Tamil Nadu occurred in 2008 and 2010 respectively and the population increased year by year. As the mirid bugs are known to attack fruiting bodies leading to shedding of squares and tender bolls, results in drastic reduction in seed cotton yield. Crop losses of up to 54 % have been reported for those

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stages by Stamp, (1987) however, Mehdi and Mohammad (2004) reported losses as high as 82 % if the pest attacked during flowering. HPR could support sustainable IPM in GM cotton systems by reducing the need to apply insecticides against emergent pests or other secondary pests. Cultivars resistant to key emergent or secondary pests would require less pesticide applications, thus reducing costs, increasing the population of beneficial insects and helping the environment. Keeping the above facts, the following experiment was carried out in 17 BG II *Bt* hybrids and two varieties to test their resistance on mirid bug *C.biseratence.*

MATERIALS AND METHODS

The experiment was laid out in Anukkur village of Perambalur Disttrict, Tamilnadu during 2015-2016 and consecutive seasons to the host plant resistant of *Bt* hybrids against mirid bug *C.biseratense* under unprotected field conditions. The hybrids comprised of four inter specific (H×B), 13 intra specific (H×H)*Bt* cotton hybrids from 7 seed companies that contain dual genes were used for this study. RCH 2 BG II Bt hybrid was used as local check and two non *Bt* varieties were used as check (Table 1).The individual treatment (had no replication) plot size was3.6 x 13.5 m^2. Each hybrids/varieties accommodated four rows with 15 plants/ row and a total of 60 plants per genotype/variety at a spacing of 90 cm between rows and 90 cm between plants in a randomized block design. Each *Bt* cotton genotypes and two varieties were sown at 2 seeds/hill on 18^{th} August 2015 and 16^{th} August, 2016 by hand dibbling method in deep black cotton soil. Gap filling and thinning was done within 5-7 days and 15 days after emergence of the crop respectively keeping one healthy seedling/hill. Each *Bt* cotton hybrids/varieties were raised with all agronomical practices recommended by Tamil Nadu Agricultural University in respect torainfed faming situation except plant protection measures.

Observations

The population of mirid bug *C.biseratense* was recorded at weekly interval from 5 randomly tagged plants from each hybrid/variety. Khan *et al*., 2004 stated that the ETL of mirid bug (0.5 miridbug/meter in cool season & 1 mirid bug /metre in warm season) by visual observation method. Observations on square damage by mirid bugs, per cent square damage, number of parrot peak bolls, per cent parrot peak bolls, were recorded from 5 tagged whole plants in respect to each hybrid/variety. The seed cotton harvested from each hybrids/varieties were extrapolated and presented as seed cotton yield (kg/ha) for the respective hybrid.

The following formula were adopted for percent damage calculation:

$$\text{Percent square damage} = \frac{\text{No. of squares damaged}}{\text{Total number of squares formed}} \times 100$$

$$\text{Percent Parrot peak bolls} = \frac{\text{No. of Parrot peak bolls observed}}{\text{Total number ofbolls}} \times 100$$

Statistical analysis

The data obtained were statistically analyzed to find out the tolerance of *Bt*-cotton hybrids with respect to mirid bug population, fruiting bodies damage and yield potential. Data were subjected to analysis of variance under randomized design using AgRes statistical software version 3.01 (Pascal Intl software solutions). A significance level of P<0.05 was used to separate means using critical difference values.

Table 1 List of *BT* hybrids/varieties tested against Mirid bug, *C.biseratense*

Sl.No.	Type of *Bt* hybrids/variety	Genotype/cultivar	Gene incorporated (Transgenic events)	Seed company
1.	Interspecific (H×B) BG II *Bt* hybrids	MRC 7918 BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Maharastra hybrid seed company Pvt. Ltd.
2.		MRC 6918 BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Maharastra hybrid seed company Pvt. Ltd.
3		RCH 708 BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Rasi seed company Pvt. Ltd.
4		Surphos Asha BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Bayer crop Science Pvt. Ltd
5	Intraspecific (H×H) BG II *Bt* hybrids	RCH 2 BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Rasi seed company Pvt. Ltd.
6		RCH 530 BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Rasi seed company Pvt. Ltd.
7		RCH 659 BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Rasi seed company Pvt. Ltd.
8		RCH 20 BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Rasi seed company Pvt. Ltd.
9		MRC 7351 BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Maharastra hybrid seed company Pvt. Ltd.
10		VICH-303 BG II	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Maharastra hybrid seed company Pvt. Ltd.
11		Ankur 3034 BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Ankur seeds Pvt. Ltd.
12		Ankur Jai BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Ankur seeds Pvt. Ltd.
13		Tulsi 144 BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Tulsi seeds Pvt. Ltd.
14		KCH- 15 K 39 BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Kaveri seeds Pvt. Ltd.
15		KCH-15 K 59 BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Kaveri Seeds Pvt. Ltd.
16		Malliga Gold BG II *Bt* cotton (NCS-859)	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Nuzuveedu seeds Pvt. Ltd.
17		Uttam BG II *Bt* cotton	Cry 1Ac & Cry 2Ab (Mon 15985)	M/s. Nuzuveedu seeds Pvt. Ltd.
18	Variety	Suraj	-	Central Institute for Cotton Research
19		Suraj	-	Central Institute for Cotton Research

RESULTS

Mirid bug population

Based on the experimental field data, lowest Mirid bug population/plant was foundon Ankur Jai BG II *Bt* (8.68 bugs/plant) followed by VICH 303 BG II *Bt* (9.09 bugs/plant).Moderate mirid bug population (in the range of 10-15 bugs/plant) was recorded in RCH 2 BG II *Bt* (10.44 bugs /plant), MRC 7351 BG II *Bt* (12.84 bugs/plant) and Tulsi144 BG II *Bt* (14.632 bugs/plant). While remaining *Bt* hybrids recorded higher mirid bug population (in the range of above 15 bugs/plant) during 2015-2016. Whereas lowest mirid bug population were recorded in Ankur Jai BG II *Bt* (7.84 bugs/plant) alone.

Moderate mirid bug population (in the range of 10-15 bugs/plant) was recorded in local check RCH 2 BG II *Bt* (10.63 bugs/plant), VICH 303 BG II *Bt* (11.55 bugs/plant) and MRC 7351 BG II *Bt* (12.80 bugs/plant) while remaining hybrids were showed highest mirid bug population (in the range of above 15 bugs/plant) during 2016-2017 (Table 2 &3).

Fruiting bodies damage

Significantly lowest per cent square damage and per cent parrot beak bolls were recorded in Ankur Jai BG II *Bt* (10.18 % and 2.27 %) followed by VICH 303 BG II *Bt* (12.73 % & 3.5 %) respectively. MRC 7351 BG II Bt hybrid was recorded comparatively lowest per cent square damage (13.32 %) and per cent parrot beak bolls (13.29 %) than the rest of other hybrids tested during 2015-2016 respectively.

Table 2 Performance of *Bt* hybrids against mirid bug *C.biseratense* under field conditions during 2015-2016

Name of the Cotton hybrids/variety	Mirid bug Population (Nos/plant)	Square damage by mirid bug (Nos/plant)	% Square damage	Parrot peak bolls (Nos/plant)	% parrot beak bolls/plant	Seed cotton Yield (kg/ha)
MRC 7918 BG II *Bt*	34.64(5.97)	40.36	26.70	22.73	34.27	1144.0
MRC 6918 BG II *Bt*	31.49 (5.7)	38.29	28.19	19.55	33.44	1131.6
RCH 708 BG II *Bt*	26.38 (5.23)	32.25	23.49	16.34	33.88	1177.0
Asha BG II *Bt*	27.74 (5.36)	33.15	26.04	20.72	36.67	1183.6
RCH 530 BG II *Bt*	17.29 (4.28)	27.23	22.29	13.43	28.21	1569.6
RCH 659 BG II *Bt*	16.98 (4.24)	29.80	25.06	14.70	27.52	1576.4
RCH 20 BG II *Bt*	22.48 (4.85)	28.72	24.78	14.15	32.86	1448.0
MRC 7351BG II *Bt*	12.85 (3.72)	15.67	13.32	6.53	13.29	1569.8
VICH-303 BG II *Bt*	9.09 (3.18)	14.65	12.73	2.07	3.5	1788.0
Ankur 3034 BG II *Bt*	22.46 (4.84)	28.23	24.86	14.63	33.52	1308.4
Ankur Jai BG II *Bt*	8.68 (3.11)	12.56	10.18	1.43	2.27	1773.2
Tulsi 144 BG II *Bt*	14.63 (3.95)	22.84	19.42	7.38	17.61	1268.0
KCH-15 K 39 BG II *Bt*	20.57 (4.64)	27.8	25.45	10.64	25.47	1212.6
KCH-15 K 59 BG II *Bt*	21.49 (4.74)	27.05	22.11	13.02	29.27	1311.4
Malliga gold BG II *Bt*	17.59 (4.31)	24.07	18.29	13.02	25.63	1454.8
Uttam BG II *Bt*	15.53 (4.07)	19.15	14.92	7.74	15.89	1530.0
RCH 2 BG II *Bt* (L.C)	10.44 (3.38)	19.22	15.33	5.13	9.17	1600.0
Suraj (C)	9.73 (3.28)	14.35	17.02	1.20	5.22	784.2
Surabi (C)	9.41 (3.23)	14.44	16.88	0.97	4.39	799.6
SEd	1.72	1.68	1.51	1.23	2.88	39.69
CD (0.05)	3.4354	3.3621	3.00	2.46	5.75	79.12
CV %	14.82	10.78	11.71	19.16	21.02	4.65

Figures in parentheses are √x+1 transformed values L.C- Local Check, C-Check

Table 3 Performance of *Bt* hybrids against mirid bug *C.biseratense* under field conditions during 2016-2017

Name of the Cotton hybrids/variety	Mirid bug Population/plant	Square damage by mirid bug	% Square damage	Parrot peak bolls/plant	% parrot beak bolls/plant	Yield (kg/ha)
MRC 7918 BG II *Bt*	34.79 (5.98)	38.94	23.69	21.76	33.9	1304.0
MRC 6918 BG II *Bt*	32.03 (5.74)	37.16	22.84	20.26	33.20	1278.0
RCH 708 BG II *Bt*	26.98 (5.29)	30.87	19.95	18.36	31.94	1223.4
Asha BG II *Bt*	28.29 (5.41)	32.04	21.46	19.87	36.48	1213.8
RCH 530 BG II *Bt*	16.29 (4.16)	24.26	19.02	13.43	21.38	1626.0.
RCH 659 BG II *Bt*	16.15 (4.14)	28.89	22.56	15.06	23.80	1654.0
RCH 20 BG II *Bt*	21.76 (4.77)	23.92	18.25	14.57	23.80	1418.4
MRC 7351BG II *Bt*	12.80 (3.71)	13.92	9.95	6.77	10.54	1481.0
VICH-303 BG II *Bt*	11.55 (3.54)	12.68	8.81	3.3	4.63	1786.0
Ankur 3034 BG II *Bt*	22.57 (4.85)	25.87	17.82	15.36	27.46	1372.4
Ankur Jai BG II *Bt*	7.84 (2.97)	11.48	7.83	1.91	2.69	1752.0
Tulsi 144 BG II *Bt*	14.74 (3.97)	20.86	15.54	8.49	16.22	1151.2
KCH-15 K 39 BG II *Bt*	20.64 (4.65)	26.3	18.15	10.41	18.48	1319.2
KCH-15 K 59 BG II *Bt*	21.03 (4.69)	26.02	17.79	11.81	21.15	1360.0
Malliga gold BG II *Bt*	17.87 (4.34)	23.42	15.31	11.67	18.71	1498.0
Uttam BG II *Bt*	17.47 (4.30)	19.22	12.99	11.64	18.51	1578.0
RCH 2 BG II *Bt*(L.C)	10.63 (3.41)	15.36	11.61	6.10	9.08	1681.4
Suraj (C)	8.65 (3.11)	12.86	13.29	1.46	3.74	780.6
Surabi (C)	8.06 (3.01)	13.12	12.73	2.22	7.35	796.0
SEd	1.29	1.14	1.02	1.33	2.56	43.96
CD (0.05)	2.57	2.26	2.03	2.66	5.11	87.62
Cv %	11.06	7.81	9.84	18.69	21.31	5.05

Figures in parentheses are √x+1 transformed valuesL.C- Local Check, C-Check

While significantly lowest per cent square damage were recorded in Ankur Jai BG II *Bt* (7.83 %), VICH 303 BG II *Bt* (8.80 %) followed by MRC 7351 BG II *Bt* (9.95 %) during 2016-2017. Remaining hybrids showed highest per cent square damage. Ankur Jai BG II *Bt* (2.69 %) followed by VICH 303 BG II *Bt* (4.63 %)recorded significantly lowest per cent parrot beak bolls compared to other hybrids during 2016-2017 (Table 2 & 3).

Seed cotton yield

The highest seed cotton was recorded in VICH 303 BG II *Bt* (1788 kg/ha), Ankur Jai BG II *Bt* (1773 kg/ha) followed by local check RCH 2 BG II *Bt* (1600 kg/ha) whereas lowest seed cotton yield were recorded in MRC 6918 BG II *Bt* (1131.6 kg/ha), MRC 7918 BG II *Bt*(1144 kg/ha) during 2015-2016. However, the hybrids VICH 303 BG II *Bt* (1786 kg/ha) followed by Ankur Jai BG II *Bt* (1752 kg/ha) recorded highest seed cotton yield when compared to MRC 6918 BG II *Bt* (1151.2 kg/ha), MRC 7918 BG II *Bt* (1193.6 kg/ha) during 2016-2017. The rest of the hybrids recorded moderate seed cotton yield during both the years (Table 2 & 3).

DISCUSSION

The release of transgenic cotton hybrids for commercial cultivation has revived the cotton production. Transgenic cotton is a promising new means of managing the boll worms, which has developed resistance to most of the insecticide groups. Although insecticides are not applied against main insect, i.e. bollworm complex, but additional applications are required against sucking pests to avoid yield losses (Xingyuan *et al.,* 2004).The introduction of *Bt* technology, at least in the early years, brought significant decreases in insecticide application among adopters, considerably alleviating the negative impacts associated with such insecticides (Kouser and Qaim, 2011; Krishna and Qaim, 2012). Despite warnings from several authors (e.g. Sharma and Ortiz, 2000; Wu and Guo, 2005) that some NTOs could appear in such numbers that they become key insect pests in *Bt* crop fields, specific measures to combat their population increases were not taken. Consequently, there have been outbreaks of secondary pests which were previously controlled by the insecticide applications originally targeting the primary pest (Lu *et al.,* 2010). This situation has been particularly evident in *Bt* cotton production in China. Less than 3 years after its introduction in 1998, several pest groups including whiteflies, plant hoppers, aphids, mirids and mealy bugs increased in number (Men *et al.,* 2004; Yang *et al.,* 2005a).

Almost all the cultivated species of *Bt* cotton hybrids are affected by miridbugs. The mirid bug *Poppiocapsidea* (=*Creontiades*) *biseratense* Distant (Miridae: Hemiptera) has recently gained more attention from scientific and farming community due to its dangerous damaging symptoms. The pest was just recorded as a minor pest, but it has gained importance during recent years and it was reported in 2005 in Karnataka and resulted in considerable damage to *Bt* cotton (Patil *et al.,* 2006). Also Saravanan *et al.,* (2014) reported that the incidence of *C.biseratense and C.livida* in Perambalur district of Tamil Nadu occurred in 2008 and 2010 respectively and the population increased year by year. As the mirid bugs are known to attack fruiting bodies leading to shedding of squares and tender bolls, results in drastic reduction in seed cotton yield. Rohini and Mallapur (2010) support the present findings, who reported that the BG II inter specific *Bt* cotton hybrids recorded maximum mirid bug population than BG intra specific *Bt* cotton hybrids and BG-II intra specific *Bt* hybrids. Our finding also corroborate with the finding of Nagrare *et al* 2014 who reported that Mirid bug population was lowest and on par among JKCH 99 BG(0.35 mirids/plant), Ankur 3042 BG II (0.25), Menaka BG II (0.34), Mahadev BG II(0.36), Classic BG II(0.41), VICH 301 BG II(0.44), Ankur Jai BG II(0.42), Madhura BG(0.46), Veda 2 BG II(0.46) and Ryan BG(0.48). Moderate mirid population (in the range 0.52 – 0.89 mirids/plant) was recorded in Namskar BG II, VICH 314 BG II, Aadhar BG, MRC 7301 BG II , Kohinoor BG, VICH 312 BG II, Krish BG II, Vanaja BG, Atal BG II, Bunny BGII, Ankur 3028 BG, ALTO BG II, SP 504 BG II, VICH 303 BG II, Ankur 3070 BG II, Express BGII, Ankur 3034 BG II, VICH 311 BG II, Ankur 216 BG II, Ishwar BG, Superman BG II, Bunny BG, Krishna BG II, Shrimanth BG, Manjeet BG II, Ankur 257 BG II, Mallika Gold BG II, VICH 313 BG II. While remaining hybrids showed high susceptibility to mirids.

Present study also corroborated by Udikeri *et al.* (2009) who observed that the mean number of 32.4 mirid bugs/25 squares in inter specific *Bt* cotton hybrids viz., MRC-6918 and RCH-708. Whereas, BG-II intra specific hybrids like MRCH-7347, MRCH-7351, RCH-2, RCH-530 and RCH-533 recorded an average of 24.9 mirid bugs/25 squares. Sankar *et al.,* (2011) supported our study that highest population of mirid bug (*C.biseratense*), square shedding, boll shedding, parrot beak bolls and lowest seed cotton yield were recorded in MRC 7918 BG II *Bt* cotton hybrid. Prakash *et al.*, 2013 reported that, Brahma recorded least number of mirid bugs (1.72 bugs/5 squares/plant) followed by VICH 303 (1.80 bugs/5 squares/plant), while non Bt hybrid DCH-32 recorded high incidence of 3.84 bugs/5 squares per plant. Mirid bug incidence was found to be high on genotypes which had higher trichome density, and hence the hairy varieties NCS-145, MRC-7351 and Tulsi-144 might have been prone to mirid attack as compared to glabrous varieties like Brahma, VICH-303 and RCH-530.

CONCLUSION

Relationship between the incidence of mirid bug and seed cotton yield could not be interpreted since the yield was largely influenced by variation in genotype of a cotton hybrid. However, Ankur Jai BG II *Bt*, VICH 303 BG II *Bt* hybrids recorded lowest mirid bug population, poor fruiting bodies damage and highest seed cotton yield when compared to others. Cotton farmers must opt for lowest mirid bug population genotypes/varieties to reduce the use of insecticidal sprays against mirid bug in cotton agroecosystem, to save input costs and to maintain ecological balance by conserving natural enemies. Use of tolerant genotypes should be an important component while formulating the IPM strategies.

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