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Screening of different cotton hybrids containing *Bt* genes against *Pectinophora gossypiella* (Saunders)

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Abstract
Field experiment was conducted at Agricultural Research Station, Dharwad farm, Dharwad during 2018-19 and 2019-20 to evaluate performance of eighteen different cotton genotypes representing four different *Bt* events. Damage due to pink boll worm (PBW) was least in interspecific (H×H) hybrids compared to interspecific hybrids (H×B) hybrids. Cotton Hybrid Everest recorded least square damage, flower damage, green boll and locule damage followed By Jadoo in both the seasons. Highest number of GOB/plant 26.68/pl and 25.89/pl observed in interspecific (H×H) hybrid Everest during 2018-19 and 2019-20, respectively, followed by Jadoo (25.61/pl in 2018-19 and 24.45/pl in 2019-20). Further, Everest recorded highest kapas yield of 15.88 q/ha and 14.52 q/ha followed Jadoo which recorded 14.90 and 13.68 q/ha of kapas yield during 2018-19 and 2019-20, respectively.

Keywords: Cotton hybrids, *Pectinophora gossypiella*, BT genes, screening

Introduction

Cotton is a significant commercial crop, playing a spectacular role in India's social, financial and political undertakings and it is gifted to human civilization (Atwal, 2002) [3]. Cotton shows a variety of insect pest spectrum and about 1326 species of insect pests have been reported worldwide (Imran Nadeem *et al.*, 2023) [11]. China, India and the United States are the leading cotton-producing countries. India cultivates more than 11 million hectares annually and has the largest area in the world. The exact area under *Bt* cotton in 2023 is 13.06 mha with production of 343.47 lakh bales (CCI, 2023) [7]. The three bollworms, American bollworm *Helicoverpa armigera* (Hubner) Hardwick, Pink bollworm (PBW) *Pectinophora gossypiella* Saunders and the Spotted bollworms- *Earias vittella* (Fabricius) and *Earias insulana* (Boisduval) are the major pests and cause serious threat to cotton production resulting in significant yield losses (Agarwal and Katiyar, 1979) [1].

The pink bollworm *P. gossypiella*, was described by W.W. Saunders in 1843 as *Depressaria gossypiella* from specimens found to damaging cotton in India. It is a stenophagous pest which has coevolved with malvaceous food plants like cotton, okra, deccan hemp and roselle (Anon, 2017) [2]. At present, the pink bollworm has been recorded in nearly all cotton-growing countries of the world and is a key pest in many of these areas. Unlike present situation approximately 40,672 t of pesticides were sprayed on cotton crop prior to the actual implementation of *Bt* cotton, these insecticides were mainly aimed at the bollworms species (Bambawale *et al.* 2004; Dhaliwal and Arora, 2003) [4, 8]. This caused widespread ecological disruption leading to exacerbation of bollworm and secondary pest problems in cotton ecosystem (Kranthi *et al*. 2002; Kranthi and Russell 2009; ICAC 2010) [19, 18, 10]. James (2014) [12] reported that *Bt* cotton cultivation has significantly reduced insecticide use, increased productivity and improved environmental quality. Field evolved resistance to *Bt* cotton has been reported in pink bollworm, *P. gossypiella* to Cry1Ac in India in 2008 (Dhurua and Gujar, 2011) [9]. Expression of Cry2Ab in Bollgard®-II is reported to be 10 to 100 fold more as compared to Cry1Ac (Knight *et al*., 2013) [14] which render the pink bollworm under more selection pressure of Cry2Ab. The suppression of bollworms is a great success in India until the survival reports of pink bollworm during 2009. In recent years, severe damage to bolls by pink bollworm and yield-losses were observed in *Bt*-cotton in many regions of Gujarat and some parts of AP, Telangana and Maharashtra (Kranthi, 2015) [17]. Thus further study was carried to assess the efficacy of various Bt cotton hybrids.

Materials and Methods

The experiment included fifteen *Bt* and three non-*Bt* cotton genotypes representing all cultivated species of cotton and different *Bt* events as well at ARS Hebballi Farm, Dharwad. The treatment details are as given in the (Table 1). The crop was raised by following the production practices recommended by UAS Dharwad, except for the plant protection measures against bollworms.

Design and layout

The experiment was laid out in Randomized Complete Block Design with three replications. The plot size was 5.4 × 5.4 m^2 with spacing of 90 × 60 cm. Each plot accommodated six rows with 10 plants/ row and a total of 60 plants per treatment.

Sowing, crop maintenance and harvest.

The sowing was done on June 16^{th}, 2018 and July 23^{rd} in 2019 in deep black cotton soils by dibbling with intra row spacing of 60 cm and inter-row spacing of 90 cm. In each plot 60 plants were maintained with gap filling and thinning after a week of germination. The fertilizer application was at the rate of 100:50:50 Kg of NPK/ha in the form of Urea, DAP and MOP with two splits of N, at sowing and at 40 DAS. Crop was kept weed free through regular intercultural operations and hand weeding. The crop was protected from sucking pests by spraying Acetamiprid 20 SP 0.15 g/l at 30 and 60 DAS, respectively during both the years. Harvesting of seed cotton was done as a single picking after allowing complete boll bearing and bursting to tap maximum genetic potentiality.

Data collection

For assessing the comparative performance of these *Bt* and non-*Bt* cotton genotypes season long observations were made on pink bollworm incidence at weekly intervals for flower and green boll damage till the harvest and were computed by the formulae as indicated below.

a) Square damage

$$\text{Damaged squares (\%)} = \frac{\text{Number of damaged squares}}{\text{Total number of square}} \times 100$$

b) Flower damage

$$\text{Rosette flowers (\%)} = \frac{\text{Number of rosette flowers}}{\text{Total number of flowers}} \times 100$$

c) Green boll damage

$$\text{Green boll damage (\%)} = \frac{\text{Number of green bolls with PBW}}{\text{Total number of green bolls}} \times 100$$

d) Larval population: Twenty randomly plucked bolls were carefully examined in the laboratory, for the presence of PBW larvae.

e) Locule damage

$$\text{Locule damage (\%)} = \frac{\text{Number of damaged locules}}{\text{Total number of locules}} \times 100$$

f) Seed cotton yield: The seed cotton was harvested from every plant except border rows. The kapas yield per plot was converted into quintal per ha. The kapas was stratified as good and bad kapas.

Data analysis

The data generated on number of larvae per 20 bolls/plant were subjected to $\sqrt{x + 0.5}$ transformation. The percent values on damage to squares, flower rosetting, green boll and locules were transformed to arc sine values and then were subjected to one way ANOVA using MSTATC® software package and treatments performance were compared through DMRT.

Results and Discussion

Square damage

2018-19

During 2018-19, square damage varied among the different *Bt* genotypes. BG-II cotton hybrid, Everest BG-II proved to be statistically superior over other BG-II, BG-I and GMF event hybrids with least mean square damage of 0.37 percent. The damage began to increase from 60 DAS to 130 DAS and declined after 150 DAS. While, (H × H) hybrids, Bindas and First class were on par with each other which recorded 1.81 and 2.15 percent respectively (Table 2).

Seasonal mean square damage in inter specific (H × B) hybrids recorded highest square damage compared to inter specific (H × H) hybrids. Among the inter specific hybrids, the level of damage on squares was highest in MRC-6918 BG-I with 8.06 percent followed by MRC-7918 (3.96%) and Sowmya (3.93%) which are on par with each other. While, BG-I hybrid VCH-5 (H × H) recorded damage to the tune of 6.76 percent**.** However, non-*Bt* genotypes of cotton DCH 32 (H× B hybrid) and DHH-263 (H × H hybrid) have shown highest square damage of 18.44 and 17.56 percent respectively, followed by conventional cotton genotype *G. hirsutum* Sahana, which recorded 15.02 percent of damaged squares.

2019-20

The incidence of PBW on squares of different *Bt* and non *Bt* cotton hybrids at different crop growth stages during 2019-20 has been tabulated in table 2. The damaged squares were observed from 60 DAS to till 150 DAS and their number increased gradually. The higher larval incidence of PBW in squares was noticed at 130 DAS in all genotypes and least mean square damage of 2.17 percent was recorded in Everest BG-II and was on par with Jadoo (2.39%) and Bindas (2.43%). While, among H × B hybrids, MRC-7918 and Sowmya recorded the damage to the extent of 4.72 and 4.23 percent respectively, which were highest and on par with each other. In GMF events Arjun-21 and Profit+ recorded 13.83 and 13.54 percent damage and were in comparable with other *Bt* events. However, Non *Bt* hybrid DCH-32 recorded mean percent square damage of 19.56 followed by DHH-263 (18.53%) and Sahana (17.71%).

From the table 2, it was also evident that square damage due to PBW larvae crossed ETL at 130 DAS (>10% damage) and interestingly it was observed in MRC-6918 and VCH-5 which were BG-I event hybrids. At 90 DAS, the damage was above ETL in non *Bt* cotton genotypes *viz.,* DCH-32, DHH-263 and Sahana. In any of the *Bt* cotton genotypes except MRC-6918 and VCH-5 (both seasons) the damage have not crossed above 10 percent at any time. Whereas, in conventional cotton genotypes, mean square damage was more than 30 percent at 130 DAS.

Flower damage due to pink bollworm

The flowers of cotton infested by PBW larvae fail to open properly and remain rosetted. The data on flower rosetting (%) in different genotypes during 2018-19 and 2019-20 observations have been presented in table 3.

2018-19

In 2018-19, the flower rosetting (%) observed in all cotton genotypes from 60 DAS to till crop harvest (Table 3). Damage level varied among different *Bt* genotypes, BG-II cotton hybrid "Everest" proved to be significantly superior over other BG-II, BG-I and GMF event hybrids. It was with variation of 1.45 to 14.81 percent flower damage in cropping season and mean of 8.90 percent followed by Jadoo (9.37 mean% damage). The damage started increasing from 60 DAS to 130 DAS and declined after 110 DAS. Among, H × H hybrids, Bindas and First class were on par with each other, with mean damaged flowers of 9.68 and 10.43 percent, respectively. The interspecific hybrids recorded highest flower damage compared to H × H hybrids. Among the H × B hybrids, highest level of flower damage was obtained in MRC-6918 (BG-I) with 15.29 percent, followed by MRC-7918 (13.92%) and Sowmya (13.36%) and were on par with each other. While, BG-I hybrid VCH-5 (H × H) recorded damage to the tune of 14.14 percent and was comparable to former interspecific hybrid**.** Among non-*Bt* genotypes of cotton, DCH-32 (H× B hybrid) and DHH-263 (H × H hybrid) have shown highest flower damage of 21.71 and 19.09 percent, respectively, followed by conventional cotton genotype *G. hirsutum,* Sahana (17.65%).

2019-20

The incidence of PBW on flowers of different *Bt* and non *Bt* cotton hybrids recorded at different duration of crop growth for the year 2019-20 was revealed in table 3 and the highest flower damage was noticed at 90 DAS in all genotypes. Meantime, lowest mean flower damage of 9.91 percent was registered in Everest BG-II and was on par with Jadoo (10.03%) and Bindas (10.26%). However, interspecific (H × B) hybrids, MRC-7918 and Sowmya recorded the highest damage to the extent of 15.10 and 14.28 percent, respectively, among all BG-II genotypes. Meanwhile, non *Bt* hybrid DCH-32 recorded highest mean percent flower damage of 23.43, followed by DHH-263 (20.58%) and Sahana (18.51%) irrespective of genotypes.

Green boll damage

2018-19

During 2018-19, data on boll damage followed the similar pattern as off square and flower damage and could reveal the fact that PBW larvae infest bolls irrespective of *Bt* or non *Bt* genotypes (Table 4). The incidence was visible and varied in the field starting from 75 days after sowing (DAS) causing peak damage at 135 DAS and persisted till harvest. It was evident from the data that Everest BG-II *Bt* registered significantly least mean boll damage of 12.93 percent among all genotypes tested. However, peak incidence of green boll damage was observed at 135 DAS with damage of 26.21 percent. This was followed by Jadoo and Bindas which were statistically on par with each other with 13.92 and 14.60 percent of mean green boll damage, respectively. Peak infestation in green bolls was observed during 135 DAS in both the cases. Whereas, genotype First class remained next in order with 15.17 percent mean green boll damage. However, H × B hybrid MRC-7918 recorded significantly highest green boll damage (18.02%) among the rest of BG-II genotypes with peak infestation of 33.90 percent at 135 DAS. Amongst of all the *Bt* genotypes, the highest damage was noticed in MRC-6918 wherein, infestation level was 22.05 with peak damage of 40.81 percent at 135 DAS. Meanwhile, GMF event *Bt* hybrids Arjun-21 and Profit+ recorded damage at the rate of 17.84 and 16.69 percent, respectively and comparable with other BG-II genotypes (Table 4).

The non-*Bt* genotypes DCH-32 recorded significantly highest seasonal mean green boll damage of 38.38 percent but the peak at 135 DAS (69.15%) and was on par with DHH-263 with seasonal mean damage of 36.48 percent and the maximum damage of 64.70 percent at 135 DAS. These were followed by *hirsutum* variety Sahana, which recorded 26.39 percent of seasonal mean green boll damage with maximum of 38.73 percent at 135 DAS.

2019-20

The incidence of PBW on green bolls of different *Bt* and non *Bt* cotton hybrids recorded at different duration of crop growth for the year 2019-20 has been formulated in table 4. The highest incidence of PBW in green bolls was noticed at 130 DAS in all genotypes. However, least seasonal mean boll damage of 14.92 percent was noticed in H × H hybrid Everest (BG-II) *Bt* and was on par with other H × H hybrids *viz,* Jadoo (15.97%) and Bindas (16.91%). While, H × B hybrids, MRC-7918 and Sowmya recorded the highest seasonal mean damage at the level of 20.60 and 20.43 percent, respectively and were highest among all BG-II genotypes and on par with each other. However, highest boll damage among BG-I hybrids was found in VCH-5 and MRC-6918 hybrids with boll damage of 23.72 and 26.64 percent, respectively. In non *Bt* genotypes, DCH-32 hybrid recorded mean percent green boll damage of 44.01, followed by DHH-263 (41.98%), while genotype Sahana recorded 28.59 percent boll damage and was on par with DHH-263.

Larval population of pink bollworm in green bolls

Irrespective of seasons, an increasing trend in the population of PBW larvae was observed till 135 DAS and gradually declined after 150 DAS across genotypes. The presence of the larval population was also striking in all the genotypes irrespective of
Bt events and conventional genotypes.

2018-19

The incidence of PBW on green bolls started from 75 DAS until the harvest of the crop. The incidence varied vividly in all the genotypes throughout the season. During 2018-19, the lowest number of 6.21, 6.68 and 7.21 larvae in 20 bolls were noticed in BG-II genotypes *viz.*, Everest, Jadoo and Bindas respectively, and were on par with each other. These were followed by 8.56 larvae in 20 bolls observed in MRC-6918. The peak activity was at 135 DAS and recorded 12.57, 12.99 and 13.11 larvae per 20 green bolls in Everest, Jadoo and Bindas, respectively. The next in order where, significantly less population was noticed in genotypes First class and President gold with 8.05 and 9.14 larvae in 20 green bolls with peak activity registered during 135 DAS with 13.48 and 15.96 larvae/20 bolls. However, the highest population of 18.56 and 17.23 larvae in 20 green bolls was observed in DCH-32 and DHH-263 both being statistically at par amongst. Whereas, Sahana recorded the population of 16.44 larvae/20 bolls and stand next in order after former non *Bt* genotypes. Further, 14.21 and 14.74 larvae were observed from green bolls of VCH-5 and MRC-6918 respectively, which were also on par with each other. Thus, pink bollworm live larval recovery was highest in non *Bt*, followed by BG-I and BG-II hybrids (Table 5).

2019-20

Similar trend of activity of PBW larval population in different *Bt* and non *Bt* cotton hybrids recorded at different duration of crop growth were noticed in 2019-20 and has been tabulated in table 5. Larval population observed from 75 DAS to till 150 DAS and the number increased gradually up to 135 DAS and thereafter gradually declined. The highest incidence of live larvae in green bolls noticed at 130 DAS in all genotypes. However, minimum number of larvae recorded was 7.30 per 20 bolls in (H × H) hybrid Everest BG-II and was on par with other H × H hybrids namely, Jadoo (7.30/20 bolls) and Bindas (7.81/20 bolls). Further less larval population noticed in BG-II H × H) hybrid First class with 8.81 larvae per 20 bolls. While, BG-II H × B hybrids, MRC-7918 and Sowmya recorded highest larval recovery of 12.86 and 12.41 larvae per 20 bolls, respectively, and on par with each other. The highest larval population from *Bt* hybrids were noticed in VCH-5 (BG -I) and MRC-6918 (BG-I) hybrids with 16.60 and 15.75 larvae per 20 bolls respectively. However, in non *Bt* genotypes, DCH-32 hybrid registered highest larval population of 20.29 per 20 bolls, followed by DHH-263 (19.18/20 bolls). While genotype Sahana recorded 18.25 larvae per 20 bolls and was on par with DHH-263. Further, GMF events *viz.*, Profit+ and Arjun-21 were next in order after BG-II hybrids with 13.46 and 14.82 larvae per 20 bolls, respectively.

Locule damage

The locule damage during 2018-19 and 2019-20 observations of two seasons have been accounted in the table 6.

2018-19

During 2018-19, significantly lowest percent locule damage of 11.69 percent recorded in BG-II hybrid Everest, followed by 12.06 and 12.18 percent in Jadoo and Bindas, respectively (Table 6). Among BG-II H × B hybrids, MRC-7918 recorded locule damage to the extent of 18.04 percent but was on par with Sowmya (17.53%) and Puli (16.87%). While BG-I hybrids recorded higher locule damage at the rate of 24.35 percent in MRC-6918 and 20.30 percent in VCH-5 and which were highest all among *Bt* genotypes. While, GMF events recorded higher locule damage of 16.80 and 15.48 percent in Arjun-21 Profit+ and were at par with each other, compare to BG-II hybrids. However, the highest locule damage of 38.19 percent was noticed in case of conventional hybrid DCH-32 followed by 36.51 and 34.30 percent in DHH-263 and Sahana, respectively.

2019-20

The highest locule damage noticed at 135 DAS in all genotypes. However, least locule damage was registered in (H × H) hybrid Everest BG-II (12.81%) and was on par with other (H × H) hybrids namely, Jadoo (13.23%) and Bindas (14.19%). Next in the order, where lowest percent of locule damage noticed in the hybrid, First class (14.71%). While, (H × B) hybrids, MRC-7918 and Sowmya recorded locule damage of 19.22 and 18.47 percent respectively, compared to other BG-II genotypes and were on par with each other (Table 6).

Boll opening

Good boll opening

2018-19

It was evident from the data that, the *Bt* genotypes had more number of good open bolls in comparison to non-*Bt* genotypes. In 2018-19, Everest BG-II hybrid recorded significantly highest number good open bolls (26.68/pl) and Jadoo (25.61/pl) was on par with it (Table 7). However, these were followed by Bindas and First class hybrids which recorded 24.37 and 23.96 good bolls per plant, respectively. Meanwhile H × B hybrid MRC-7918 had received 12.13 good opened bolls which was significantly lowest amongst BG-II events. BG-I hybrids MRC-6918 (H × B) and VCH-5 (H × H) were recorded 11.73/pl and 12.06/pl of good opened bolls which were significantly lowest amongst all *Bt* genotypes. On the contrary DCH-32, DHH-263 and Sahana have recorded 6.39, 7.63 and 9.19 GOBs and were at par with each other.

2019-20

Data on GOB of 2019-20 had followed same trend and has been tabulated in table 7. Significantly highest number of GOBs were obtained in Everest BG-II hybrid (25.89/pl) and was followed by Jadoo (24.45/pl) but both being at par with each other. Next best hybrids after former were, Bindas and First class which accounted for 23.22 and 22.41 GOBs per plant, respectively. However, (H × B) hybrids, MRC-7918 (11.01/pl) and Sowmya (11.48/pl) recorded the least number of GOBs per plant, respectively and were least among all BG-II genotypes but were at par with each other.

However, when compared to all *Bt* hybrids less number of GOBs were found in MRC-6918 (BG-I) and VCH-5 (BG -I) hybrids, with 9.42 and 10.97 GOBs/plant, respectively. While, non *Bt* genotype, DCH-32 recorded lowest number of 5.83 GOBs/plant followed by DHH-263 (6.51 GOBs/pl) and Sahana (8.30 GOBs/pl). While, GMF events *viz.*, Profit+ and Arjun-21 recorded GOBs of 14.43 and 13.78 per plant

Bad boll opening

2018-19

The data of 2018-19, depicted that the number of bad boll opening (BOBs) was minimum in Everest (4.21/pl) followed by Jadoo (4.50/pl) and Bindas (5.07/pl) but were statistically on par with each other. These were followed by MRC-6918 and president gold with less number of BOBs *i.e.* 5.16 and 5.20 per plant respectively. (Table 7)

The non-*Bt* cotton genotypes have registered more number of BOBs in comparison to the *Bt* genotypes. The highest number of BOBs have been noticed in hybrid DCH-32

(10.04/pl) followed by DHH-263 (9.06/pl) and Sahana (7.58/pl). Comparatively conventional cottons have shown higher number of bad boll opening than the *Bt* events. The boll opening has varied significantly in all the genotypes.

2019-20

In 2019-20, same trend was followed, wherein, Everest (5.04 BOBs/pl) and Jadoo (5.41/pl) were found to superior with less number of BOBs and was followed by Bindas and First class with 6.13 and 6.18 BOBs/plant which were statistically on par with each other (Table 7). Among all *Bt* hybrids highest BOBs/plant were noticed in MRC-6918 (BG-I) and VCH-5 (BG -I) hybrids, with 7.80 and 7.58 BOBs/plant respectively. However, non *Bt* genotypes, DCH-32 registered highest number of BOBs 11.15/plant followed by DHH-263 (10.27 BOBs/pl) and Sahana (7.70 BOBs/pl). While, GMF event hybrids *viz.*, Profit+ and Arjun-21 recorded 6.76 and 6.74 BOBs/plant.

Seed cotton yield

2018-19

The comparative seed cotton yield levels in 2018-19 amongst *Bt* cotton genotypes (Table 8) indicated that intra specific BG-II hybrid Everest and Jadoo excelled over others by producing significantly higher seed cotton yield and also good kapas than genotypes of any other events. Everest had recorded good kapas yield of 15.88 q ha^{-1} followed by Jadoo (14.96 q ha^{-1}) of good kapas both being statistically on par with each other. These were followed by Bindas and First class, with 14.69 and 13.96 q ha^{-1} of good kapas yield, respectively. But both being at par with each other. However, MRC-7918 recorded least yield of 10.73 q ha^{-1} of good kapas amongst BG-II genotypes. Of all *Bt* genotypes, least kapas yield was noticed in MRC-6918 (H × B) and VCH-5 (H × H) which accounted for 10.63 and 10.76 q ha^{-1} of good kapas. Non-*Bt* genotypes yielded significantly lower than *Bt* events. Sahana yielded 7.90 q ha^{-1} of good kapas followed by DHH-263 and DCH-32 with 7.54 and 6.49 q ha^{-1}, respectively and all being at par amongst.

2019-20

During 2019-20, yield levels were less than the previous season, however the trend remained unchanged. Significantly highest seed cotton yield was recorded in Everest (14.52 q ha^{-1}) followed by Jadoo (13.68 q ha^{-1}), Bindas (13.23 q ha^{-1}) and First class (12.89 q ha^{-1}) which were statistically on par with each other (Table 8). Among all *Bt* hybrids least seed cotton yield was noticed in MRC-6918 (BG-I) and VCH-5 (BG -I) hybrids, with 9.41 and 10.01 q ha^{-1} respectively. However, non *Bt* genotypes, DCH-32 registered least yield of 5.45 q ha^{-1}, followed by DHH-263 (6.04 q ha^{-1}) and Sahana (7.70 q ha^{-1}). Further, GMF event hybrids *viz.*, Profit+ and Arjun-21 recorded 8.47 and 8.01 q ha^{-1} yield.

Over past two decades, the interest in *Bt* toxins grew enormously, especially with the advent of molecular biology techniques. The adoption rate of *Bt* trangenics has been very high, ever since the first introduction in 1996. The area under *Bt* cotton has rapidly increasing in several other countries including India. It has been known better that cry toxins preferably Cry1Ac δ endotoxin has a great deal of bioactivity against the bollworms including *P. gossypiella.* Among the three bollworms *viz.*, American bollworm, spotted bollworm and PBW, the latter one is said to be highly susceptible to Cry toxins (Kranthi *et al*. 2004) [16]. The initial studies with respect to Bollgard I genotypes expressing Cry1Ac only (Udikeri *et al.* 2003 and Patil 2003) [28, 25] and Bollgard II (Cry1Ac+Cry2Ab) also (Onkarmurthy *et al.*, 2016 and Bruce *et al.* 2013) [24, 6] have shown the complete suppression of PBW in India or elsewhere. Until 2008, *Bt* cotton was very effective in controlling all the three bollworm species. However, resistance monitoring reports published by Monsanto (Monsanto, 2010) [21] showed that the pink bollworm had started to evolve resistance to the *Bt*-toxin Cry1Ac in 2008 as was confirmed with insect populations collected from Amreli district in Gujarat. Despite reports in 2015 of possible breakdown of BG-II resistance the contribution of stakeholders of the technology was grossly inadequate to ensure its sustainability.

The observations on fruiting body damage (squares, flowers and bolls) indicated the incidence of PBW in all genotypes under the study. This was in contrast to the only late season survival (Surulivelu *et al.*, 2004) [27] of this pest in *Bt* cotton. The non *Bt* cottons used to receive low to moderate incidence of PBW in fruiting bodies during pre *Bt* era (Katagihallimath, 1959 and Korat, 1991) [13, 15] and negligible in *Bt* era (Bheemanna *et al.* 2008) [5]. However in the present study it is evident that some of *Bt* genotypes received the incidence of PBW enough to cause the damage reaching economic thresholds. However, the higher incidence was noticed in non *Bt* genotypes *viz.*, DCH-32, DHH-263 and Sahana.

In general H×B hybrids received higher incidence than H×H genotypes/ hybrids (Fig. 1). The interspecific hybrids from *G. hirsutum*×*G. barbadense* developed for expression of Cry1Ac toxin found to be susceptible to pink bollworm than the parents (Lucia *et al.* 2013) [20]. Further, Udikeri (2006) [29] has shown higher damage from bollworm including PBW in interspecific *Bt* BG-I hybrid MRC-6918 compared to interspecific BG-I or BG-II hybrids. The issue of quite considerable incidence and damage to fruiting structure was evident in all the transgenic formats studied here, though there was a significant difference existing among them at certain period of observation. Relatively, the incidence was lower in Everest, Jadoo, Bindas, First class, Arjun-21, compared to MRC-7918, MRC-6918 and VCH-5. Such differences are due to the presence of single or dual genes and the type of genotype also. Such comparisons have been made and significant differences have been observed by different researchers in India (Naik *et al.* 2016 and Shinde *et al.*, 2018) [22, 26].

There was a considerable live larval recovery from the green bolls of all genotypes which were very close to each other at the beginning of season and varied significantly later. However, in contrast to the damage pattern the larval recovery followed a close pattern from the boll maturity stage onwards. The larval incidence was high in all genotypes. Thus, it was evident that the suicidal population emergence, the incidence on squares and flowers has led to a significant contribution towards its survival in the mid and late season leading to a great damage. This type of survival could be due to the resistance in PBW to Cry1Ac or Cry2Ab or Cry1A. The relatively moderate level of resistance in Dharwad population has been reported already by Naik *et al.* (2016) [22]. Further similar results were observed by Niranjan and Udikeri (2023) [23]

Table 1: Treatment details (Different popular *Bt* and non *Bt* cotton hybrids)

Treatments	Genotypes (trade name)	Type of genotype	Transgenic event
T_1	Bindas	H×H	BG-II
T_2	President gold	H×H	BG-II
T_3	Jadoo	H×H	BG-II
T_4	Everest	H×H	BG-II
T_5	First class	H×H	BG-II
T_6	ATM	H×H	BG-II
T_7	MRC-7351	H×H	BG-II
T_8	MRC-7353	H×H	BG-II
T_9	MRC-7918	H×B	BG-II
T_{10}	Puli	H×B	BG-II
T_{11}	Sowmya	H×B	BG-II
T_{12}	VCH-5	H×H	BG-I
T_{13}	MRC-6918	H×B	BG-I
T_{14}	Arjun-21	GMF	GMF
T_{15}	Profit +	GMF	GMF
T_{16}	DCH-32	H×B	Non *Bt*
T_{17}	DHH-263	H×H	Non *Bt*
T_{18}	Sahana	-	Non *Bt*

Table 2: Square damage due to pink bollworm in different *Bt* and non *Bt* cotton genotypes during 2018-19 and 2019-20

Genotypes	Transgenic event	Percent square damage													
		60 DAS		75 DAS		90 DAS		105 DAS		130 DAS		150 DAS		Mean	
		2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Bindas (H×H)	BG- II	0.59 (4.39)^{no}	0.66 (4.65)^{no}	1.33 (6.62)^{lm}	1.56 (7.18)^{no}	2.26 (8.65)^{op}	2.60 (9.28)^{op}	3.12 (10.17)^{no}	3.62 (10.97)^{op}	4.28 (11.93)^{op}	5.59 (16.68)^{fg}	3.26 (10.4)^{op}	4.33 (12.01)^{op}	1.81 (7.73)^{op}	2.43 (8.97)^{op}
President gold (H×H)	BG- II	0.79 (5.11)^{ij}	0.93 (5.52)^{jk}	1.45 (6.91)^{ij}	1.78 (7.67)^{hi}	3.46 (10.73)^{f}	3.81 (11.26)^{hi}	3.87 (11.34)^{kl}	4.53 (12.29)^{kl}	5.41 (13.45)^{kl}	6.36 (14.61)^{lm}	4.21 (11.84)^{kl}	4.88 (12.77)^{kl}	2.31 (8.75)^{kl}	3.01 (9.99)^{mn}
Jadoo (H×H)	BG-II	0.46 (3.87)^{op}	0.61 (4.47)^{op}	1.11 (6.06)^{op}	1.49 (7.01)^{pq}	1.94 (8.01)^{pq}	2.43 (8.97)^{pq}	2.86 (9.74)^{pq}	3.57 (10.9)^{pq}	4.23 (11.87)^{pq}	5.37 (13.39)^{pq}	3.19 (10.28)^{pq}	3.82 (11.27)^{pq}	1.71 (7.52)^{pq}	2.39 (8.89)^{pq}
Everest (H×H)	BG- II	0.37 (3.49)^{qr}	0.47 (3.93)^{qr}	1.01 (5.76)^{qr}	1.22 (6.35)^{qr}	1.76 (7.62)^{qr}	2.34 (8.81)^{qr}	2.48 (9.05)^{qr}	3.48 (10.75)^{qr}	4.02 (11.57)^{qr}	4.95 (12.86)^{qr}	2.98 (9.94)^{qr}	3.42 (10.63)^{qr}	1.49 (7.01)^{qr}	2.17 (8.47)^{qr}
First class (H×H)	BG- II	0.63 (4.55)^{mn}	0.70 (4.79)^{mn}	1.03 (5.83)^{pq}	1.67 (7.43)^{kl}	3.10 (10.14)^{jk}	3.49 (10.77)^{jk}	4.09 (11.67)^{ij}	4.49 (12.23)^{lm}	4.94 (12.85)^{no}	6.35 (14.6)^{mn}	3.45 (10.71)^{no}	4.68 (12.49)^{mn}	2.15 (8.43)^{no}	2.92 (9.84)^{no}
ATM (H×H)	BG-II	0.73 (4.9)^{kl}	0.89 (5.41)^{kl}	1.30 (6.56)^{no}	1.51 (7.03)^{op}	2.49 (9.08)^{no}	3.04 (10.05)^{op}	3.36 (10.57)^{mn}	3.98 (11.5)^{no}	5.50 (13.57)^{f}	6.27 (14.51)^{op}	4.04 (11.6)^{mn}	4.52 (12.28)^{no}	2.24 (8.61)^{mn}	3.01 (9.99)^{lm}
MRC-7351 (H×H)	BG-II	0.81 (5.16)^{gh}	0.97 (5.66)^{gh}	1.31 (6.57)^{mn}	1.62 (7.22)^{mn}	2.90 (9.8)^{no}	4.01 (11.55)^{ef}	3.40 (10.63)^{fg}	4.71 (12.53)^{ij}	5.24 (13.23)^{lm}	6.31 (14.54)^{no}	4.11 (11.70)^{lm}	4.76 (12.6)^{lm}	2.26 (8.64)^{lm}	3.88 (11.36)^{kl}
MRC-7353 (H×H)	BG-II	0.74 (4.93)^{jk}	1.04 (5.85)^{ef}	1.5 (7.03)^{hi}	1.77 (7.64)^{ij}	3.19 (10.28)^{mn}	3.34 (10.53)^{hi}	4.35 (12.03)^{mn}	5.18 (13.15)^{mn}	5.57 (13.65)^{jk}	7.21 (15.58)^{jk}	4.36 (12.06)^{jk}	5.04 (12.97)^{jk}	2.89 (9.78)^{jk}	3.89 (11.38)^{jk}
MRC-7918 (H×B)	BG-II	1.10 (6.02)^{de}	1.43 (6.86)^{e}	1.74 (7.59)^{gh}	2.05 (8.23)^{fg}	2.90 (9.8)^{mn}	3.94 (11.44)^{fg}	4.32 (11.97)^{hi}	6.68 (14.98)^{e}	7.12 (15.47)^{kl}	8.85 (17.3)^{e}	5.11 (13.06)^{hi}	7.30 (15.68)^{ef}	3.96 (11.47)^{f}	4.72 (12.55)^{f}
Puli (H×B)	BG-II	0.88 (5.38)^{fg}	1.01 (5.76)^{fg}	1.36 (6.69)^{kl}	1.63 (7.34)^{lm}	2.94 (9.88)^{lm}	3.27 (10.42)^{lm}	3.98 (11.51)^{jk}	4.84 (12.71)^{hi}	6.11 (14.31)^{ij}	7.32 (15.67)^{f}	4.59 (12.37)^{ij}	6.08 (14.27)^{hi}	3.25 (10.32)^{hi}	3.95 (11.46)^{hi}
Sowmya (H×B)	BG-II	0.92 (5.51)^{f}	1.33 (6.62)^{d}	1.41 (6.83)^{jk}	1.91 (7.94)^{gh}	3.42 (10.65)^{gh}	4.08 (11.65)^{e}	5.29 (13.30)^{fg}	6.20 (14.42)^{ef}	6.87 (15.20)^{fg}	8.18 (16.62)^{gh}	5.23 (13.22)^{gh}	5.16 (13.13)^{ij}	3.93 (11.45)^{fg}	4.23 (11.87)^{gh}
VCH-5 (H×H)	BG-I	1.97 (8.07)^{d}	0.96 (5.61)^{ij}	3.60 (10.30)^{e}	4.79 (11.49)^{jk}	8.56 (17.01)^{de}	8.88 (11.36)^{gh}	9.83 (18.27)^{de}	10.77 (13.9)^{fg}	11.53 (15.93)^{de}	12.41 (16.85)^{ef}	5.60 (13.69)^{ef}	6.35 (14.6)^{gh}	6.76 (15.07)^{de}	7.45 (15.84)^{de}
MRC-6918 (H×B)	BG-I	2.32 (8.77)^{bc}	2.51 (9.11)^{bc}	7.11 (15.46)^{cd}	7.44 (15.83)^{cd}	9.08 (17.54)^{d}	9.4 (17.86)^{d}	11.4 (19.74)^{d}	12.72 (20.9)^{d}	12.55 (20.75)^{d}	13.1 (21.22)^{d}	8.57 (17.03)^{d}	10.02 (18.45)^{d}	8.06 (16.49)^{d}	9.20 (17.66)^{d}
Arjun-21	GMF	0.66 (4.66)^{lm}	0.79 (5.11)^{lm}	2.89 (9.79)^{f}	3.11 (10.15)^{e}	3.24 (10.36)^{ij}	3.41 (10.64)^{kl}	3.72 (11.13)^{lm}	4.59 (12.38)^{jk}	6.70 (15.01)^{gh}	8.06 (16.5)^{hi}	5.61 (13.70)^{de}	7.67 (16.08)^{de}	3.63 (10.98)^{gh}	4.33 (12.01)^{fg}
Profit+	GMF	0.39 (3.6)^{pq}	0.56 (4.29)^{pq}	2.02 (8.17)^{g}	2.24 (8.61)^{f}	3.05 (10.06)^{kl}	3.76 (11.18)^{ij}	4.76 (12.61)^{gh}	5.70 (13.82)^{gh}	6.28 (14.51)^{hi}	7.64 (16.05)^{ij}	5.55 (13.63)^{fg}	6.60 (14.89)^{fg}	3.05 (10.06)^{ij}	3.92 (11.42)^{ij}
DCH-32 (H×B)	Non *Bt*	3.65 (10.48)^{a}	3.44 (10.69)^{a}	8.06 (16.49)^{a}	8.35 (16.8)^{a}	14.63 (22.49)^{a}	15.31 (23.03)^{a}	29.68 (33.01)^{a}	31.02 (33.85)^{a}	34.29 (35.84)^{a}	36.01 (36.88)^{a}	20.32 (26.8)^{a}	22.45 (28.28)^{a}	18.44 (25.43) a	19.61 (26.28) a
DHH-263 (H×H) (H×H)	Non *Bt*	2.56 (9.39)^{b}	2.77 (9.58)^{b}	7.89 (16.31)^{ab}	8.14 (16.58)^{ab}	13.72 (21.74)^{ab}	14.1 (22.06)^{ab}	27.81 (31.83)^{ab}	29.16 (32.68)^{ab}	33.36 (35.28)^{ab}	35.5 (36.57)^{ab}	19.99 (26.56)^{ab}	21.52 (27.64)^{ab}	17.56 (24.77)^{ab}	18.53 (25.50)^{ab}
Sahana	Non *Bt*	0.80 (5.12)^{hi}	0.96 (5.63)^{hi}	7.37 (15.76)^{bc}	7.75 (16.16)^{bc}	12.94 (21.08)^{bc}	13.66 (21.69)^{bc}	26.84 (31.21)^{bc}	28.92 (32.53)^{bc}	32.83 (34.96)^{bc}	34.58 (36.02)^{bc}	18.99 (25.84)^{bc}	20.4 (26.85)^{bc}	15.02 (22.8)^{bc}	17.71 (24.89)^{bc}
S.Em(±)		0.23	0.31	0.39	0.44	0.69	0.67	0.85	0.88	1.13	1.06	1.26	1.29	0.91	1.02
CD (p=0.05)		0.68	0.91	1.14	1.27	1.98	1.93	2.44	2.53	3.27	3.08	4.87	3.74	2.62	2.94
CV (%)		8.84	9.32	7.69	8.05	9.83	9.06	9.60	9.32	11.16	9.71	15.02	14.22	14.36	14.30

* Figures in the parentheses are arcsine transformed values, Mean followed by the same alphabet in a column do not differ significantly (P=0.05) by DMRT DAS: Days After Sowing

Table 3: Rosetted flower damage due to pink bollworm in different *Bt* and non *Bt* cotton genotypes during 2018-19 and 2019-20

Genotypes	Transgenic event	Percent rosetted flower damage													
		60 DAS		75 DAS		90 DAS		110 DAS		135 DAS		150 DAS		Mean	
		2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Bindas (H×H)	BG- II	1.64 (7.36)^{no}	2.36 (8.84)^{l}	11.39 (19.72)^{jk}	12.68 (20.86)^{kl}	15.78 (23.41)^{op}	16.38 (23.87)^{op}	15.77 (23.4)^{op}	16.11 (23.66)^{op}	9.96 (18.4)^{pq}	10.36 (18.78)^{pq}	5.22 (13.21)^{op}	5.93 (14.09)^{op}	9.68 (18.13)^{op}	10.26 (18.68)^{op}
President gold (H×H)	BG- II	3.69 (11.07)^{hi}	3.97 (11.49)^{jk}	10.33 (18.75)^{lm}	11.02 (19.39)^{no}	20.16 (26.68)^{mn}	21.36 (27.53)^{mn}	18.25 (25.29)^{de}	19.01 (25.85)^{ef}	12.21 (20.45)^{mn}	12.75 (20.92)^{mn}	7.99 (16.42)^{hi}	8.41 (16.86)^{gh}	12.11 (20.36)^{jk}	12.75 (20.92)^{jk}
Jadoo (H×H)	BG-II	1.76 (7.62)^{mn}	1.93 (7.99)^{no}	10.20 (18.63)^{mn}	12.19 (20.43)^{lm}	15.56 (23.23)^{pq}	16.03 (23.6)^{pq}	14.09 (22.05)^{pq}	14.79 (22.62)^{pq}	9.83 (18.27)^{qr}	10.03 (18.46)^{qr}	5.11 (13.06)^{pq}	5.32 (13.34)^{pq}	9.37 (17.82)^{pq}	10.03 (18.47)^{pq}
Everest (H×H)	BG- II	1.45 (6.92)^{op}	1.89 (7.9)^{op}	7.64 (16.05)^{qr}	8.11 (16.55)^{qr}	13.74 (21.76)^{qr}	14.81 (22.63)^{qr}	13.69 (21.72)^{qr}	14.21 (22.15)^{qr}	10.26 (18.68)^{op}	11.39 (19.72)^{op}	3.90 (11.39)^{qr}	4.72 (12.55)^{qr}	8.89 (17.36)^{qr}	9.91 (18.34)^{qr}
First class (H×H)	BG- II	1.82 (7.75)^{lm}	2.06 (8.25)^{mn}	9.10 (17.56)^{pq}	13.05 (21.18)^{jk}	18.31 (25.33)^{no}	20.36 (26.82)^{no}	16.18 (23.72)^{lm}	18.96 (25.81)^{fg}	10.51 (18.92)^{no}	12.11 (20.36)^{no}	6.66 (14.96)^{mn}	6.93 (15.26)^{no}	10.43 (18.84)^{mn}	12.25 (20.48)^{lm}
ATM (H×H)	BG-II	0.63 (4.55)^{qr}	0.91 (5.47)^{qr}	9.61 (18.06)^{op}	10.23 (18.65)^{pq}	20.31 (26.79)^{lm}	21.39 (27.55)^{lm}	16.48 (23.95)^{kl}	18.02 (25.12)^{kl}	12.71 (20.89)^{lm}	13.19 (21.3)^{kl}	7.01 (15.34)^{lm}	7.82 (16.24)^{kl}	11.07 (19.43)^{lm}	11.61 (19.92)^{no}
MRC-7351 (H×H)	BG-II	0.73 (4.9)^{pq}	1.02 (5.8)^{pq}	9.98 (18.42)^{no}	10.82 (19.2)^{op}	20.40 (26.85)^{kl}	21.99 (27.97)^{jk}	16.12 (23.67)^{mn}	16.80 (24.19)^{no}	12.89 (21.04)^{kl}	12.89 (21.04)^{lm}	7.13 (15.49)^{kl}	7.13 (15.49)^{mn}	10.27 (18.69)^{no}	11.83 (20.12)^{mn}
MRC-7353 (H×H)	BG-II	2.10 (8.33)^{kl}	2.36 (8.84)^{lm}	10.76 (19.15)^{kl}	11.84 (20.13)^{mn}	21.27 (27.46)^{ij}	22.06 (28.01)^{hi}	17.63 (24.83)^{fg}	19.04 (25.87)^{de}	13.74 (21.76)^{jk}	13.74 (21.76)^{jk}	7.48 (15.87)^{jk}	7.48 (15.87)^{lm}	11.97 (20.24)^{kl}	12.58 (20.78)^{kl}
MRC-7918 (H×B)	BG-II	4.69 (12.51)^{de}	4.91 (12.8)^{ef}	14.68 (22.53)^{fg}	15.73 (23.37)^{ef}	22.36 (28.22)^{ef}	24.01 (29.34)^{ef}	17.02 (24.37)^{gh}	18.94 (25.8)^{gh}	15.73 (23.37)^{cd}	17.02 (24.37)^{bc}	9.04 (17.5)^{cd}	9.97 (18.41)^{cd}	13.92 (21.91)^{ef}	15.10 (22.86)^{de}
Puli (H×B)	BG-II	3.69 (11.07)^{gh}	4.02 (11.57)^{gh}	13.69 (21.72)^{gh}	14.20 (22.14)^{ij}	20.56 (26.96)^{jk}	22.03 (27.99)^{ij}	16.94 (24.3)^{ij}	18.02 (25.12)^{jk}	14.88 (22.69)^{ef}	15.52 (23.2)^{gh}	8.69 (17.14)^{fg}	8.93 (17.39)^{ef}	13.08 (21.2)^{hi}	13.94 (21.92)^{gh}
Sowmya (H×B)	BG-II	4.58 (12.36)^{ef}	5.02 (12.95)^{de}	13.66 (21.69)^{ij}	14.87 (22.68)^{hi}	21.58 (27.68)^{fg}	23.6 (29.06)^{fg}	16.93 (24.3)^{hi}	18.11 (25.19)^{ij}	14.69 (22.54)^{fg}	15.93 (23.52)^{fg}	8.73 (17.19)^{de}	9.10 (17.56)^{de}	13.36 (21.44)^{fg}	14.28 (22.21)^{fg}
VCH-5 (H×H)	BG-I	4.36 (12.05)^{fg}	4.73 (12.56)^{fg}	16.04 (23.61)^{de}	17.01 (24.36)^{de}	22.97 (28.64)^{de}	24.05 (29.37)^{de}	17.94 (25.06)^{ef}	18.67 (25.6)^{hi}	15.67 (23.32)^{de}	16.81 (24.19)^{cd}	7.84 (16.26)^{ij}	8.43 (16.88)^{fg}	14.14 (22.09)^{de}	14.98 (22.77)^{ef}
MRC-6918 (H×B)	BG-I	4.69 (12.51)^{d}	5.12 (13.08)^{cd}	16.96 (24.32)^{cd}	17.30 (24.58)^{cd}	23.67 (29.11)^{d}	24.12 (29.41)^{d}	20.36 (26.82)^{cd}	21.97 (27.95)^{d}	16.94 (24.3)^{ab}	17.56 (24.77)^{ab}	9.12 (17.58)^{b}	10.01 (18.44)^{bc}	15.29 (23.02)^{dc}	16.01 (23.59)^{cd}
Arjun-21	GMF	3.62 (10.97)^{ij}	4.01 (11.55)^{hi}	13.69 (21.72)^{hi}	15.03 (22.81)^{gh}	21.58 (27.68)^{gh}	22.81 (28.53)^{gh}	16.94 (24.3)^{jk}	17.56 (24.77)^{lm}	14.69 (22.54)^{gh}	15.38 (23.09)^{hi}	8.69 (17.14)^{ef}	8.12 (16.56)^{hi}	13.20 (21.31)^{gh}	13.83 (21.83)^{hi}
Profit+	GMF	3.11 (10.16)^{jk}	3.97 (11.49)^{ij}	14.95 (22.75)^{ef}	15.11 (22.87)^{fg}	21.43 (27.58)^{hi}	21.97 (27.95)^{kl}	16.02 (23.59)^{no}	17.03 (24.37)^{mn}	14.50 (22.38)^{hi}	15.12 (22.88)^{ij}	8.40 (16.85)^{gh}	8.11 (16.55)^{ij}	13.07 (21.19)^{ij}	13.54 (21.59)^{ij}
DCH-32 (H×B)	Non *Bt*	10.63 (19.03)^{a}	12.36 (20.58)^{a}	22.06 (28.01)^{a}	24.58 (29.72)^{a}	36.58 (37.22)^{a}	39.02 (38.66)^{a}	29.68 (33.01)^{a}	31.25 (33.99)^{a}	18.36 (25.37)^{a}	19.07 (25.89)^{a}	12.97 (21.11)^{a}	14.30 (22.22)^{a}	21.71 (27.77)^{a}	23.43 (28.95)^{a}
DHH-263 (H×H)	Non *Bt*	8.12 (16.56)^{b}	10.36 (18.78)^{ab}	20.26 (26.75)^{ab}	21.97 (27.95)^{ab}	34.12 (35.74)^{ab}	36.05 (36.90)^{ab}	26.99 (31.30)^{ab}	27.99 (31.94)^{ab}	15.97 (23.55)^{bc}	16.12 (23.67)^{ef}	9.05 (17.51)^{bc}	11.01 (19.38)^{b}	19.09 (25.90)^{ab}	20.58 (26.98)^{ab}
Sahana	Non *Bt*	6.89 (15.22)^{bc}	7.12 (15.48)^{c}	17.26 (24.55)^{bc}	18.89 (25.76)^{bc}	31.59 (34.20)^{bc}	33.64 (35.45)^{bc}	24.29 (29.53)^{bc}	26.80 (31.18)^{bc}	14.23 (22.16)^{ij}	16.54 (24.01)^{de}	6.49 (14.76)^{no}	8.06 (16.49)^{jk}	17.65 (24.84)^{bc}	18.51 (25.48)^{bc}
S.Em(±)		0.84	0.92	1.04	0.88	0.90	1.35	1.22	1.04	0.92	0.91	0.99	0.98	1.02	1.09
CD (p=0.05)		2.43	2.76	3.01	2.60	2.71	3.87	3.70	3.18	2.80	2.63	2.98	2.83	3.11	3.26
CV (%)		11.69	10.45	11.78	10.45	9.74	9.29	11.34	9.25	11.61	10.12	14.16	10.14	13.28	14.01

* Figures in the parentheses are arcsine transformed values, Mean followed by the same alphabet in a column do not differ significantly (P=0.05) by DMRT DAS: Days After Sowing

Table 4: Green boll damage due to pink bollworm in different *Bt* and non *Bt* cotton genotypes during 2018-19 and 2019-20

Genotypes	Transgenic event	Percent green boll damage													
		75 DAS		90 DAS		105 DAS		120 DAS		135 DAS		150 DAS		Mean	
		2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Bindas (H×H)	BG- II	1.18 (6.24)^{pq}	2.06 (8.25)^{no}	5.01 (12.92)^{op}	5.34 (13.16)^{qr}	9.27 (17.73)^{qr}	9.27 (17.73)^{qr}	19.24 (26.02)^{kl}	20.11 (26.64)^{no}	26.21 (30.79)^{op}	28.10 (32.01)^{op}	27.67 (31.74)^{op}	29.25 (32.74)^{no}	14.60 (22.46)^{op}	16.91 (24.28)^{op}
President gold (H×H)	BG- II	2.01 (8.15)^{kl}	2.36 (8.84)^{lm}	7.45 (15.84)^{gh}	8.05 (16.48)^{gh}	11.94 (20.21)^{lm}	15.11 (22.87)^{gh}	20.81 (27.13)^{ij}	21.37 (27.53)^{jk}	29.25 (32.74)^{mn}	31.14 (33.92)^{no}	27.89 (31.88)^{no}	29.76 (33.06)^{mn}	16.31 (23.82)^{kl}	18.99 (25.83)^{jk}
Jadoo (H×H)	BG-II	1.06 (5.91)^{q}	1.54 (7.13)^{op}	4.92 (12.82)^{pq}	6.03 (14.21)^{mn}	10.12 (18.55)^{op}	12.15 (20.4)^{mn}	17.69 (24.87)^{op}	18.45 (25.44)^{pq}	26.17 (30.77)^{pq}	27.91 (31.89)^{pq}	25.42 (30.28)^{pq}	26.08 (30.71)^{pq}	13.92 (21.91)^{pq}	15.97 (23.55)^{pq}
Everest (H×H)	BG- II	0.70 (4.80)^{qr}	0.89 (4.96)^{r}	4.81 (12.67)^{qr}	5.22 (13.21)^{pq}	9.34 (17.8) pq	10.02 (18.45)^{pq}	15.73 (23.37)^{qr}	16.02 (23.59)^{qr}	24.63 (29.75)^{qr}	25.03 (30.02)^{qr}	23.87 (29.25)^{qr}	24.86 (29.91)^{qr}	12.93 (21.08)^{qr}	14.92 (22.72)^{qr}
First class (H×H)	BG- II	1.63 (7.34)^{no}	1.99 (8.11)^{op}	5.17 (13.14)^{no}	6.02 (14.2)^{no}	11.27 (19.62)^{mn}	12.03 (20.29)^{no}	18.14 (25.21)^{no}	20.13 (26.66)^{mn}	27.55 (31.66)^{no}	28.04 (31.97)^{q}	28.17 (32.06)^{mn}	31.12 (33.91)^{jk}	15.17 (22.93)^{no}	17.87 (25.01)^{mn}
ATM (H×H)	BG-II	1.75 (7.6)^{mn}	2.13 (8.39)^{mn}	5.54 (13.61)^{lm}	5.99 (14.17)^{op}	13.24 (21.34)^{ij}	14.53 (22.41)^{jk}	19.23 (26.01)^{lm}	20.82 (27.15)^{lm}	31.13 (33.91)^{lm}	32.08 (34.5)^{mn}	28.57 (32.31)^{lm}	29.07 (32.62)^{op}	15.92 (23.52)^{lm}	18.28 (25.32)^{lm}
MRC-7351 (H×H)	BG-II	1.85 (7.82)^{lm}	2.56 (9.21)^{kl}	5.53 (13.60)^{mn}	6.15 (14.36)^{lm}	13.63 (21.67)^{hi}	14.97 (22.76)^{ij}	20.30 (26.78)^{jk}	21.93 (27.92)^{ij}	31.49 (34.14)^{jk}	32.75 (34.91)^{lm}	28.98 (32.57)^{kl}	29.96 (33.19)^{lm}	16.34 (23.84)^{jk}	18.76 (25.66)^{kl}
MRC-7353 (H×H)	BG-II	2.03 (8.19)^{jk}	2.96 (9.91)^{jk}	5.61 (13.70)^{kl}	6.08 (14.20)^{kl}	14.46 (22.35)^{fg}	16.20 (23.73)^{fg}	20.93 (27.23)^{hi}	21.99 (27.97)^{hi}	31.88 (34.37)k	33.04 (35.09)^{jk}	29.01 (32.59)^{jk}	30.78 (33.70)^{kl}	16.75 (24.16)^{hi}	19.14 (25.95)ij
MRC-7918 (H×B)	BG-II	2.62 (9.32)^{fg}	3.12 (10.17)^{fg}	6.92 (15.25)^{ij}	7.97 (16.40)^{hi}	15.52 (23.20)^{ef}	16.32 (23.83)^{f}	22.66 (28.43)^{ef}	24.52 (29.68)^{ef}	33.90 (35.61)^{gh}	34.83 (36.17)^{hi}	30.84 (33.73)^{gh}	31.59 (34.2)^{hi}	18.02 (25.12)^{ef}	20.60 (26.99)^{ef}
Puli (H×B)	BG-II	2.39 (8.89)^{hi}	3.02 (10.01)^{hi}	7.81 (16.23)^{fg}	7.12 (15.48)^{jk}	12.68 (20.86)^{kl}	13.26 (21.35)^{lm}	21.37 (27.53)^{fg}	22.01 (27.98)^{gh}	32.25 (34.60)^{ij}	32.83 (34.96)^{kl}	29.25 (32.74)^{ij}	32.01 (34.45)^{ef}	15.60 (23.27)^{mn}	17.50 (24.73)^{no}
Sowmya (H×B)	BG-II	2.50 (9.10)^{gh}	3.15 (10.22)^{ij}	6.83 (15.15)^{jk}	7.26 (15.63)^{ij}	13.87 (21.87)^{gh}	15.02 (22.8)^{hi}	21.45 (27.59)^{gh}	23.85 (29.23)^{fg}	32.83 (34.96)^{hi}	34.37 (35.89)^{ij}	30.62 (33.6)^{hi}	31.50 (34.14)^{ij}	17.31 (24.58)^{gh}	20.43 (26.87)^{fg}
VCH-5 (H×H)	BG-I	3.96 (11.48)^{de}	5.03 (12.96)^{de}	9.22 (17.68)^{d}	10.57 (18.97)^{de}	19.24 (26.02)^{d}	21.36 (27.53)^{de}	26.38 (30.9)^{d}	27.46 (31.6)^{de}	38.73 (38.49)^{cd}	39.84 (39.14)^{de}	31.95 (34.42)^{fg}	33.64 (35.45)^{gh}	21.27 (27.46)^{de}	23.72 (29.15)^{de}
MRC-6918 (H×B)	BG-I	4.15 (11.75)^{cd}	5.49 (13.55)^{bc}	8.75 (17.21)^{de}	12.36 (20.58)^{cd}	18.36 (25.37)^{de}	23.07 (28.71)^{d}	24.94 (29.96)^{de}	28.10 (32.01)^{d}	40.81 (39.70)^{c}	40.97 (39.80)^{cd}	35.75 (36.72)^{c}	35.01 (36.28)^{cd}	22.05 (28.01)^{cd}	24.64 (29.76)^{cd}

Arjun-21	GMF	2.81 (9.65) ^{ef}	3.26 (10.4) ^{f}	8.11 (16.55)^{ef}	9.04 (17.50) ^{ef}	12.74 (20.91)^{jk}	13.60 (21.64)^{kl}	18.15 (25.22)^{mn}	20.94 (27.23) ^{kl}	36.20 (36.99)^{ef}	38.29 (38.23)^{ef}	33.80 (35.55)^{cd}	35.26 (36.43) ^{c}	17.84 (24.99)^{fg}	19.72 (26.37)^{gh}
Profit+	GMF	2.12 (8.37) ^{ij}	3.11 (10.16)^{gh}	7.40 (15.79)^{hi}	8.39 (16.84)^{fg}	10.36 (18.78)^{no}	11.98 (20.25)^{op}	16.38 (23.87)^{pq}	19.15 (25.95)^{op}	34.21 (35.8) ^{fg}	36.82 (37.36)^{gh}	32.94 (35.02)^{de}	33.97 (35.65)^{fg}	16.69 (24.11) ^{ij}	19.28 (26.05)^{hi}
DCH-32 (H×B)	Non *Bt*	5.32 (13.34) ^{b}	6.08 (14.28) ^{b}	18.35 (25.36) ^{a}	19.11 (25.92) ^{a}	29.42 (32.85) ^{a}	30.15 (33.30) ^{a}	50.63 (45.36) ^{a}	51.98 (46.13) ^{a}	69.15 (56.26) ^{a}	70.48 (57.09) ^{a}	71.49 (57.73) ^{a}	72.94 (58.65) ^{a}	38.38 (38.28) ^{a}	44.01 (41.56) ^{a}
DHH-263 (H×H)	Non *Bt*	4.17 (11.78)^{bc}	5.29 (13.3) ^{cd}	16.72 (24.14)^{ab}	17.86 (25.00)^{ab}	27.94 (31.91)^{ab}	28.6 (32.33)^{bc}	48.81 (44.32)^{ab}	49.72 (44.84)^{ab}	64.70 (53.55)^{ab}	68.99 (56.16)^{ab}	68.50 (55.86)^{ab}	70.20 (56.91)^{ab}	36.48 (37.16)^{ab}	41.98 (40.39) ^{b}
Sahana	Non *Bt*	8.64 (17.09) ^{a}	10.03 (18.46) ^{a}	14.12 (22.07)^{bc}	16.11 (23.66)^{bc}	27.23 (31.45)^{bc}	29.63 (32.98)^{ab}	34.92 (36.22) ^{c}	37.30 (37.64) ^{c}	38.73 (38.49)^{de}	41.67 (40.20) ^{c}	40.95 (34.42)^{ef}	35.01 (36.28)^{de}	26.39 (30.91) ^{c}	28.59 (32.32)^{bc}
S.Em(±)		0.73	0.7	1.07	1.10	1.04	1.07	1.40	1.37	1.41	1.28	1.43	1.44	1.42	1.27
CD (p=0.05)		2.11	2.03	3.07	3.26	2.98	3.05	4.03	3.96	4.12	3.19	4.11	4.14	3.98	3.54
CV (%)		14.51	12.54	11.79	10.07	8.09	12.04	12.53	10.07	13.03	9.35	11.48	14.79	13.26	12.18

* Figures in the parentheses are arcsine transformed values, Mean followed by the same alphabet in a column do not differ significantly (P=0.05) by DMRT DAS: Days After Sowing

Table 5: Larval population of pink bollworm in different *Bt* and non *Bt* cotton genotypes in 2018-19 and 2019-20

Genotypes	Transgenic event	Larval incidence/20 bolls													
		75 DAS		90 DAS		105 DAS		120 DAS		135 DAS		150 DAS		Mean	
		2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Bindas (H×H)	BG- II	1.20 (1.30)^{op}	1.46 (1.40) ^{op}	3.19 (1.92) ^{qr}	3.89 (2.10) ^{qr}	5.49 (2.45)^{op}	6.01 (2.55) ^{no}	11.74 (3.50) ^{qr}	12.36 (3.59) ^{qr}	13.11 (3.69)^{op}	14.01 (3.81)^{op}	8.50 (3.00)^{op}	9.11 (3.10)^{op}	7.21 (2.78)^{op}	7.81 (2.88)^{op}
President gold (H×H)	BG- II	1.54 (1.43)^{lm}	1.90 (1.55)^{mn}	4.21 (2.17)^{mn}	5.02 (2.35)^{mn}	6.86 (2.71)^{mn}	7.19 (2.77)^{mn}	15.28 (3.97)^{mn}	16.01 (4.06)^{mn}	15.96 (4.06)^{mn}	16.22 (4.09)^{mn}	11.2 (3.42)^{mn}	13.06 (3.68)^{kl}	9.14 (3.11)^{mn}	9.87 (3.22)^{mn}
Jadoo (H×H)	BG-II	1.12 (1.27)^{pq}	1.31 (1.35)^{pq}	3.8 (2.07)^{op}	4.52 (2.24)^{op}	5.11 (2.37)^{pq}	5.83 (2.52)^{op}	12.47 (3.60)^{op}	13.30 (3.71) ^{op}	12.99 (3.67)^{pq}	13.84 (3.79)^{pq}	4.60 (2.26)^{q}	5.01 (2.35)^{q}	6.68 (2.68)^{pq}	7.3 (2.79)^{pq}
Everest (H×H)	BG- II	1.07 (1.25)^{qr}	1.12 (1.27) ^{qr}	3.58 (2.02)^{pq}	4.01 (2.12)^{pq}	4.29 (2.19)^{qr}	5.11 (2.37)^{qr}	11.86 (3.52) ^{pq}	12.59 (3.62) ^{pq}	12.57 (3.62)^{qr}	13.32 (3.72)^{qr}	3.87 (2.09)^{qr}	4.20 (2.17)^{qr}	6.21 (2.59)^{qr}	6.73 (2.69)^{qr}
First class (H×H)	BG- II	1.35 (1.36)^{no}	1.70 (1.48)^{no}	3.94 (2.11)^{no}	4.97 (2.34)^{no}	5.85 (2.52)^{no}	5.66 (2.48)^{pq}	12.78 (3.64) ^{no}	13.91 (3.8) ^{no}	13.48 (3.74)^{no}	15.20 (3.96)^{no}	10.72 (3.35)^{no}	11.23 (3.42)^{no}	8.05 (2.92)^{no}	8.81 (3.05)^{no}
ATM (H×H)	BG-II	1.51 (1.42)^{mn}	2.03 (1.59)^{lm}	4.89 (2.32)^{lm}	5.56 (2.46)^{lm}	7.01 (2.74)^{lm}	8.19 (2.95)^{lm}	15.59 (4.01)^{lm}	16.70 (4.15)^{lm}	16.01 (4.06)^{lm}	17.14 (4.2) ^{lm}	11.89 (3.52)^{lm}	12.11 (3.55)^{mn}	9.48 (3.16)^{lm}	10.29 (3.28)^{lm}
MRC-7351 (H×H)	BG-II	1.96 (1.57)^{kl}	2.37 (1.69) ^{kl}	5.48 (2.45)^{kl}	6.11 (2.57)^{kl}	7.52 (2.83)^{kl}	8.43 (2.99)^{kl}	16.01 (4.06) ^{kl}	17.28 (4.22) ^{kl}	16.47 (4.12)^{kl}	17.56 (4.25)^{kl}	12.10 (3.55)^{kl}	12.98 (3.67)^{lm}	9.92 (3.23) ^{kl}	10.79 (3.36) ^{kl}
MRC-7353 (H×H)	BG-II	2.15 (1.63)^{jk}	3.06 (1.89) ^{jk}	6.12 (2.57) ^{ij}	7.03 (2.74) ^{ij}	8.05 (2.92)^{jk}	9.11 (3.10) ^{jk}	16.87 (4.17) ^{jk}	17.95 (4.3) ^{jk}	17.54 (4.25)^{jk}	18.02 (4.3) ^{jk}	12.97 (3.67)^{jk}	13.65 (3.76) ^{jk}	10.62 (3.33) ^{jk}	11.47 (3.46) ^{jk}
MRC-7918 (H×B)	BG-II	3.89 (2.1) ^{cd}	4.01 (2.12) ^{gh}	6.18 (2.58)^{hi}	7.09 (2.75)^{hi}	9.01 (3.08)^{hi}	10.29 (3.28) ^{gh}	18.02 (4.30) ^{gh}	19.06 (4.42) ^{gh}	19.26 (4.45)^{gh}	21.67 (4.71)^{gh}	13.66 (3.76)^{gh}	15.13 (3.95)^{gh}	11.67 (3.49)^{gh}	12.86 (3.66)^{gh}
Puli (H×B)	BG-II	2.56 (1.75) ^{ij}	3.78 (2.07) ^{ij}	5.90 (2.53)^{jk}	6.72 (2.69)^{jk}	8.81 (3.05) ^{ij}	9.50 (3.16) ^{ij}	17.67 (4.26) ^{ij}	18.05 (4.31) ^{ij}	18.15 (4.32)^{ij}	19.23 (4.44) ^{ij}	13.05 (3.68) ^{ij}	14.26 (3.84) ^{ij}	11.14 (3.41) ^{ij}	12.05 (3.54) ^{ij}
Sowmya (H×B)	BG-II	3.26 (1.94)^{fg}	3.89 (2.10) ^{hi}	7.01 (2.74)^{gh}	7.88 (2.89) ^{gh}	8.99 (3.08)^{gh}	10.22 (3.27)^{hi}	17.89 (4.29) ^{hi}	18.31 (4.34) ^{hi}	18.40 (4.35) ^{hi}	20.01 (4.53)^{hi}	13.24 (3.71) ^{hi}	14.83 (3.92) ^{hi}	11.35 (3.44) ^{hi}	12.41 (3.59) ^{hi}
VCH-5 (H×H)	BG-I	3.30 (1.95)^{ef}	5.49 (2.45) ^{de}	10.77 (3.36)^{de}	11.63 (3.48)^{de}	13.01 (3.68)^{de}	13.99 (3.81)^{de}	20.76 (4.61) ^{de}	22.01 (4.74) ^{de}	22.01 (4.74)^{de}	24.28 (4.98)^{de}	15.38 (3.98)^{de}	17.10 (4.2) ^{de}	14.21 (3.83)^{de}	15.75 (4.03)^{de}
MRC-6918 (H×B)	BG-I	3.63 (2.03)^{de}	6.77 (2.70) ^{cd}	10.97 (3.39)^{cd}	11.84 (3.51)^{cd}	13.56 (3.75) ^{d}	14.21 (3.84) ^{d}	21.44 (4.68) ^{cd}	23.47 (4.9) ^{cd}	22.78 (4.82)^{cd}	25.13 (5.06)^{cd}	16.03 (4.07)^{cd}	18.15 (4.32)^{cd}	14.74 (3.9) ^{cd}	16.60 (4.13)^{cd}
Arjun-21	GMF	3.16 (1.91)^{gh}	5.03 (2.35) ^{ef}	10.34 (3.29)^{ef}	11.05 (3.40) ^{ef}	12.36 (3.59)^{ef}	13.01 (3.68)^{ef}	20.11 (4.54) ^{ef}	21.39 (4.68) ^{ef}	21.56 (4.70) ^{ef}	22.03 (4.75)^{ef}	14.92 (3.93)^{ef}	16.41 (4.11) ^{ef}	13.74 (3.77) ^{ef}	14.82 (3.91) ^{ef}
Profit+	GMF	2.72 (1.79)^{hi}	4.01 (2.12) ^{fg}	7.96 (2.91) ^{g}	8.45 (2.99) ^{g}	9.60 (3.18) ^{g}	11.02 (3.39)^{fg}	18.42 (4.35) ^{fg}	19.35 (4.46) ^{fg}	20.11 (4.54)^{fg}	21.99 (4.74)^{fg}	14.08 (3.82)^{fg}	15.93 (4.05)^{fg}	12.15 (3.56)^{fg}	13.46 (3.74)^{fg}
DCH-32 (H×B)	Non *Bt*	4.93 (2.33) ^{a}	7.83 (2.89) ^{a}	12.40 (3.59) ^{a}	13.86 (3.79) ^{a}	21.40 (4.68) ^{a}	23.09 (4.86) ^{a}	26.97 (5.24) ^{a}	27.15 (5.26) ^{a}	27.93 (5.33) ^{a}	30.31 (5.55) ^{a}	17.73 (4.27) ^{a}	19.49 (4.47) ^{a}	18.56 (4.37) ^{a}	20.29 (4.56) ^{a}
DHH-263 (H×H)	Non *Bt*	4.77 (2.3) ^{ab}	7.56 (2.84) ^{ab}	11.53 (3.47)^{ab}	12.8 (3.65)^{ab}	19.54 (4.48)^{ab}	22.04 (4.75)^{ab}	24.89 (5.04) ^{ab}	25.66 (5.11) ^{ab}	25.65 (5.11)^{ab}	28.01 (5.34)^{ab}	17.01 (4.18)^{ab}	19.01 (4.42)^{ab}	17.23 (4.21)^{ab}	19.18 (4.44)^{ab}
Sahana	Non *Bt*	4.59 (2.26)^{bc}	7.29 (2.79) ^{bc}	11.12 (3.41)^{bc}	12.39 (3.59)^{bc}	18.41 (4.35)^{bc}	20.14 (4.54)^{bc}	22.93 (4.84) ^{bc}	24.52 (5.00)^{bc}	25.01 (5.05)^{bc}	26.22 (5.17)^{bc}	16.59 (4.13)^{bc}	18.96 (4.41)^{bc}	16.44 (4.12)^{bc}	18.25 (4.33)^{bc}
S.Em(±)		0.04	0.04	0.08	0.11	0.12	0.21	0.19	0.18	0.21	0.19	0.24	0.25	0.16	0.15
CD (p=0.05)		0.28	0.28	0.25	0.33	0.36	0.59	0.58	0.53	0.57	0.54	0.72	0.69	0.48	0.31
CV (%)		10.28	10.28	8.77	8.14	8.31	11.75	11.08	8.38	8.89	8.43	10.63	13.61	9.24	11.05

* Figures in the parentheses transformed values, Mean followed by the same alphabet in a column do not differ significantly (P=0.05) by DMRT DAS: Days After Sowing

Table 6: Locule damage due to pink bollworm in different *Bt* and non *Bt* cotton genotypes

Genotypes	Transgenic event	Percent locule damage							
		105 DAS		120 DAS		135 DAS		Mean	
		2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Bindas (H×H)	BG-II	9.36 (17.81) ^{op}	10.58 (18.98) ^{op}	11.36 (19.7) ^{pq}	13.07 (21.19) ^{pq}	15.82 (23.44) ^{op}	16.03 (23.6) ^{qr}	12.18 (20.43) ^{op}	14.19 (22.13) ^{op}
President gold (H×H)	BG-II	10.66 (19.06) ^{mn}	11.09 (19.45) ^{no}	13.63 (21.67) ^{mn}	15.03 (22.81) ^{no}	16.38 (23.87) ^{no}	18.01 (25.11) ^{no}	13.56 (21.6) ^{mn}	15.01 (22.79) ^{mn}
Jadoo (H×H)	BG-II	9.21 (17.67) ^{pq}	10.30 (18.72) ^{pq}	11.36 (19.7) ^{op}	14.28 (22.2) ^{op}	15.69 (23.33) ^{pq}	17.99 (25.1) ^{op}	12.06 (20.32) ^{pq}	13.23 (21.33) ^{pq}
Everest (H×H)	BG-II	9.12 (17.58) ^{qr}	10.02 (18.45) ^{qr}	10.97 (19.34) ^{qr}	12.03 (20.29) ^{qr}	14.89 (22.7) ^{qr}	16.37 (23.87) ^{pq}	11.69 (19.99) ^{qr}	12.81 (20.97) ^{qr}
First class (H×H)	BG-II	10.52 (18.93) ^{no}	11.37 (19.71) ^{mn}	13.36 (21.44) ^{no}	15.42 (23.12) ^{mn}	16.39 (23.88) ^{mn}	18.23 (25.28) ^{lm}	13.42 (21.49) ^{no}	14.71 (22.55) ^{no}
ATM (H×H)	BG-II	10.96 (19.33) ^{lm}	12.17 (20.42) ^{kl}	13.69 (21.72) ^{lm}	17 .01 (24.35) ^{kl}	17.02 (24.37) ^{lm}	20.01 (26.57) ^{jk}	13.89 (21.88) ^{lm}	15.72 (23.36) ^{lm}
MRC-7351 (H×H)	BG-II	11.02 (19.39) ^{kl}	11.91 (20.19) ^{lm}	14.05 (22.01) ^{kl}	17.24 (24.53) ^{ij}	17.63 (24.83) ^{kl}	18.02 (25.12) ^{mn}	14.23 (22.16) ^{kl}	16.39 (23.88) ^{kl}
MRC-7353 (H×H)	BG-II	11.63 (19.94) ^{jk}	13.08 (21.2) ^{jk}	17.69 (24.87) ^{gh}	18.92 (25.78) ^{gh}	19.18 (25.97) ^{ij}	21.04 (27.3) ^{gh}	16.17 (23.71) ^{ij}	17.68 (24.86) ^{hi}
MRC-7918 (H×B)	BG-II	14.99 (22.78) ^{ef}	15.86 (23.47) ^{ef}	17.96 (25.07) ^{ef}	18.94 (25.8) ^{fg}	21.36 (27.53) ^{ef}	23.61 (29.07) ^{ef}	18.04 (25.14) ^{ef}	19.22 (26.00) ^{ef}
Puli (H×B)	BG-II	13.62 (21.66) ^{hi}	14.08 (22.04) ^{ij}	17.08 (24.41) ^{hi}	16.23 (23.76) ^{lm}	19.92 (26.51) ^{gh}	20.33 (26.8) ^{hi}	16.87 (24.25) ^{gh}	16.88 (24.26) ^{jk}
Sowmya (H×B)	BG-II	14.02 (21.99) ^{fg}	15.16 (22.91) ^{gh}	17.78 (24.94) ^{fg}	18.18 (25.24) ^{hi}	20.60 (26.99) ^{fg}	21.50 (27.62) ^{fg}	17.53 (24.75) ^{fg}	18.47 (25.45) ^{fg}
VCH-5 (H×H)	BG-I	15.26 (22.99) ^{de}	16.87 (24.25) ^{de}	20.39 (26.84) ^{de}	21.05 (27.31) ^{e}	25.26 (30.17) ^{de}	27.91 (31.89) ^{de}	20.30 (26.78) ^{de}	21.94 (27.93) ^{de}
MRC-6918 (H×B)	BG-I	18.69 (25.61) ^{d}	20.96 (27.25) ^{d}	22.69 (28.45) ^{d}	28.41 (32.21) ^{d}	31.67 (34.25) ^{cd}	32.50 (34.76) ^{cd}	24.35 (29.57) ^{d}	27.29 (31.49) ^{d}
Arjun-21	GMF	14.02 (21.99) ^{gh}	15.39 (23.1) ^{fg}	16.97 (24.33) ^{ij}	19.66 (26.32) ^{ef}	19.42 (26.15) ^{hi}	20.20 (26.71) ^{ij}	16.80 (24.2) ^{hi}	18.42 (25.41) ^{gh}
Profit+	GMF	12.36 (20.58) ^{ij}	14.63 (22.49) ^{hi}	15.98 (23.56) ^{jk}	17.22 (24.52) ^{jk}	18.11 (25.19) ^{jk}	19.34 (26.09) ^{kl}	15.48 (23.17) ^{jk}	17.06 (24.4) ^{ij}
DCH-32 (H×B)	Non *Bt*	31.20 (33.96) ^{a}	34.39 (35.90) ^{a}	37.67 (37.86) ^{a}	38.42 (38.30) ^{a}	39.40 (38.88) ^{a}	41.77 (40.26) ^{a}	36.09 (36.92) ^{a}	38.19 (38.17) ^{a}
DHH-263 (H×H)	Non *Bt*	30.36 (33.44) ^{ab}	33.01 (35.07) ^{ab}	33.69 (35.48) ^{ab}	36.41 (37.11) ^{ab}	37.01 (37.47) ^{ab}	40.12 (39.30) ^{ab}	33.69 (35.48) ^{ab}	36.51 (37.18) ^{ab}
Sahana	Non *Bt*	29.53 (32.92) ^{bc}	31.94 (34.41) ^{bc}	32.98 (35.05) ^{bc}	34.88 (36.2) ^{bc}	33.6 (35.43) ^{bc}	36.08 (36.92) ^{bc}	32.04 (34.47) ^{bc}	34.30 (35.85) ^{bc}
S.Em(±)		1.02	1.27	1.53	1.35	1.74	1.79	1.47	1.41
CD (p=0.05)		3.11	3.68	4.41	3.88	5	5.14	4.38	4.07
CV (%)		9.78	9.95	15.23	9.39	11.46	11.42	12.14	9.86

***** Figures in the parentheses are arcsine transformed values, Mean followed by the same alphabet in a column do not differ significantly (P=0.05) by DMRT DAS: Days After Sowing

Table 7: Boll opening in different *Bt* and non *Bt* cotton genotypes

Genotypes	Transgenic event	Good open bolls/plant		Bad open bolls/plant	
		2018-19	2019-20	2018-19	2019-20
Bindas (H×H)	BG-II	24.37^{bc}	23.22^{bc}	5.07^{op}	6.13^{op}
President gold (H×H)	BG-II	23.01^{de}	21.20^{de}	5.20^{mn}	6.37^{lm}
Jadoo (H×H)	BG-II	25.61^{ab}	24.45^{ab}	4.50 ^{pq}	5.41^{pq}
Everest (H×H)	BG-II	26.68^{a}	25.89^{a}	4.21^{qr}	5.04^{qr}
First class (H×H)	BG-II	23.96^{cd}	22.41^{cd}	5.10^{no}	6.18^{no}
ATM (H×H)	BG-II	18.11^{f}	16.84 ^{f}	5.31^{lm}	6.27^{mn}
MRC-7351 (H×H)	BG-II	16.46^{fg}	15.61 ^{fg}	5.39^{jk}	6.52^{kl}
MRC-7353 (H×H)	BG-II	16.26^{gh}	14.85 ^{gh}	5.42 ^{ij}	6.66^{jk}
MRC-7918 (H×B)	BG-II	12.13^{lm}	11.01 ^{lm}	6.34^{ef}	7.09^{fg}
Puli (H×B)	BG-II	13.98 ^{jk}	12.53^{jk}	6.09^{gh}	6.82^{gh}
Sowmya (H×B)	BG-II	12.45^{kl}	11.48^{kl}	6.20 ^{fg}	7.43^{ef}
VCH-5 (H×H)	BG-I	12.06^{mn}	10.97^{mn}	6.42^{de}	7.58^{de}
MRC-6918 (H×B)	BG-I	11.73^{no}	9.42^{no}	6.47^{cd}	7.80^{dc}
Arjun-21	GMF	14.61^{ij}	13.70^{ij}	5.33^{kl}	6.74^{ij}
Profit+	GMF	15.34^{hi}	14.43^{hi}	5.61^{hi}	6.76^{hi}
DCH-32 (H×B)	Non *Bt*	6.39^{qr}	5.83^{qr}	10.04^{a}	11.15^{a}
DHH-263 (H×H)	Non *Bt*	7.63^{pq}	6.51^{pq}	9.06 ^{ab}	10.27^{ab}
Sahana	Non *Bt*	9.19^{p}	8.3^{op}	7.58 ^{c}	7.70^{cd}
S.Em(±)		0.63	0.55	0.41	0.48
CD (p=0.05)		1.85	1.58	1.18	1.38
CV (%)		10.38	8.12	11.91	11.70

*Mean followed by the same alphabet in a column do not differ significantly (P=0.05) by DMRT

Table 8: Kapas yield of different genotypes (q/ha)

Genotypes	Transgenic event	Total yield (q/ha)		Good kapas yield (q/ha)		Bad kapas yield (q/ha)	
		2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Bindas (H×H)	BG-II	14.69 bc	13.23bc	8.11c	7.82bc	5.84 ij	5.48 gh
President gold (H×H)	BG-II	13.43de	12.57de	7.05fg	6.10fg	6.58 ab	5.41 ij
Jadoo (H×H)	BG-II	14.96ab	13.68ab	9.12b	8.20ab	5.65 jk	5.55 fg
Everest (H×H)	BG-II	15.88a	14.52a	10.23a	8.97a	4.59 no	4.67 lm
First class (H×H)	BG-II	13.96cd	12.89cd	7.93cd	7.01cd	6.38 cd	6.47 ab
ATM (H×H)	BG-II	12.52 ef	11.68ef	7.26ef	6.27ef	6.70 a	6.62 a
MRC-7351 (H×H)	BG-II	12.48fg	11.39gh	6.08hi	5.32ij	6.43 bc	6.06 de
MRC-7353 (H×H)	BG-II	12.23gh	11.12hi	5.94jk	5.63hi	6.29 de	6.23 cd
MRC-7918 (H×B)	BG-II	11.01jk	9.87kl	6.01ij	4.89jk	5.01lm	4.76 kl
Puli (H×B)	BG-II	12.12hi	11.59fg	7.82de	6.94de	4.30op	4.24 no
Sowmya (H×B)	BG-II	11.47 ij	10.50ij	6.20h	5.74gh	5.27 kl	4.65 mn
VCH-5 (H×H)	BG-I	10.76kl	10.01jk	4.81l	3.74l	5.95 gh	5.89 ef
MRC-6918 (H×B)	BG-I	10.63lm	9.41lm	4.60lm	3.52lm	6.03 fg	6.27 bc
Arjun-21	GMF	9.97mn	8.47mn	3.22op	2.93no	5.88 hi	5.12 jk
Profit+	GMF	9.62no	8.01no	3.59n	3.01mn	6.03 ef	5.46 hi
DCH-32 (H×B)	Non *Bt*	6.49qr	5.45qr	2.91qr	2.14qr	3.58 qr	3.31 pq
DHH-263 (H×H)	Non *Bt*	7.54pq	6.04pq	3.02pq	2.64pq	4.23 pq	3.20qr
Sahana	Non *Bt*	7.90p	6.48p	3.26no	2.87op	4.64 mn	3.61 op
S.Em(±)		0.36	0.41	0.28	0.32	0.32	0.40
CD (p=0.05)		1.10	1.22	0.67	0.93	0.98	1.08
CV (%)		14.34	8.30	14.72	13.89	12.15	14.29

*Mean followed by the same alphabet in a column do not differ significantly (P=0.05) by DMRT

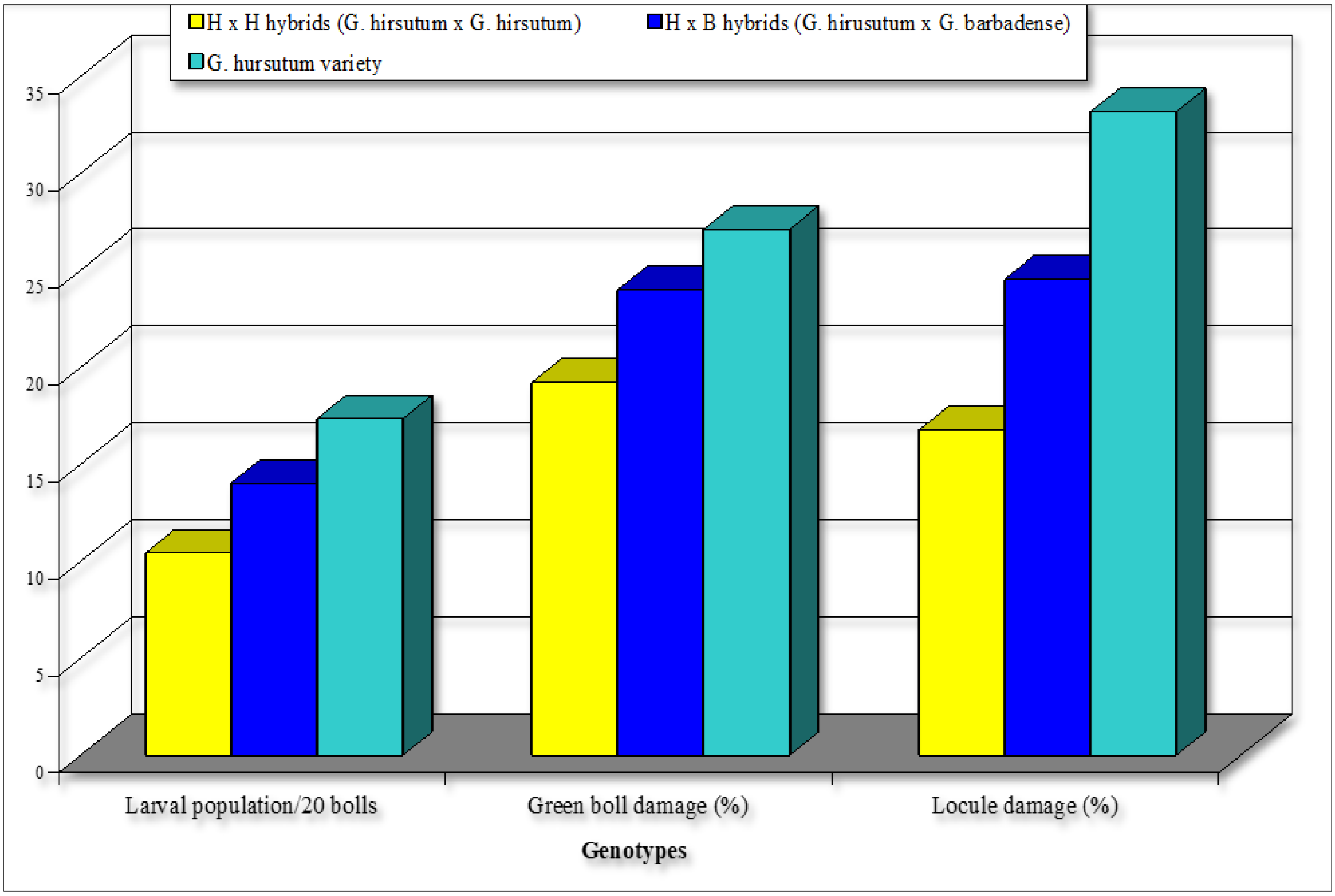

Fig 1: Pink Bollworm larval incidence and its damage in contrast with different genotype formats of cotton

Conclusion

Minimum pink bollworm infestation was recorded in *Bt* BG-II genotypes, compared to BG-I, GMF and non *Bt* genotypes. Among the genotypes, Everest BG-II hybrid yielded higher kapas followed by Jadoo In non-*Bt* genotypes yields were significantly lower thus implying as promising hybrid under rainfed conditions.

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