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# Screening of Bt cotton genotypes for their reaction to shoot weevil, *Alcidodes affaber* Aurivillius infestation and their biochemical analysis

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**Abstract**
Screening of Bt cotton genotypes for their reaction to shoot weevil, *Alcidodes affaber* Aurivillius infestation and their biochemical analysis revealed that, Bt cotton hybrids *viz.*, Neeraja, Cash, Bunny and Brahma were found to be promising lines by registering lower incidence of shoot weevil followed by Miracle, RCH 2Bt, DCH 32, Steplon, Puli BGII, Chetak, Mallika, Bindas, Chiranjeevi and Sudarshan. On the contrary, Bt genotypes *viz*., Shalimar and MRC-7351 were found to be susceptible lines by recording higher shoot weevil incidence as compared to rest of the genotypes. Correlation coefficients indicated that, moisture percentage and total sugars have positive relationship with shoot weevil infestation and gossypol had no influence on infestation. Infestation was negatively related with tannin and total phenol content.

**Keywords:** Screening, Bt genotypes, shoot weevil, *Alcidodes affaber*, biochemical analysis

## 1. Introduction
The shoot weevil, *Alcidodes affaber* Aurivillius has been reported to be a minor pest of cotton in South India [8] but in recent years this pest has assumed major proportions in the transgenic cotton era in transitional cotton belt of Karnataka. The weevils lay eggs at the node axle and the newly hatched grubs feed on the tissue. Consequently the affected plant leaves wilt and droop. The younger plants are more vulnerable for the infestation. The grubs bore into shoots tip and leaf axils which lead to death of younger plants. Under severe cases tunneling reaches the base of the stem resulting in breakage of the stem. The affected plants exhibit withering of shoot tips initially and later on holes with excreta on the shoot tip and leaf petiole. The affected portion with fresh faecal pellets is the clear indication of presence of grubs [1].
Hence, there is a imperative to study the screening of Bt cotton genotypes for their reaction to shoot weevil infestation and their biochemical analysis to know their relation with the shoot weevil infestation for its effective management. So for no efforts have been made to study the screening of Bt cotton genotypes for their reaction to shoot weevil infestation. Its menace is increasing year after year particularly after the introduction of transgenic Bt cotton. Keeping this in view, the studies on screening of Bt cotton genotypes was undertaken.

## 2. Materials and method
The field experiment was carried out at B. Gudihal (Tq. Kalghatagi; Dist. Dharwad) during the 2013-14 and 2014-15 *kharif* seasons under rainfed conditions. Totally, fifteen popular Bt cotton genotypes including one non Bt genotype (DCH 32) were screened during the study. The experiment was laid out in randomized block design involving five rows of 5.4 meters length with a spacing of 90 cm x 60 cm comprising of fifty plants and were replicated twice. Sowing was taken up during third week of June during 2013-14 *kharif* and in third week of July during 2014-15 *kharif* due to delay in the rainfall. All standard agronomic practices recommended for Bt cotton were followed to raise good crop except plant protection measures. During the experimentation period, at 15, 30, 45 and 60 days after sowing (DAS), number of adult weevils per plot (comprising of 50 plants) was recorded during morning hours on each entry. Similarly, the number of infested plants were counted in each genotype and were converted into percentage at 15, 30, 45 and 60 DAS. At 60 and 90 days after sowing, stem was

split open and recorded number of grubs present in ten infested plants in each genotype and converted to per plant basis. Similarly, average tunnel length and number of broken branches from ten infested plants in each genotype were recorded both at 60 and 90 DAS. Seed cotton was harvested separately from each genotype. Seed cotton obtained from each plot was expressed in terms of quintals per hectare. An attempt was made to study the relationship between biochemical constituents and resistance of Bt cotton genotypes to shoot weevil attack. Biochemical analysis *viz.*, total phenols, total sugars, gossypol and tannins were estimated from each genotype besides moisture content at Agriculture Research Station, Dharwad farm during 2014.

## 3. Results and Discussion

### 3.1 Adult population

Pooled data on adult population at 15 DAS indicated that, genotypes Neeraja, Cash and Bunny recorded lowest adult population of 3.75, 3.75 and 4.00 per plot, respectively (Table 1.). Brahma (4.75/plot) was found to be next best genotype in the order of superiority followed by Miracle (6.00/plot) and RCH2 Bt (6.75/plot). However, significantly highest adult population was recorded in MRC-7351 (18.00/plot). Observations at 30 DAS revealed that, Neeraja found significantly superior over rest of the genotypes by recording lowest adult population of 7.25 per plot which was statistically on par with Cash (8.00/plot). Genotype Bunny (8.75/plot) was found to be next best genotype in the order of superiority followed by Brahma (9.50/plot), Miracle (11.25/plot) and RCH2 Bt (13.25/plot). On the other hand, significantly highest adult population (24.75/plot) was recorded in MRC-7351 (Table 1.).

Similarly, observations made at 45 DAS revealed that Neeraja recorded lowest adult population of 6.00 per plot which was statistically on par with Cash (6.50/plot) and Bunny (7.25/plot). Genotype Brahma (8.00/plot) was found to be next best genotype followed by Miracle (9.50/plot), RCH2 Bt (11.00/plot) and DCH 32 (11.75/plot). On the other hand, significantly highest adult population of 22.25 per plot was recorded in MRC-7351 (Table 1).

Further, observations made at 60 DAS revealed that Neeraja found to be significantly superior over rest of the Bt genotypes by recording lowest adult population of 1.00 per plot and was on par with Cash (1.75/plot) and Bunny (2.00/plot) (Table 1). Genotype Brahma (2.25/plot) was found to be next best genotype in the order of superiority followed by Miracle (3.25/plot). However, significantly higher adult population was recorded in Shalimar (13.50/plot) and MRC-7351 (15.50/plot).

Pooled data on mean adult population revealed that genotype Neeraja found to be significantly superior by recording lowest adult population of 4.50 per plot which was statistically on par with Cash (5.00/plot). Whereas, Bunny (5.50/plot) was found to be next best genotype in the order of superiority followed by Brahma (6.13/plot), Miracle (7.50/plot), RCH2 Bt (9.00/plot) and DCH 32 (10.00/plot). Whereas, Steplon (11.50/plot) and Puli BG II (11.63/plot) were on par with each other followed by Chetak (13.25/plot), Bindas (13.38/plot) and Mallika (13.75/plot) genotypes. Further, genotypes Chiranjeevi and Sudarshan were recorded higher adult population of 15.38 and 16.38 per plot, respectively and were on par with each other and followed by Shalimar (18.06/plot) and MRC-7351 (20.13/plot). Almost similar trend with respect to adult population was followed during 2013-14 and 2014-15 seasons (Table 1.).

**Table 1:** Adult population of shoot weevil on different Bt cotton genotypes

| Treatment | Adult weevils population per plot (50 plants) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 DAS | | | 30 DAS | | | 45 DAS | | | 60 DAS | | | Mean | | |
| | 2013 | 2014 | Pooled | 2013 | 2014 | Pooled | 2013 | 2014 | Pooled | 2013 | 2014 | Pooled | 2013 | 2014 | Pooled |
| Neeraja | 4.50 (2.23)$^{a}$ | 3.00 (1.85)$^{a}$ | 3.75 (2.05)$^{a}$ | 8.00 (2.92)$^{a}$ | 6.50 (2.64)$^{a}$ | 7.25 (2.78)$^{a}$ | 7.00 (2.73)$^{a}$ | 5.00 (2.34)$^{a}$ | 6.00 (2.54)$^{a}$ | 2.00 (1.58)$^{a}$ | 0.00 (0.71)$^{a}$ | 1.00 (1.22)$^{a}$ | 5.38 (2.42)$^{a}$ | 3.63 (2.03)$^{a}$ | 4.50 (2.23)$^{a}$ |
| Cash | 5.00 (2.35)$^{ab}$ | 2.50 (1.73)$^{a}$ | 3.75 (2.06)$^{a}$ | 9.00 (3.08)$^{ab}$ | 7.00 (2.73)$^{ab}$ | 8.00 (2.91)$^{ab}$ | 7.00 (2.74)$^{a}$ | 6.00 (2.55)$^{ab}$ | 6.50 (2.65)$^{ab}$ | 2.50 (1.73)$^{ab}$ | 1.00 (1.22)$^{b}$ | 1.75 (1.50)$^{ab}$ | 5.88 (2.52)$^{ab}$ | 4.13 (2.15)$^{ab}$ | 5.00 (2.35)$^{ab}$ |
| Shalimar | 17.00 (4.18)$^{fg}$ | 15.50 (4.00)$^{hi}$ | 16.25 (4.09)$^{ij}$ | 24.00 (4.95)$^{h}$ | 21.50 (4.69)$^{i}$ | 22.75 (4.82)$^{l}$ | 21.00 (4.64)$^{g}$ | 18.50 (4.36)$^{hi}$ | 19.75 (4.50)$^{hi}$ | 16.50 (4.12)$^{h}$ | 10.50 (3.32)$^{hi}$ | 13.50 (3.74)$^{h}$ | 19.63 (4.49)$^{i}$ | 16.50 (4.12)$^{kl}$ | 18.06 (4.31)$^{j}$ |
| Mallika | 13.50 (3.74)$^{e}$ | 10.00 (3.24)$^{e}$ | 11.75 (3.50)$^{f}$ | 20.50 (4.58)$^{fg}$ | 16.00 (4.06)$^{fg}$ | 18.25 (4.33)$^{ij}$ | 18.00 (4.30)$^{ef}$ | 16.00 (4.00)$^{hi}$ | 17.00 (4.18)$^{gh}$ | 7.00 (2.74)$^{def}$ | 7.00 (2.74)$^{fg}$ | 7.00 (2.74)$^{defg}$ | 14.75 (3.90)$^{g}$ | 12.75 (3.64)$^{hi}$ | 13.75 (3.77)$^{h}$ |
| Chetak | 10.50 (3.32)$^{d}$ | 10.00 (3.24)$^{e}$ | 10.25 (3.28)$^{e}$ | 20.00 (4.53)$^{f}$ | 14.00 (3.81)$^{ef}$ | 17.00 (4.18)$^{hi}$ | 18.00 (4.30)$^{ef}$ | 18.00 (4.30)$^{hi}$ | 18.00 (4.30)$^{gh}$ | 8.50 (3.00)$^{efg}$ | 7.00 (2.74)$^{fg}$ | 7.75 (2.87)$^{fg}$ | 14.25 (3.84)$^{g}$ | 12.25 (3.57)$^{h}$ | 13.25 (3.71)$^{h}$ |
| Steplon | 9.50 (3.16)$^{d}$ | 8.50 (3.00)$^{d}$ | 9.00 (3.08)$^{e}$ | 17.00 (4.18)$^{e}$ | 12.50 (3.60)$^{de}$ | 14.75 (3.90)$^{f}$ | 14.00 (3.81)$^{cd}$ | 12.00 (3.81)$^{f}$ | 13.00 (3.81)$^{f}$ | 9.00 (3.08)$^{fg}$ | 7.50 (2.82)$^{fg}$ | 8.25 (2.96)$^{g}$ | 12.38 (3.59)$^{ef}$ | 10.63 (3.33)$^{g}$ | 11.50 (3.46)$^{g}$ |
| Brahma | 6.50 (2.64)$^{bc}$ | 3.00 (1.87)$^{a}$ | 4.75 (2.29)$^{b}$ | 10.50 (3.32)$^{c}$ | 8.50 (3.00)$^{bc}$ | 9.50 (3.16)$^{c}$ | 8.50 (3.00)$^{a}$ | 7.50 (2.83)$^{bc}$ | 8.00 (2.91)$^{bc}$ | 2.50 (1.73)$^{ab}$ | 2.00 (1.58)$^{bc}$ | 2.25 (1.66)$^{bc}$ | 7.00 (2.74)$^{b}$ | 5.25 (2.40)$^{cd}$ | 6.13 (2.57)$^{c}$ |
| Sudarshan | 16.00 (4.06)$^{ef}$ | 14.50 (3.87)$^{gh}$ | 15.25 (3.97)$^{hi}$ | 24.00 (4.95)$^{h}$ | 20.00 (4.53)$^{hi}$ | 22.00 (4.74)$^{l}$ | 21.00 (4.64)$^{g}$ | 17.00 (4.18)$^{gh}$ | 19.00 (4.41)$^{gh}$ | 10.00 (3.23)$^{g}$ | 8.50 (3.00)$^{gh}$ | 9.25 (3.12)$^{g}$ | 17.75 (4.27)$^{h}$ | 15.00 (3.94)$^{jk}$ | 16.38 (4.11)$^{i}$ |
| Chiranjivi | 15.00 (3.94)$^{ef}$ | 13.00 (3.67)$^{fg}$ | 14.00 (3.81)$^{gh}$ | 22.50 (4.80)$^{gh}$ | 18.50 (4.36)$^{gh}$ | 20.50 (4.58)$^{k}$ | 20.50 (4.58)$^{fg}$ | 17.00 (4.18)$^{gh}$ | 18.75 (4.39)$^{gh}$ | 9.00 (3.08)$^{fg}$ | 7.50 (2.83)$^{fg}$ | 8.25 (2.96)$^{g}$ | 16.75 (4.15)$^{h}$ | 14.00 (3.81)$^{ij}$ | 15.38 (3.98)$^{i}$ |
| Puli BG II | 10.00 (3.24)$^{d}$ | 9.00 (3.08)$^{de}$ | 9.50 (3.16)$^{e}$ | 19.00 (4.42)$^{f}$ | 13.50 (3.74)$^{e}$ | 16.25 (4.09)$^{gh}$ | 15.50 (4.00)$^{de}$ | 11.50 (3.46)$^{e}$ | 13.50 (3.74)$^{f}$ | 8.00 (2.92)$^{efg}$ | 6.50 (2.64)$^{fg}$ | 7.25 (2.78)$^{efg}$ | 13.13 (3.69)$^{fg}$ | 10.13 (3.26)$^{fg}$ | 11.63 (3.48)$^{g}$ |
| Miracle | 7.00 (2.74)$^{c}$ | 5.00 (2.35)$^{b}$ | 6.00 (2.55)$^{c}$ | 13.50 (3.74)$^{d}$ | 9.00 (3.08)$^{c}$ | 11.25 (3.43)$^{d}$ | 11.00 (3.39)$^{b}$ | 8.00 (2.92)$^{cd}$ | 9.50 (3.16)$^{cd}$ | 4.00 (2.11)$^{bc}$ | 2.50 (1.73)$^{cd}$ | 3.25 (1.93)$^{c}$ | 8.88 (3.06)$^{c}$ | 6.13 (2.57)$^{d}$ | 7.50 (2.83)$^{d}$ |
| Bindas | 14.00 (3.81)$^{e}$ | 11.50 (3.46)$^{f}$ | 12.75 (3.64)$^{fg}$ | 21.00 (4.64)$^{fg}$ | 16.50 (4.12)$^{fg}$ | 18.75 (4.39)$^{j}$ | 18.50 (4.36)$^{fg}$ | 15.00 (3.93)$^{fg}$ | 16.75 (4.15)$^{g}$ | 5.00 (2.35)$^{cd}$ | 5.50 (2.43)$^{ef}$ | 5.25 (2.39)$^{de}$ | 14.63 (3.89)$^{g}$ | 12.13 (3.55)$^{h}$ | 13.38 (3.72)$^{h}$ |
| MRC-7351 | 19.00 (4.41)$^{g}$ | 17.00 (4.18)$^{i}$ | 18.00 (4.3)$^{j}$ | 27.00 (5.24)$^{i}$ | 22.50 (4.79)$^{i}$ | 24.75 (5.02)$^{m}$ | 24.00 (4.95)$^{h}$ | 20.50 (4.58)$^{i}$ | 22.25 (4.77)$^{i}$ | 18.00 (4.30)$^{h}$ | 13.00 (3.67)$^{i}$ | 15.50 (4.00)$^{h}$ | 22.00 (4.74)$^{j}$ | 18.25 (4.33)$^{l}$ | 20.13 (4.54)$^{k}$ |
| BunnyBt | 5.00 (2.35)$^{ab}$ | 3.00 (1.87)$^{a}$ | 4.00 (2.12)$^{ab}$ | 9.50 (3.16)$^{bc}$ | 8.00 (2.91)$^{abc}$ | 8.75 (3.04)$^{bc}$ | 8.00 (2.91)$^{a}$ | 6.50 (2.64)$^{abc}$ | 7.25 (2.78)$^{ab}$ | 3.00 (1.87)$^{ab}$ | 1.00 (1.22)$^{b}$ | 2.00 (1.58)$^{abc}$ | 6.38 (2.62)$^{ab}$ | 4.63 (2.26)$^{bc}$ | 5.50 (2.45)$^{bc}$ |
| RCH2 Bt | 7.00 | 6.50 | 6.75 | 15.50 | 11.00 | 13.25 | 12.50 | 9.50 | 11.00 | 6.00 | 4.00 | 5.00 | 10.25 | 7.75 | 9.00 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (2.74)$^{c}$ | (2.64)$^{c}$ | (2.69)$^{cd}$ | (4.00)$^{e}$ | (3.39)$^{d}$ | (3.71)$^{e}$ | (3.60)$^{bc}$ | (3.16)$^{de}$ | (3.39)$^{de}$ | (2.55)$^{cde}$ | (2.12)$^{de}$ | (2.35)$^{d}$ | (3.28)$^{d}$ | (2.87)$^{e}$ | (3.08)$^{e}$ |
| DCH-32 | 7.50 (2.83)$^{c}$ | 7.00 (2.74)$^{c}$ | 7.25 (2.78)$^{d}$ | 17.00 (4.18)$^{e}$ | 13.50 (3.74)$^{e}$ | 15.25 (3.97)$^{fg}$ | 12.50 (3.60)$^{bc}$ | 11.00 (3.39)$^{e}$ | 11.75 (3.50)$^{ef}$ | 7.50 (2.83)$^{efg}$ | 4.00 (2.12)$^{de}$ | 5.75 (2.50)$^{def}$ | 11.13 (3.41)$^{de}$ | 8.88 (3.06)$^{ef}$ | 10.00 (3.24)$^{f}$ |
| S.Em± | 0.09 | 0.08 | 0.06 | 0.08 | 0.09 | 0.05 | 0.09 | 0.09 | 0.09 | 0.14 | 0.14 | 0.11 | 0.06 | 0.06 | 0.04 |
| CD (P=0.05) | 0.26 | 0.25 | 0.18 | 0.22 | 0.27 | 0.14 | 0.28 | 0.27 | 0.26 | 0.41 | 0.42 | 0.33 | 0.16 | 0.17 | 0.13 |

DAS- Days after sowing, Figures in parentheses are √x+0.5 transformation values,
Means followed by similar alphabets in the vertical column do not differ significantly by DMRT (p=0.05)

### 3.2 Percent infestation

Pooled data on percent infestation at 15 DAS shown that, lowest percent infestation was recorded in Neeraja (2.00%) followed by, Cash (5.00%) and Bunny (6.50%) were on par with each other (Table 2.). The next best genotype in the order of superiority was Brahma (8.50%) followed by Miracle (14.00%), RCH2 Bt (16.50%) and DCH 32 (17.50%) which were on par with each other. However, significantly highest percent infestation was recorded in MRC-7351 (35.00%). Observations made at 30 DAS revealed that, the genotypes Neeraja, Cash and Bunny were recorded lowest percent infestation of 14.50, 15.00 and 17.00 percent, respectively (Table 2.). Brahma (18.00%) found to be next best genotype in the order of superiority followed by Miracle (21.50%) and DCH 32 (26.50%). However, highest percent infestation was recorded in MRC-7351 (61.50%).

At 45 DAS observation revealed that, Neeraja and Cash genotypes recorded lowest percent infestation of 17.00 and 18.50 percent, respectively and were statistically on par with each other (Table 2.). Genotypes, Bunny (22.00%) and Brahma (22.50%) were on par with each other and found to be next best genotypes followed by Miracle (25.50%) and RCH2 Bt (33.00%). On the other hand, the highest percent infestation was recorded in MRC-7351 (81.50%). Observations at 60 DAS revealed that, genotypes Neeraja and Cash were recorded significantly lowest percent infestation of 18.00 and 19.50 percent, respectively were on par with each other (Table 2.). Bunny (23.50%) and Brahma (24.50%) genotypes were on par with each other and found next best genotypes in the order of superiority followed by Miracle (28.00%) and RCH2 Bt (36.50%). On the other hand, highest percent infestation of 86.50 percent was recorded in MRC-7351.

Pooled data of two consecutive years on mean percent infestation indicated that, genotype Neeraja was found to be significantly superior over rest of the genotypes by recording lowest percent infestation of 12.88 percent followed by Cash (14.50%). Genotypes, Bunny (17.25%) and Brahma (18.38%) were at par with each other and found next best genotypes in the order of superiority followed by Miracle (22.25%) and RCH-2 Bt (28.13%). Further, DCH 32 (32.25%) and Steplon (33.13%) were on par with each other followed by Puli BGII (35.25%), Chetak (39.50%), Mallika (42.63%), Bindas (46.50%), Chiranjeevi (50.50%), Sudarshan (54.75%), Shalimar (61.75%) and MRC-7351 (66.13%). Almost similar trend with respect to percent infestation was followed during 2013-14 and 2014-15 seasons (Table 2.).

**Table 2:** Percent infestation of shoot weevil on different Bt cotton genotypes

| Treatment | Percent infestation | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 DAS | | | 30 DAS | | | 45 DAS | | | 60 DAS | | | Mean | | |
| | 2013 | 2014 | Pooled | 2013 | 2014 | Pooled | 2013 | 2014 | Pooled | 2013 | 2014 | Pooled | 2013 | 2014 | Pooled |
| Neeraja | 3.00 (7.09)$^{a}$ | 1.00 (4.06)$^{a}$ | 2.00 (7.85)$^{a}$ | 16.00 (23.53)$^{a}$ | 13.00 (21.11)$^{a}$ | 14.50 (22.35)$^{a}$ | 19.00 (25.82)$^{a}$ | 15.00 (22.77)$^{a}$ | 17.00 (24.34)$^{a}$ | 20.00 (26.53)$^{a}$ | 16.00 (23.57)$^{a}$ | 18.00 (25.09)$^{a}$ | 14.50 (22.36)$^{a}$ | 11.25 (19.59)$^{a}$ | 12.88 (21.02)$^{a}$ |
| Cash | 7.00 (15.30)$^{b}$ | 3.00 (9.83)$^{b}$ | 5.00 (12.85)$^{b}$ | 18.00 (25.09)$^{a}$ | 12.00 (20.26)$^{a}$ | 15.00 (22.78)$^{a}$ | 20.00 (26.55)$^{a}$ | 17.00 (24.33)$^{ab}$ | 18.50 (25.46)$^{a}$ | 21.00 (27.26)$^{a}$ | 18.00 (25.09)$^{ab}$ | 19.50 (26.19)$^{a}$ | 16.50 (23.96)$^{a}$ | 12.5 (20.69)$^{b}$ | 14.50 (22.37)$^{b}$ |
| Shalimar | 39.00 (38.63)$^{h}$ | 28.00 (31.94)$^{hi}$ | 33.50 (35.35)$^{ij}$ | 62.00 (51.93)$^{j}$ | 46.00 (42.69)$^{i}$ | 54.00 (47.28)$^{j}$ | 80.00 (63.41)$^{j}$ | 78.00 (62.03)$^{k}$ | 79.00 (62.71)$^{k}$ | 81.00 (64.14)$^{j}$ | 80.00 (63.44)$^{l}$ | 80.50 (63.78)$^{k}$ | 65.50 (54.01)$^{k}$ | 58.00 (49.58)$^{n}$ | 61.75 (51.78)$^{m}$ |
| Mallika | 30.00 (33.19)$^{efgh}$ | 22.00 (27.96)$^{fgh}$ | 26.00 (30.64)$^{gh}$ | 48.00 (43.84)$^{fg}$ | 36.00 (36.86)$^{g}$ | 42.00 (40.38)$^{h}$ | 56.00 (48.43)$^{fg}$ | 44.00 (41.54)$^{g}$ | 50.00 (44.98)$^{g}$ | 56.00 (48.43)$^{f}$ | 49.00 (44.41)$^{h}$ | 52.50 (46.41)$^{g}$ | 47.50 (43.55)$^{g}$ | 37.75 (37.89)$^{j}$ | 42.63 (40.74)$^{i}$ |
| Chetak | 25.00 (29.98)$^{defg}$ | 19.00 (25.82)$^{efg}$ | 22.00 (27.96)$^{fg}$ | 44.00 (41.53)$^{ef}$ | 32.00 (34.43)$^{f}$ | 38.00 (38.04)$^{g}$ | 53.00 (46.70)$^{f}$ | 44.00 (41.53)$^{g}$ | 48.50 (44.12)$^{g}$ | 54.00 (47.28)$^{f}$ | 45.00 (42.11)$^{gh}$ | 49.50 (44.70)$^{f}$ | 44.00 (41.54)$^{f}$ | 35.00 (36.26)$^{i}$ | 39.50 (38.92)$^{h}$ |
| Steplon | 22.00 (27.94)$^{def}$ | 17.00 (24.33)$^{def}$ | 19.50 (26.19)$^{ef}$ | 37.00 (37.43)$^{cd}$ | 28.00 (31.94)$^{e}$ | 32.50 (34.74)$^{ef}$ | 42.00 (40.38)$^{de}$ | 35.00 (36.25)$^{de}$ | 38.50 (38.34)$^{e}$ | 44.00 (41.54)$^{e}$ | 40.00 (39.22)$^{f}$ | 42.00 (40.38)$^{e}$ | 36.25 (37.00)$^{e}$ | 30.00 (33.20)$^{g}$ | 33.13 (35.12)$^{f}$ |
| Brahma | 10.00 (18.34)$^{bc}$ | 7.00 (15.30)$^{c}$ | 8.50 (16.88)$^{c}$ | 20.00 (26.55)$^{a}$ | 16.00 (23.57)$^{bc}$ | 18.00 (25.09)$^{b}$ | 26.00 (30.63)$^{b}$ | 19.00 (25.82)$^{b}$ | 22.50 (28.30)$^{b}$ | 27.00 (31.29)$^{bc}$ | 22.00 (27.96)$^{c}$ | 24.50 (29.66)$^{b}$ | 20.75 (27.08)$^{b}$ | 16.00 (23.57)$^{d}$ | 18.38 (25.37)$^{c}$ |
| Sudarshan | 37.00 (37.45)$^{gh}$ | 27.00 (31.29)$^{hi}$ | 32.00 (34.44)$^{ij}$ | 58.00 (49.59)$^{ij}$ | 44.00 (41.54)$^{i}$ | 51.00 (45.55)$^{ij}$ | 71.00 (57.42)$^{i}$ | 64.00 (53.12)$^{j}$ | 67.50 (55.24)$^{j}$ | 72.00 (58.03)$^{i}$ | 65.00 (53.71)$^{k}$ | 68.50 (55.84)$^{j}$ | 59.50 (50.46)$^{j}$ | 50.00 (44.98)$^{m}$ | 54.75 (47.71)$^{l}$ |
| Chiranjivi | 34.00 (35.65)$^{gh}$ | 25.00 (29.98)$^{ghi}$ | 29.50 (32.88)$^{hij}$ | 54.00 (47.28)$^{hi}$ | 43.00 (40.96)$^{hi}$ | 48.50 (44.12)$^{i}$ | 65.00 (53.71)$^{h}$ | 56.00 (48.43)$^{i}$ | 60.50 (51.04)$^{j}$ | 67.00 (54.92)$^{h}$ | 60.00 (50.75)$^{j}$ | 63.50 (52.81)$^{i}$ | 55.00 (47.85)$^{i}$ | 46.00 (42.69)$^{l}$ | 50.50 (45.27)$^{k}$ |
| Puli BG II | 22.00 (27.94)$^{def}$ | 18.00 (25.09)$^{ef}$ | 20.00 (26.55)$^{ef}$ | 41.00 (39.80)$^{de}$ | 28.00 (31.94)$^{e}$ | 34.50 (35.96)$^{f}$ | 46.00 (42.69)$^{e}$ | 40.00 (39.22)$^{fg}$ | 43.00 (40.96)$^{f}$ | 46.00 (42.69)$^{e}$ | 41.00 (39.80)$^{fg}$ | 43.50 (41.25)$^{e}$ | 38.75 (38.48)$^{e}$ | 31.75 (34.28)$^{h}$ | 35.25 (36.41)$^{g}$ |
| Miracle | 16.00 (23.53)$^{cd}$ | 12.00 (20.20)$^{d}$ | 14.00 (21.91)$^{d}$ | 25.00 (29.98)$^{b}$ | 18.00 (25.09)$^{c}$ | 21.50 (27.61)$^{c}$ | 28.00 (31.94)$^{b}$ | 23.00 (28.64)$^{c}$ | 25.50 (30.32)$^{c}$ | 30.00 (33.20)$^{c}$ | 26.00 (30.63)$^{d}$ | 28.00 (31.93)$^{c}$ | 24.75 (29.82)$^{c}$ | 19.75 (26.37)$^{e}$ | 22.25 (28.13)$^{d}$ |
| Bindas | 33.00 (35.05)$^{fgh}$ | 23.00 (28.64)$^{fgh}$ | 28.00 (31.94)$^{hi}$ | 50.00 (44.98)$^{gh}$ | 40.00 (39.21)$^{h}$ | 45.00 (42.11)$^{h}$ | 60.00 (50.75)$^{g}$ | 51.00 (45.55)$^{h}$ | 55.50 (48.14)$^{h}$ | 61.00 (51.34)$^{g}$ | 54.00 (47.28)$^{i}$ | 57.50 (49.29)$^{h}$ | 51.00 (45.55)$^{h}$ | 42.00 (40.38)$^{k}$ | 46.50 (42.98)$^{j}$ |
| MRC-7351 | 38.00 (38.04)$^{h}$ | 32.00 (34.43)$^{i}$ | 35.00 (36.25)$^{j}$ | 69.00 (56.15)$^{k}$ | 54.00 (47.28)$^{j}$ | 61.50 (51.63)$^{k}$ | 82.00 (64.90)$^{j}$ | 81.00 (64.14)$^{k}$ | 81.50 (64.52)$^{l}$ | 87.00 (68.85)$^{k}$ | 86.00 (68.05)$^{m}$ | 86.50 (68.45)$^{l}$ | 69.00 (56.14)$^{l}$ | 63.25 (52.66)$^{o}$ | 66.13 (54.39)$^{n}$ |
| BunnyBt | 8.00 (16.30)$^{b}$ | 5.00 (12.85)$^{bc}$ | 6.50 (14.75)$^{bc}$ | 20.00 (26.55)$^{a}$ | 14.00 (21.96)$^{ab}$ | 17.00 (24.34)$^{ab}$ | 25.00 (29.98)$^{b}$ | 19.00 (25.82)$^{b}$ | 22.00 (27.96)$^{b}$ | 26.00 (30.63)$^{b}$ | 21.00 (27.26)$^{bc}$ | 23.50 (28.98)$^{b}$ | 19.75 (26.37)$^{b}$ | 14.75 (22.58)$^{c}$ | 17.25 (24.53)$^{c}$ |
| RCH2 Bt | 19.00 (25.76)$^{de}$ | 14.00 (21.91)$^{de}$ | 16.50 (23.90)$^{de}$ | 32.00 (34.43)$^{c}$ | 21.00 (27.26)$^{d}$ | 26.50 (30.97)$^{d}$ | 34.00 (35.65)$^{c}$ | 32.00 (34.43)$^{d}$ | 33.00 (35.05)$^{d}$ | 38.00 (38.04)$^{d}$ | 35.00 (36.25)$^{e}$ | 36.50 (37.15)$^{d}$ | 30.75 (33.66)$^{d}$ | 25.50 (30.31)$^{f}$ | 28.13 (32.01)$^{e}$ |
| DCH-32 | 21.00 (27.26)$^{de}$ | 14.00 (21.96)$^{de}$ | 17.50 (24.72)$^{def}$ | 37.00 (37.45)$^{cd}$ | 25.00 (29.98)$^{e}$ | 31.00 (33.82)$^{e}$ | 40.00 (39.22)$^{d}$ | 37.00 (37.43)$^{ef}$ | 38.50 (38.33)$^{e}$ | 44.00 (41.54)$^{e}$ | 40.00 (39.21)$^{f}$ | 42.00 (40.38)$^{e}$ | 35.50 (36.56)$^{e}$ | 29.00 (32.57)$^{g}$ | 32.25 (34.59)$^{f}$ |
| S.Em± | 2.25 | 1.39 | 1.13 | 0.96 | 0.63 | 0.65 | 0.90 | 0.87 | 0.57 | 0.71 | 0.80 | 0.55 | 0.61 | 0.27 | 0.35 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CD (P=0.05) | 6.58 | 4.05 | 3.29 | 2.81 | 1.83 | 1.91 | 2.61 | 2.53 | 1.65 | 2.07 | 2.33 | 1.60 | 1.78 | 0.79 | 1.03 |

DAS- Days after sowing, Figures in parentheses are arcsine transformation values,
Means followed by similar alphabets in the vertical column do not differ significantly by DMRT (p=0.05)

### 3.3 Grub load, tunnel length and number of broken branches in different Bt cotton genotypes due to shoot weevil infestation (60 DAS)

#### 3.3.1 Number of grubs per plant

Pooled data of two consecutive years revealed that, significantly least number of grubs per plant was recorded in Neeraja (0.05/plant) followed by Cash (0.1/plant). Whereas, Bunny (0.18/plant) and Brahma (0.20/plant) were on par with each other followed by Miracle (0.25/plant). However, significantly higher number of grubs per plant was recorded in MRC-7351 (1.00/plant) genotype. Similar trend was followed even during 2013-14 and 2014-15 (Table 3.).

#### 3.3.2 Average tunnel length

Pooled data of two consecutive years on tunnel length indicated that, Neeraja was found to be least preferred genotype by recording lowest tunnel length of 3.20 cm and was on par with Cash (3.88 cm). Genotypes, Bunny (4.33 cm) and Brahma (5.23 cm) were found next least preferred by shoot weevil. On the other hand, MRC-7351 found highly preferred genotype for feeding by recording longest tunnel length of 12.13 cm. Similar trend was followed even during 2013-14 and 2014-15 (Table 3.).

#### 3.3.3 Number of broken branches

Pooled data of 2013-14 and 2014-15 indicated that, the least number of broken branches were recorded in Neeraja (0.5) genotype followed by Cash (1.75). Whereas, Bunny, Brahma and Miracle recorded broken branches of 2.25, 2.25 and 2.50, respectively and were statistically on par with each other. Contrarily, the higher number of broken branches was recorded in MRC-7351 (8.50) indicating its susceptibility to shoot weevil infestation. Similar trend was followed even during 2013-14 and 2014-15 (Table 3.).

**Table 3:** Grub load, tunnel length and number of broken branches in different Bt cotton genotypes due to shoot weevil infestation (60 DAS)

| Treatments | No. grubs per plant (Mean from 10 infested plants) | | | Average tunnel length (cm) from 10 infested plants | | | No. broken branches per 10 infested plants | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled |
| Neeraja | 0.05 (0.74)$^{a}$ | 0.05 (0.74)$^{a}$ | 0.05 (0.74)$^{a}$ | 3.55 (1.99)$^{a}$ | 2.85 (1.82)$^{a}$ | 3.20 (1.90)$^{a}$ | 1.00 (1.22)$^{a}$ | 0.00 (0.71)$^{a}$ | 0.50 (1.00)$^{a}$ |
| Cash | 0.15 (0.81)$^{b}$ | 0.05 (0.74)$^{ab}$ | 0.10 (0.77)$^{b}$ | 4.05 (2.11)$^{b}$ | 3.70 (2.03)$^{ab}$ | 3.88 (2.07)$^{ab}$ | 2.50 (1.73)$^{b}$ | 1.00 (1.22)$^{b}$ | 1.75 (1.50)$^{b}$ |
| Shalimar | 0.70 (1.09)$^{g}$ | 0.60 (1.05)$^{g}$ | 0.65 (1.07)$^{h}$ | 10.45 (3.30)$^{h}$ | 9.85 (3.22)$^{i}$ | 10.15 (3.26)$^{j}$ | 8.00 (2.92)$^{f}$ | 6.50 (2.64)$^{fgh}$ | 7.25 (2.78)$^{h}$ |
| Mallika | 0.45 (0.97)$^{de}$ | 0.30 (0.89)$^{de}$ | 0.38 (0.94)$^{f}$ | 7.95 (2.90)$^{f}$ | 7.65 (2.84)$^{fgh}$ | 7.80 (2.87)$^{ghi}$ | 6.00 (2.55)$^{de}$ | 5.50 (2.45)$^{f}$ | 5.75 (2.50)$^{f}$ |
| Chetak | 0.45 (0.97)$^{de}$ | 0.30 (0.89)$^{de}$ | 0.38 (0.94)$^{f}$ | 7.45 (2.81)$^{ef}$ | 6.85 (2.71)$^{efg}$ | 7.15 (2.76)$^{fgh}$ | 4.50 (2.23)$^{c}$ | 4.00 (2.12)$^{e}$ | 4.25 (2.18)$^{e}$ |
| Steplon | 0.40 (0.95)$^{de}$ | 0.20 (0.84)$^{cd}$ | 0.30 (0.89)$^{e}$ | 7.05 (2.74)$^{e}$ | 6.35 (2.61)$^{ef}$ | 6.70 (2.67)$^{efg}$ | 4.50 (2.23)$^{c}$ | 2.50 (1.73)$^{d}$ | 3.50 (2.00)$^{d}$ |
| Brahma | 0.25 (0.87)$^{bc}$ | 0.15 (0.81)$^{bc}$ | 0.20 (0.84)$^{cd}$ | 5.45 (2.43)$^{c}$ | 5.00 (2.34)$^{cd}$ | 5.23 (2.38)$^{cd}$ | 2.50 (1.73)$^{b}$ | 2.00 (1.58)$^{cd}$ | 2.25 (1.66)$^{c}$ |
| Sudarshan | 0.60 (1.05)$^{fg}$ | 0.40 (0.95)$^{ef}$ | 0.50 (1.00)$^{g}$ | 9.05 (3.08)$^{g}$ | 8.95 (3.07)$^{hi}$ | 9.00 (3.08)$^{ij}$ | 6.50 (2.64)$^{e}$ | 7.00 (2.74)$^{gh}$ | 6.75 (2.69)$^{gh}$ |
| Chiranjivi | 0.55 (1.02)$^{efg}$ | 0.50 (1.00)$^{fg}$ | 0.53 (1.01)$^{g}$ | 9.05 (3.08)$^{g}$ | 8.40 (2.98)$^{h}$ | 8.73 (3.03)$^{i}$ | 7.00 (2.74)$^{ef}$ | 6.00 (2.55)$^{fg}$ | 6.50 (2.65)$^{gh}$ |
| Puli BG II | 0.40 (0.95)$^{de}$ | 0.20 (0.84)$^{cd}$ | 0.30 (0.89)$^{e}$ | 7.35 (2.79)$^{ef}$ | 6.50 (2.64)$^{ef}$ | 6.93 (2.72)$^{fg}$ | 5.00 (2.35)$^{cd}$ | 4.00 (2.12)$^{e}$ | 4.50 (2.24)$^{e}$ |
| Miracle | 0.35 (0.92)$^{cd}$ | 0.15 (0.81)$^{bc}$ | 0.25 (0.87)$^{de}$ | 6.05 (2.55)$^{d}$ | 5.05 (2.35)$^{cd}$ | 5.55 (2.45)$^{de}$ | 3.00 (1.87)$^{b}$ | 2.00 (1.58)$^{cd}$ | 2.50 (1.73)$^{c}$ |
| Bindas | 0.50 (1.00)$^{ef}$ | 0.35 (0.92)$^{e}$ | 0.43 (0.96)$^{f}$ | 8.65 (3.02)$^{g}$ | 8.05 (2.92)$^{gh}$ | 8.35 (2.97)$^{hi}$ | 6.50 (2.64)$^{e}$ | 6.00 (2.55)$^{fg}$ | 6.25 (2.60)$^{fg}$ |
| MRC-7351 | 1.10 (1.26)$^{h}$ | 0.90 (1.18)$^{h}$ | 1.00 (1.22)$^{i}$ | 12.75 (3.64)$^{i}$ | 11.50 (3.46)$^{j}$ | 12.13 (3.55)$^{k}$ | 9.50 (3.16)$^{g}$ | 7.50 (2.83)$^{h}$ | 8.50 (3.00)$^{i}$ |
| BunnyBt | 0.20 (0.84)$^{b}$ | 0.15 (0.81)$^{bc}$ | 0.18 (0.82)$^{c}$ | 4.45 (2.21)$^{b}$ | 4.20 (2.17)$^{bc}$ | 4.33 (2.19)$^{bc}$ | 3.00 (1.87)$^{b}$ | 1.50 (1.40)$^{bc}$ | 2.25 (1.66)$^{c}$ |
| RCH2 Bt | 0.35 (0.92)$^{cd}$ | 0.20 (0.83)$^{cd}$ | 0.28 (0.88)$^{e}$ | 6.15 (2.57)$^{d}$ | 5.85 (2.51)$^{de}$ | 6.00 (2.54)$^{def}$ | 4.00 (2.12)$^{c}$ | 2.00 (1.58)$^{cd}$ | 3.00 (1.87)$^{d}$ |
| DCH-32 | 0.35 (0.92)$^{cd}$ | 0.20 (0.84)$^{cd}$ | 0.28 (0.88)$^{e}$ | 6.35 (2.61)$^{d}$ | 6.35 (2.62)$^{ef}$ | 6.35 (2.61)$^{def}$ | 4.50 (2.23)$^{c}$ | 2.50 (1.73)$^{d}$ | 3.50 (2.00)$^{d}$ |
| S.Em± | 0.02 | 0.02 | 0.01 | 0.04 | 0.08 | 0.05 | 0.07 | 0.08 | 0.04 |
| CD (P=0.05) | 0.07 | 0.06 | 0.03 | 0.11 | 0.22 | 0.15 | 0.21 | 0.24 | 0.12 |

DAS- Days after sowing, Figures in parentheses are $\sqrt{x+0.5}$ transformation values,
Means followed by similar alphabets in the vertical column do not differ significantly by DMRT (p=0.05)

### 3.4 Grub load, tunnel length and number of broken branches in different Bt cotton genotypes due to shoot weevil infestation (90 DAS)

#### 3.4.1 Number of grubs per plant

Pooled data of two consecutive years revealed that, significantly least number of grubs per plant was recorded in Cash (0.20/plant), Neeraja (0.28/plant) and Bunny (0.33/plant) which were statistically on par with each other followed by Brahma (0.40/plant) and Miracle (0.40/plant). However, significantly higher number of grubs per plant (2.63/plant) was recorded in MRC-7351. Similar trend was followed even during 2013-14 and 2014-15 (Table 4.).

#### 3.4.2 Average tunnel length

Pooled data two consecutive years on tunnel length indicated that, Neeraja recorded significantly lowest tunnel length of 4.03 cm and found least preferred genotype followed by Cash (5.05 cm), Bunny (7.60 cm) and Brahma (10.05 cm) genotypes. On the other hand, MRC-7351 found highly preferred genotype for feeding by recording longest tunnel length of 20.55 cm. Similar trend was followed even during 2013-14 and 2014-15 (Table 4.).

#### 3.4.3 Number of broken branches

Pooled data of two consecutive years on number broken branches indicated that, the least number of broken branches were recorded in Neeraja (2.00) and Cash (2.00) genotype which were statistically on par with each other followed by Bunny (3.00) and Brahma (3.75). Genotype, RCH2 Bt with 6.25 broken branches was statistically on par with DCH 32 (7.25), Miracle (7.25) and Steplon (7.50). On the contrary, the higher number of broken branches (25.75) was recorded in MRC-7351 indicating its susceptibilty to shoot weevil infestation. Similar trend was followed even during 2013-14 and 2014-15 (Table 4.).

**Table 4:** Grub load, tunnel length and number of broken branches in different Bt cotton genotypes due to shoot weevil infestation (90 DAS)

| Treatments | No. grubs per plant (Mean from 10 infested plants) | | | Average tunnel length (cm) from 10 infested plants | | | No. broken branches per 10 infested plants | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled |
| Neeraja | 0.30 (0.89)$^{ab}$ | 0.25 (0.87)$^{ab}$ | 0.28 (0.88)$^{ab}$ | 4.50 (2.23)$^{a}$ | 3.55 (2.01)$^{a}$ | 4.03 (2.12)$^{a}$ | 2.50 (1.73)$^{a}$ | 1.50 (1.40)$^{a}$ | 2.00 (1.57)$^{a}$ |
| Cash | 0.25 (0.87)$^{a}$ | 0.15 (0.81)$^{a}$ | 0.20 (0.84)$^{a}$ | 5.70 (2.48)$^{b}$ | 4.40 (2.21)$^{a}$ | 5.05 (2.35)$^{b}$ | 2.50 (1.73)$^{a}$ | 1.50 (1.40)$^{a}$ | 2.00 (1.58)$^{a}$ |
| Shalimar | 2.30 (1.67)$^{g}$ | 1.85 (1.53)$^{i}$ | 2.08 (1.60)$^{i}$ | 19.65 (4.49)$^{h}$ | 18.00 (4.30)$^{j}$ | 18.83 (4.40)$^{j}$ | 20.50 (4.58)$^{j}$ | 17.00 (4.18)$^{g}$ | 18.75 (4.39)$^{h}$ |
| Mallika | 1.00 (1.22)$^{e}$ | 0.70 (1.1)$^{fg}$ | 0.85 (1.16)$^{fg}$ | 16.30 (4.10)$^{g}$ | 15.95 (4.06)$^{hi}$ | 16.13 (4.08)$^{i}$ | 11.00 (3.39)$^{g}$ | 8.00 (2.92)$^{d}$ | 9.50 (3.16)$^{e}$ |
| Chetak | 0.80 (1.14)$^{d}$ | 0.70 (1.10)$^{fg}$ | 0.75 (1.12)$^{efg}$ | 16.20 (4.08)$^{g}$ | 15.65 (4.02)$^{ghi}$ | 15.93 (4.05)$^{hi}$ | 9.00 (3.08)$^{f}$ | 7.00 (2.74)$^{cd}$ | 8.00 (2.92)$^{d}$ |
| Steplon | 0.70 (1.10)$^{d}$ | 0.55 (1.02)$^{de}$ | 0.63 (1.06)$^{de}$ | 15.60 (4.01)$^{fg}$ | 14.00 (3.81)$^{fg}$ | 14.80 (3.91)$^{gh}$ | 8.00 (2.92)$^{def}$ | 7.00 (2.74)$^{cd}$ | 7.50 (2.83)$^{cd}$ |
| Brahma | 0.50 (1.00)$^{c}$ | 0.30 (0.89)$^{bc}$ | 0.40 (0.95)$^{bc}$ | 11.60 (3.47)$^{d}$ | 8.50 (3.00)$^{c}$ | 10.05 (3.25)$^{d}$ | 5.00 (2.35)$^{c}$ | 2.50 (1.73)$^{b}$ | 3.75 (2.06)$^{b}$ |
| Sudarshan | 2.05 (1.60)$^{f}$ | 1.70 (1.48)$^{i}$ | 1.88 (1.54)$^{i}$ | 18.40 (4.35)$^{h}$ | 17.95 (4.30)$^{j}$ | 18.18 (4.32)$^{j}$ | 15.50 (4.00)$^{i}$ | 12.50 (3.60)$^{f}$ | 14.00 (3.81)$^{g}$ |
| Chiranjivi | 1.90 (1.55)$^{f}$ | 1.40 (1.38)$^{h}$ | 1.65 (1.47)$^{h}$ | 18.20 (4.32)$^{h}$ | 17.50 (4.24)$^{ij}$ | 17.85 (4.28)$^{j}$ | 14.50 (3.87)$^{hi}$ | 11.00 (3.39)$^{ef}$ | 12.75 (3.64)$^{fg}$ |
| Puli BG II | 0.75 (1.12)$^{d}$ | 0.65 (1.07)$^{ef}$ | 0.70 (1.10)$^{ef}$ | 15.60 (4.01)$^{fg}$ | 15.00 (3.94)$^{fgh}$ | 15.30 (3.97)$^{hi}$ | 8.50 (3.00)$^{ef}$ | 7.00 (2.74)$^{cd}$ | 7.75 (2.87)$^{d}$ |
| Miracle | 0.50 (1.00)$^{c}$ | 0.30 (0.89)$^{bc}$ | 0.40 (0.95)$^{bc}$ | 12.80 (3.64)$^{de}$ | 11.50 (3.46)$^{d}$ | 12.15 (3.55)$^{e}$ | 8.00 (2.92)$^{def}$ | 6.50 (2.64)$^{cd}$ | 7.25 (2.78)$^{cd}$ |
| Bindas | 1.00 (1.22)$^{e}$ | 0.85 (1.16)$^{g}$ | 0.93 (1.19)$^{g}$ | 18.20 (4.32)$^{h}$ | 17.90 (4.29)$^{j}$ | 18.05 (4.31)$^{j}$ | 13.00 (3.67)$^{h}$ | 10.00 (3.24)$^{e}$ | 11.50 (3.46)$^{f}$ |
| MRC-7351 | 2.80 (1.82)$^{h}$ | 2.45 (1.72)$^{j}$ | 2.63 (1.77)$^{j}$ | 21.60 (4.70)$^{i}$ | 19.50 (4.47)$^{j}$ | 20.55 (4.59)$^{k}$ | 28.00 (5.34)$^{k}$ | 23.50 (4.89)$^{h}$ | 25.75 (5.12)$^{i}$ |
| BunnyBt | 0.40 (0.95)$^{bc}$ | 0.25 (0.87)$^{ab}$ | 0.33 (0.91)$^{ab}$ | 8.20 (2.94)$^{c}$ | 7.00 (2.74)$^{b}$ | 7.60 (2.84)$^{c}$ | 4.00 (2.12)$^{b}$ | 2.00 (1.58)$^{ab}$ | 3.00 (1.87)$^{b}$ |
| RCH2 Bt | 0.50 (1.00)$^{c}$ | 0.50 (1.00)$^{de}$ | 0.50 (1.00)$^{cd}$ | 13.90 (3.79)$^{e}$ | 12.00 (3.54)$^{de}$ | 12.95 (3.67)$^{ef}$ | 7.00 (2.74)$^{d}$ | 5.50 (2.45)$^{c}$ | 6.25 (2.60)$^{c}$ |
| DCH-32 | 0.65 (1.07)$^{d}$ | 0.40 (0.95)$^{cd}$ | 0.53 (1.01)$^{cd}$ | 14.10 (3.82)$^{ef}$ | 13.50 (3.74)$^{ef}$ | 13.80 (3.78)$^{fg}$ | 7.50 (2.83)$^{de}$ | 7.00 (2.74)$^{cd}$ | 7.25 (2.78)$^{cd}$ |
| S.Em± | 0.03 | 0.02 | 0.02 | 0.07 | 0.06 | 0.05 | 0.08 | 0.11 | 0.07 |
| CD (P=0.05) | 0.08 | 0.06 | 0.05 | 0.20 | 0.17 | 0.14 | 0.23 | 0.31 | 0.20 |

DAS- Days after sowing, Figures in parentheses are √x+0.5 transformation values,
Means followed by similar alphabets in the vertical column do not differ significantly by DMRT (p=0.05)

### 3.5 Seed cotton yield in different Bt cotton genotypes as influenced by shoot weevil infestation

Pooled data of two consecutive years on seed cotton yield revealed that, genotype Neeraja was significantly superior by recording highest yield (23.33 q/ha) followed by Cash (20.74 q/ha) and Bunny (19.72 q/ha) and were on par with each other. Whereas, Brahma (18.52 q/ha) and Miracle (18.06 q/ha) were on par with each other and found next best genotypes in the order of superiority followed by RCH2 Bt (16.20 q/ha), Steplon (15.74 q/ha), DCH 32 (15.37 q/ha) and Puli BG II (15.19 q/ha). While, MRC-7351 recorded lowest seed cotton yield of 9.63 q/ha as compared to rest of the genotypes (Table 5.).

Owing to the scanty information, the present findings are compared with [9] who recorded 15.83, 23.57, 45.59 and 58.17 percent shoot weevil incidence on Bhagya, Laxmi, Hybrid-4

and Varalaxmi cotton, respectively at Dharwad in Karnataka. From this study, susceptibility of various hybrids was highlighted. Similarly [3], from Dharwad, screened about 16 cotton genotypes for their reaction to cotton shoot weevil, *A. affaber*. Among which G-22, AK 235, DB 3-12, Jayadhar and suyodhar were found to be resistant to shoot weevil with infestation ranging from 0.72 to 5.33 percent. Similarly, some other authors have also reported varied interaction of cotton cultivars and hybrids to cotton stem weevil, *P. affinis* [2, 6, 7].

**Table 5:** Influence of shoot weevil infestation on yield in different Bt cotton genotypes

| Treatments | Seed cotton yield (q/ha) | | |
|---|---|---|---|
| | 2013-14 | 2014-15 | Pooled |
| Neeraja | 21.85$^{a}$ | 24.81$^{a}$ | 23.33$^{a}$ |
| Cash | 19.44$^{b}$ | 22.04$^{b}$ | 20.74$^{b}$ |
| Shalimar | 9.63$^{ij}$ | 11.11$^{e}$ | 10.37$^{fg}$ |
| Mallika | 11.11$^{ghi}$ | 12.04$^{e}$ | 11.57$^{ef}$ |
| Chetak | 11.85$^{gh}$ | 13.70$^{e}$ | 12.78$^{e}$ |
| Steplon | 12.96$^{fg}$ | 18.52$^{cd}$ | 15.74$^{d}$ |
| Brahma | 18.15$^{bc}$ | 18.89$^{cd}$ | 18.52$^{c}$ |
| Sudarshan | 10.19$^{hij}$ | 12.04$^{e}$ | 11.11$^{efg}$ |
| Chiranjivi | 10.19$^{hij}$ | 11.48$^{e}$ | 10.83$^{fg}$ |
| Puli BG II | 12.96$^{fg}$ | 17.41$^{d}$ | 15.19$^{d}$ |
| Miracle | 17.22$^{cd}$ | 18.89$^{cd}$ | 18.06$^{c}$ |
| Bindas | 10.93$^{ghi}$ | 11.67$^{e}$ | 11.30$^{efg}$ |
| MRC-7351 | 8.52$^{j}$ | 10.74$^{e}$ | 9.63$^{g}$ |
| BunnyBt | 18.89$^{bc}$ | 20.56$^{bc}$ | 19.72$^{bc}$ |
| RCH2 Bt | 15.37$^{de}$ | 17.04$^{d}$ | 16.20$^{d}$ |
| DCH-32 | 14.07$^{ef}$ | 16.67$^{d}$ | 15.37$^{d}$ |
| S.Em± | 0.4 | 0.89 | 0.57 |
| CD (P=0.05) | 1.1 | 2.58 | 1.67 |

Means followed by similar alphabets in the vertical column do not differ significantly by DMRT (p=0.05)

### 3.6 Correlation and regression between number of grubs per plant and biochemical parameters

Correlation coefficient was worked out using number of grubs per plant as dependent variable and biochemical parameters as independent variables at 60 and 90 DAS (Table 6.). At 60 DAS the correlation coefficients indicated that there was significant negative correlation between number of grubs per plant with phenol (r=-0.91**) and tannin (r=-0.91*). Similarly positive significant correlation was noticed with total sugar (r=0.75**) and moisture percent (r=0.78**). However, gossypol (r=0.32) statistically had no influence on imparting resistance to shoot weevil. Likewise, all the biochemical parameters contributed about 89 percent influence on number of grubs per plant irrespective of Bt cotton genotypes at 60 DAS. Similarly at 90 DAS the correlation coefficients indicated the significant negative correlation between number of grubs per plant with phenol (r=-0.91**) and tannin (r=-0.89*). Similarly positive significant correlation was noticed with total sugar (r=0.70**) and moisture percent (r=0.77**). However, gossypol (r=0.29) statistically had no role on imparting resistance to shoot weevil. Likewise, all the biochemical parameters contributed about 90 percent influence on number of grubs per plant irrespective of Bt cotton genotypes at 90 DAS (Table 7.). The present findings are in line with [3] who reported highly significant positive correlation between moisture percentage, total sugars and shoot weevil infestation. Whereas, the infestation was negatively correlated with tannin content. However, total phenols and gossypol had negligible level of influence on shoot weevil infestation. Similarly, [4] and [5] also reported higher level of tannins and phenolics in cotton stem imparted the resistance to stem weevil, *P. affinis*.

**Table 6:** Correlation studies between shoot weevil grub per plant and biochemical parameters

| Biochemical parameter | Grubs (No./plant) | |
|---|---|---|
| | 60 DAS | 90 DAS |
| Total sugars (mg/g) | 0.75** | 0.70** |
| Phenols (mg/g) | -0.91** | -0.91** |
| Gossypol (mg/g) | 0.32 | 0.29 |
| Tannins (mg/g) | -0.91** | -0.89** |
| Moisture (%) | 0.78** | 0.77** |

****-** Correlation is highly significant at the 0.01 level (2 tailed)

**Table 7:** Regression equations for shoot weevil grub infestation and biochemical parameters

| Dependent variable | Regression Equation | $R^2$ |
|---|---|---|
| Grub (60 DAS) | $Y= 0.357-0.164X_1+1.183X_2-1.037X_3-5.274X_4+0.223X_5$ | 0.89 |
| Grub (90 DAS) | $Y=85.966-0.713X_1-7.911X_2-2.584X_3-7.936X_4+0.641X_5$ | 0.90 |

$X_1$-Total sugars, $X_2$-Phenols, $X_3$-Gossypol, $X_4$-Tannins, $X_5$-Moisture percent, DAS-Days after sowing

## 4. References


1. Bhuvaneswari K. Shoot weevil (*Alcidodes affaber*) on Cotton in Tamil Nadu. Insect Environment. 2006; 12(3):104.
2. Chandramani P, Murugesan N, Ramalingam A. Screening of cotton genotypes against stem weevil, *Pempherulus affinis* Faust in field conditions. J Cotton Res. Dev. 2006; 20(2):292.
3. Deshpande VP. Investigation on cotton shoot weevil, *Alcidodes affaber* Aurivillius (Coleoptera: Curculionidae) Ph. D. Thesis, Uni. Agric. Sci., Dharwad, Karnataka (India), 1990.
4. Dharmarajulu K. The nature of resistance in cotton plants to stem weevil. In: Proc. Assoc. Econ. Biol. 1935; 3:21-31.
5. Dharmarajulu K, Ayyangar GS, Mudaliar VR, Balasubramanian R. Study on host resistance of cotton stem weevil, *Pempherulus affinis* Faust. Indian. J Agric. Sci. 1948; 18:151-164.
6. Ratna Kumari B, Chandrasekaran S. Field screening of cotton accessions for resistance to cotton stem weevil, *Pempherulus afflnis* Faust. Madras Agric. J. 2008; 95(1-6):232-236.
7. Sivasubramanian P, Balaji K, Joshua Samson A. Field screening of cotton cultivars and germplasm against cotton stem weevil (*Pempherulus affinis* Faust) (Curculionidea: Coleoptera). J Cotton Res. Dev. 2008; 22(2):243-245.
8. Subramanian TR. Biology of *Alcidodes affaber* Aurivillius, Indian J Agric. Sci. 1959; 29(4):81-89.
9. Thimmaiah G, Gubbaiah Kulkarni KA, Bhat KM. Occurrence of the shoot weevil, *Alcidodes affaber* Aurivillius on cotton and bhendi. Curr. Res. 1975; 4:104-105.