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ASSESSMENT OF COTTON SEED BUG, *OXYCARENUS LAETUS* KIRBY DAMAGE IN TRANSGENIC AND NON-TRANSGENIC GENOTYPES OF COTTON.

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ABSTRACT

By introduction of transgenic cotton, dusky cotton bug (DCB) (*Oxycarenus laetus* Kirby) has attained the status of major pests of cotton. In order to assess its damage on cotton crop current study was undertaken under field condition at the research area of Cotton Research Institute, Multan. For this purpose, two transgenic cotton genotypes viz. MNH-886 and MNH-988 and two non-transgenic cotton genotypes viz. MNH-814 and VH-289 were cultivated during the two cropping seasons during 2014 and 2015. The cotton plants were covered with muslin cloth at reproductive stage to keep crop free from attack of any other insect pest at the time of data recording. A total of 400 bugs were manually released in caged plants possessing on an average 10 semi- opened bolls/plant. The bug density was maintained during the time of data recording. The results revealed that *O. laetus* caused significant decline in cotton seed germination %, 100-seed weight, boll weight, staple length, mike, staple strength and lint index ranged from 35.11 to 49.68%, 17.4 to 39.6%, 28.27 to 33.24%, 3.33 to 8.58%, 2.93 to 6.59%, 11.32 to 28.24% and 8.16 to 15.02%, respectively of both Bt and non Bt cultivars of cotton. Whereas, due to cotton seed density Ginning Out Turn percentage increased over control ranged from 11.43 to 19.39% in both transgenic and conventional cultivars of cotton. If we see the combine effect of coefficient of determination on both transgenic and non-transgenic genotypes of cotton it exerted 45.10% variability in boll weight, 56.90% in GOT, 5.00% in staple length, 16.5% in mike, 70.9% in staple strength, 73.20% in seed index, 16.30% in lint index and 84.70% in cotton seed germination. The regression model in combine effect was observed statistically significant to all the parameters of cotton except in case of staple length.

Key words: - Cotton Seed Bug, Fiber Characteristics, Transgenic and Non-Transgenic Cotton

INTRODUCTION

Agriculture sector of Pakistan plays a key role to provide the raw material to the industry and boost up the economy of country. It contributes 19.8% in GDP and is considered a "lifeline" and a major employer accommodating 42.3% labor force of the country (Anonymous 2016-17). Cotton is regarded as a cash crop and contributes a major share in order to meet requirement of fiber as an export item, source of edible oil and cotton seed cake for animal feed (Ozyigit et al., 2007). Ranking of Pakistan is 4th in cotton production all over the world (Iqbal et al., 2010). Cotton is the second largest crop on area basis after wheat in Pakistan contributing gross domestic product as for 1.0% and 5.1% in value addition in agriculture (GOP, 2016).

A surprisingly very fast increase in cultivation of transgenic cotton (Bt-Cotton) during the last two decades has changed the scenario of arthropod community in cotton. America was the pioneer country to launch Bt technology/ Bt-cotton in the field since 1990's, it was exponentially spread and became one of the most expansively cultivated among all other genetically engineered crops worldwide (Qaim and Zilberman, 2003). Short term cultivation of transgenic cotton provided quick response and benefited by reduction in cost of production due to less use of insecticides against lepidopterous larvae, environmental safety from contamination of insecticides and improved yield potential (James, 2002, Dhillon et al., 2011). Long term cultivation of transgenic cotton has induced field evolved resistance in lepidopterous larvae (Peshin et al., 2007, Arshad et al., 2011). It also has changed the status and some minor insect pest have become major insect pest of cotton.

With the introduction of Bt cotton, now reduced use of insecticides against lepidopterous larvae have resulted in abrupt increase in population of DCB (Ullah et al., 2016, Shahid et al., 2017). Both nymphs and adults of it suck cell sap (Akin et al., 2010, Sammaiah et al., 2012) excessively from premature seeds, affect embryos which fails to ripe and remains low weight than the normal (Vennila et al., 2007, Akram et al., 2013). It sucks cell sap from reproductive parts of plants and deteriorates seed quality. Significant qualitative and quantitative losses are reported in cotton due to DCB infestation (Ahmed et al., 2015). Its invasion is principal source that can badly affect embryo development and seed germination (Srinivas and Patil, 2004). Researchers have observed food choice behavior among host plants during different seasons (Holtz, 2006). The last generation hibernate on weeds, fallen leaves/branches and soil covering grasses or cravices. The insect avoids mating due to arrested metabolic activity until the climatic suitability and availability of host plant species (Schaefer and Panizzi, 2000). It is a polyphagous insect pest species that mainly endeavor on plants of family Malvaceae (especially *Gossypium* spp) and okra also feed on avocado, apple, grapes, peach, dates, pineapple, pomegranate and Figs (USDA, 2010). In Pakistan, it continues its activity all around the year and can survive on alternative host plants like moringa, guava, mango, chilies, lemon, okra, and cotton (Shah et al., 2016).

Keeping in view significant impact of DCB the present study was carried out to evaluate the effect of *O. laetus* damage on cotton yield and fiber qualities in transgenic and non- transgenic genotypes of cotton.

MATERIALS AND METHODS

For assessment of cotton seed bug, *O. laetus* kirby damage in transgenic and non-transgenic geno -types of cotton a field experiment of *O. laetus*., (Hemiptera, Pyrrhocoridae) was conducted on transgenic cotton genotypes MNH-886 and MNH-988 and non-transgenic cotton genotype MNH-814 and VH-289 at Cotton Research Station, Multan during the two cropping season 2014 & 2015 to observe the impact of *O. laetus* on cotton yield and fiber qualities of cotton. The crop was cultivated in the month of May during the both cropping seasons and all the recommended agronomic practices were done. Prior to the coverage of plants with the muslin's cloth the plants were sprayed with the systemic (Nitenpyram) and stomach (Emamectin benzoate) insecticides in order to protect the plants from both the sucking and bollworms pests. After one week of pesticide application the cotton plants were covered with muslin's cloth cages binding with wires to prevent the entry or escape of any insect pest at the time of boll formation (Srinivas and Patil 2004).

Collection and Rearing of *O. laetus:* Nymphs as well as fully mature adults of *O. laetus* collected from cotton field were kept in various plastic jars. The collected samples were brought to the laboratory at 30±5 °C and 60-65% R.H. and mass reared on cotton plants in net cages in insect rearing laboratory to get the homogenous population. In rearing cages both adults and nymphs of *O. laetus* were preferably released on plants at bloom stage to ensure their food provision (immature seed cotton and squares). Seed-cotton was also kept in cages for collection of eggs which were safely separated and shifted on soaked filter paper till emergence of nymphs. The hatched nymphs were then separated and shifted to new cages.

Release of *O. laetus:* The hatched nymphs of *O. laetus* were released on transgenic cotton genotypes MNH-886 and MNH-988 and non-transgenic cotton genotypes MNH-814 and VH-289 covered with muslin cloth at the time of boll formation. 400 numbers of DCB nymphs (40/boll) were released on each cotton plant having an average 10 bolls/plant that were already covered with muslin cloth at the time of semi opened boll with one control in cotton field. Picking of opened bolls were done after 30 days of DCB feeding. Observations were made on cotton seed germination (%), bolls weight (g), seed index (100 seed weight), staple length, mike, staple strength, lint index and GOT (%). Germination test of cotton seed was conducted in laboratory by using paper towel method. Fiber quality or characteristics of cotton lint was analyzed with the help of automated parameters measuring device High Volume Instrument 1000 (USTER HVI) to determine different parameters (staple length, mike & staple strength) just followed by seed-cotton ginning. Formulae for various calculations are given as under:

$$Lint\ Index\ (\%) = \frac{Seed\ Index \times G.O.T.}{100 - G.O.T.}$$

$$GOT.(\%) = \frac{Lint\ Weight}{Total\ Weight} \times 100$$

$$Seed\ Index\ (g) = 100\ Seed\ Weight$$

$$Seed\ Germination\ (\%) = \frac{G_s}{T_s} \times 100$$

T_s = Total number of seeds

G_s = Number of germinating seeds

Statistical Analysis: Dependent variable data including germination, GOT%, 100 seed weight, staple length, lint index, mike and strength were subjected to analysis using regression model with the help of statistical package SPSS to determine significance for various variables and means value of different treatments.

RESULTS AND DISCUSSION

Impact of *O. laetus* on cotton seed germination: The graphical representation (Fig. 1) exhibited that a significant variation was observed in the percent germination as well as in the percent reduction in germination over control due to *O. laetus*. The percent germination ranged from 33.82% to 45.0% and percent reduction in germination increased over control ranged from 35.11% to 49.68% in both transgenic and non-transgenic genotypes of cotton where 400 numbers (40/boll) of DCB was released/ plant. Among the tested cultivars VH-289, MNH-814 and MNH-988 were highly influenced by density of *O. laetus* as compared with MNH-886. The germination percentage in control was 65.33 %, 67.2%, 69.35% and 70.6% among MNH-814, MNH-886, VH-289 and MNH-988 that was reduced to 40.37, 33.82, 45.0 and 43.35% respectively. The percentage reduction was 49.68, 38.6, 38.2 and 35.11% among MNH-886, MNH-988, MNH-814 and VH-289, respectively.

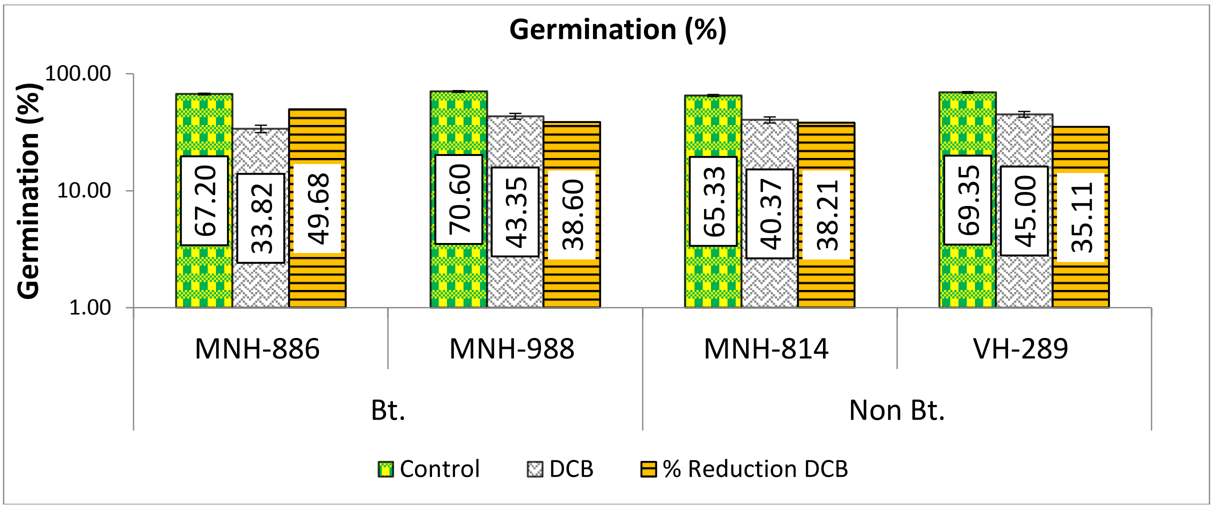

Fig. -1: Graphical representation regarding impact of *O. laetus* on cotton seed germination

Impact of *O. laetus* on boll weight: The graphical representation (Fig. 2) revealed that a significant variation was observed regarding boll weight due to feeding of *O. laetus*. The boll weight ranged from 3.04 to 4.31 gm and percent reduction in boll weight increased over control ranged from 17.4% to 39.6% in both transgenic and non-transgenic genotypes of cotton where 400 numbers (40/boll) of DCB was released/plant. Among the tested cultivars MNH-814 and MNH-988 were highly influenced by density of *O. laetus* as compared with MNH-886 and VH-289. The boll weight in control was 3.04 gm, 3.95 gm, 4.07 gm and 4.31 gm among VH-289, MNH-814, MNH-988 and MNH-886 that was reduced to 2.51, 2.39, 2.53 and 3.3 gm, respectively. The percentage reduction in boll weight was 39.6%, 37.79%, 23.27% and 17.4% among MNH-814, MNH-988, MNH-886, and VH-289, respectively.

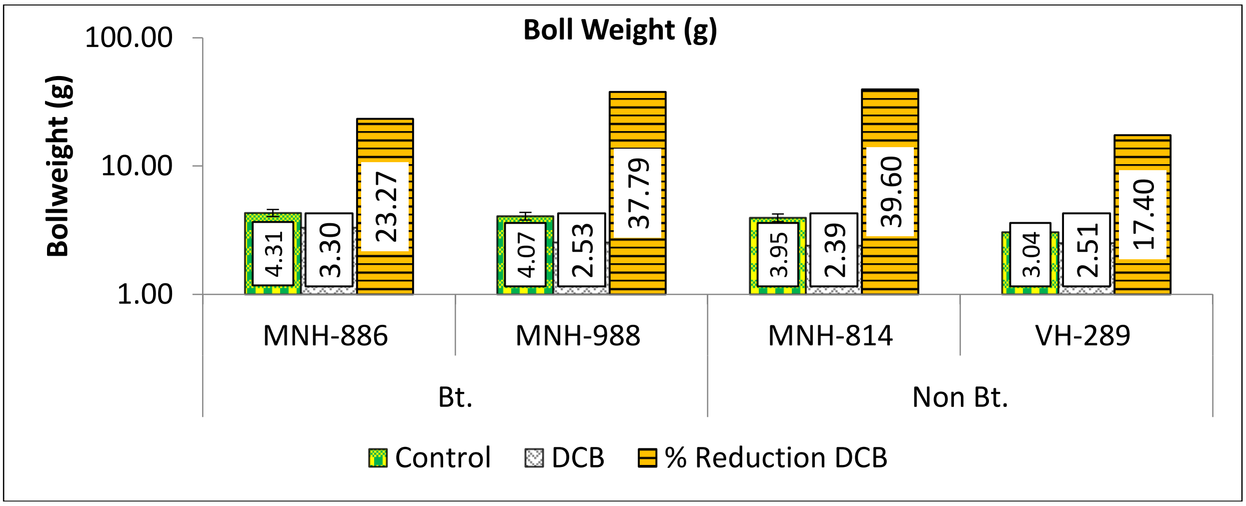

Fig. -2: Graphical representation regarding impact of *O. laetus* on boll weight

Impact of *O. laetus* on 100-seed weight or seed index: The graphical representation (Fig. 3) predicted that a significant variation was observed regarding 100 seed weight due to *O. laetus*. The 100 seed weight ranged from 5.76 to 7.23 gm and percent reduction in 100 seed weight increased over control ranged from 28.27 to 33.24% in both transgenic and non-transgenic genotypes of cotton where 400 numbers (40/boll) of DCB was released/ plant. Among the tested cultivars MNH-814 and MNH-988 were highly influenced by density of *O. laetus* as compared with MNH-886 and VH-289.

The 100 seed weight in control was 8.16 gm, 9.77 gm, 10.08 gm and 10.18 gm among VH-289, MNH-814, MNH-886 and MNH-998 that was reduced to 5.76, 6.52, 7.23 and 7.01gm, respectively. The percentage reduction in 100 seed weight was 33.24, 31.19, 29.47 and 28.27% among MNH-814, MNH-988, VH-289 and MNH-886, respectively.

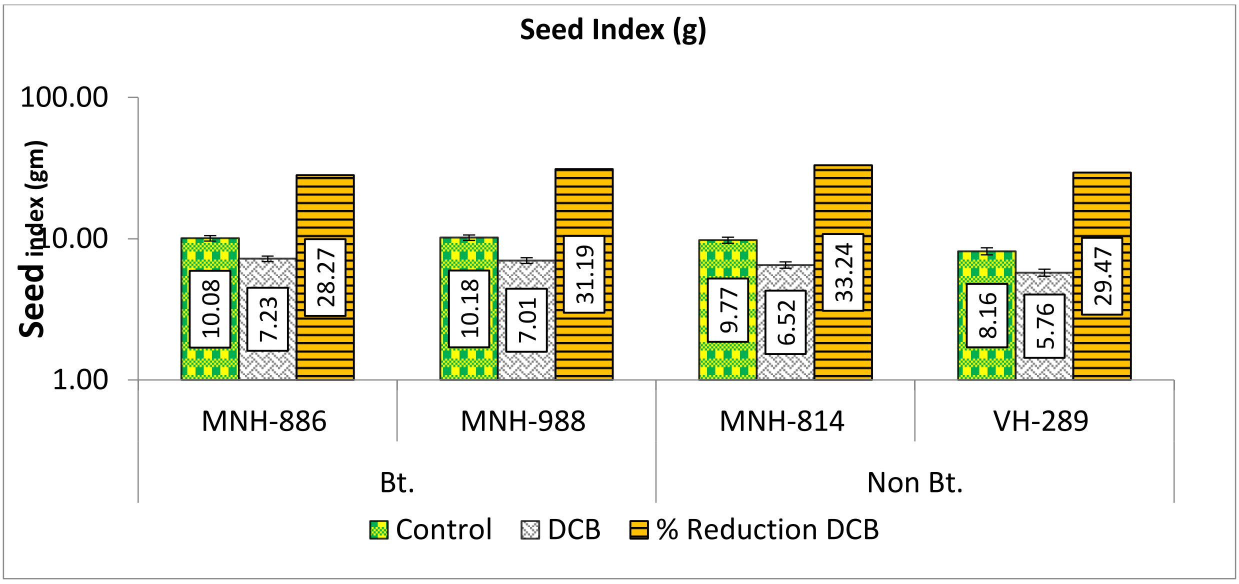

Fig. -3: Graphical representation regarding impact of *O. laetus* on seed index

Impact of *O. laetus* on staple length: The graphical representation (Fig. 4) exhibited that a significant variation was observed regarding staple length due to *O. laetus*. The staple length ranged from 26.28 to 29.02 mm and percent reduction in staple length increased over control ranged from 3.33 to 8.58 mm in both transgenic and non-transgenic genotypes of cotton where 400 numbers of DCB was released/plant. Among the tested cultivars MNH-814 and MNH-886 were highly influenced by density of *O. laetus* as compared with MNH-988 and VH-289. The staple length in control was 28.75 mm, 30.02 mm, 30.23 mm and 30.63 mm among MNH-814, MNH-988, MNH-886 and VH-289 that was reduced to 26.28 mm, 29.02 mm, 27.93 mm and 28.62 mm, respectively. The percentage reduction in staple length was 8.58, 7.61, 6.58 and 3.33% among MNH-814, MNH-886, VH-289 and MNH-988, respectively.

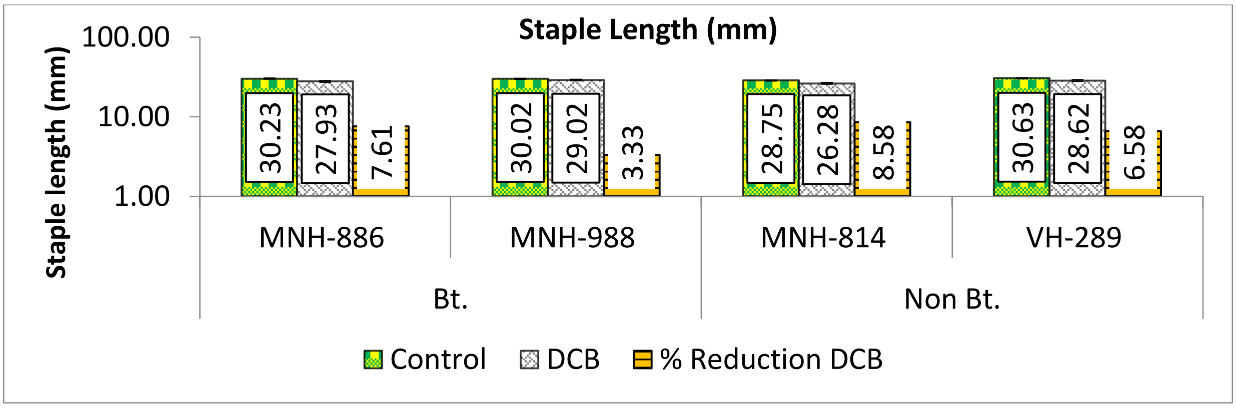

Fig. -4: Graphical representation regarding impact of *O. laetus* on staple length

Impact of *O. laetus* on mike: The graphical representation (Fig. 5) revealed that a significant variation was also observed regarding mike due to feeding of *O. laetus*. The mike ranged from 4.53 to 4.75 µg/ inch and percent reduction in mike increased over control ranged from 4.07 to 6.59 % in both transgenic and non-transgenic genotypes of cotton where 400 numbers of DCB was released/plant. Among the tested cultivars VH-289 was highly influenced by density of *O. laetus* as compared with MNH-814, MNH-988 and MNH-886. The mike in control was 4.67, 4.92, 4.96 and 4.97µg/inch among MNH-814, MNH-988, VH-289 and MNH-886 that was decreesed to 4.53, 4.72, 4.63 and 4.75 µg/inch, respectively. The percentage reduction in mike was 6.59, 4.36, 4.07 and 7.93% among VH-289, MNH-886, MNH-988 and MNH-814, respectively.

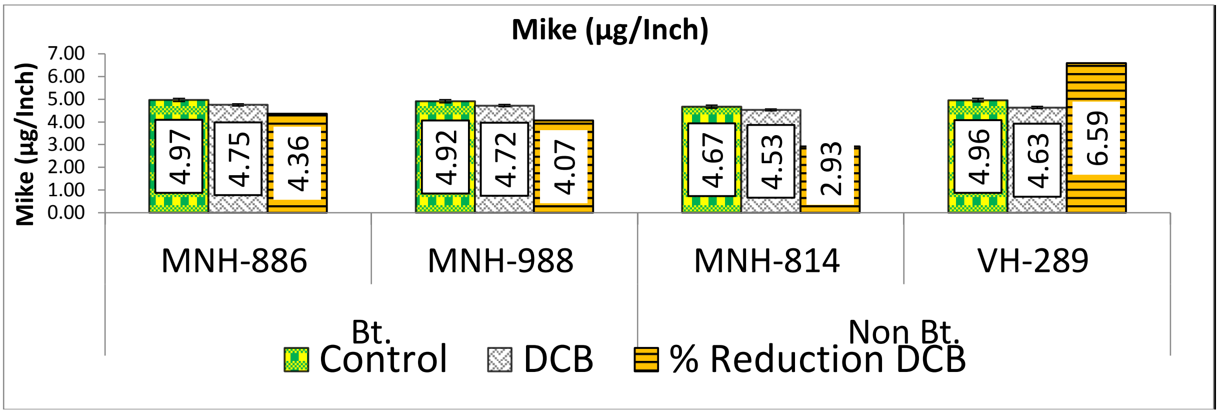

Fig. -5: Graphical representation regarding impact of *O. laetus* on mike

Impact of *O. laetus* on staple strength (g/tex): The graphical representation (Fig. 6) demonstrated that a significant variation was observed regarding staple strength due to feeding of *O. laetus*. The staple strength ranged from 30.37 g/tex to 32.52 g/tex and percent reduction in staple strength increased over control ranged from 11.32 g/tex to 28.24 g/tex in both transgenic and non-transgenic genotypes of cotton where 400 numbers of DCB was released/plant. Among the tested cultivar MNH-988 was highly influenced by density of *O. laetus* as compared with MNH-886, MNH-814 and VH-289. The staple strength in control was 35.62, 38.13, 38.23 and 42.32 g/tex among MNH-886, MNH-814, VH-289 and MNH-988 that was decreased to 31.58, 32.52, 30.75 and 30.37 g/tex, respectively. The percentage reduction in mike was 28.24, 19.57, 14.73 and 11.32% among MNH-988, VH-289, MNH-814 and MNH-886, respectively.

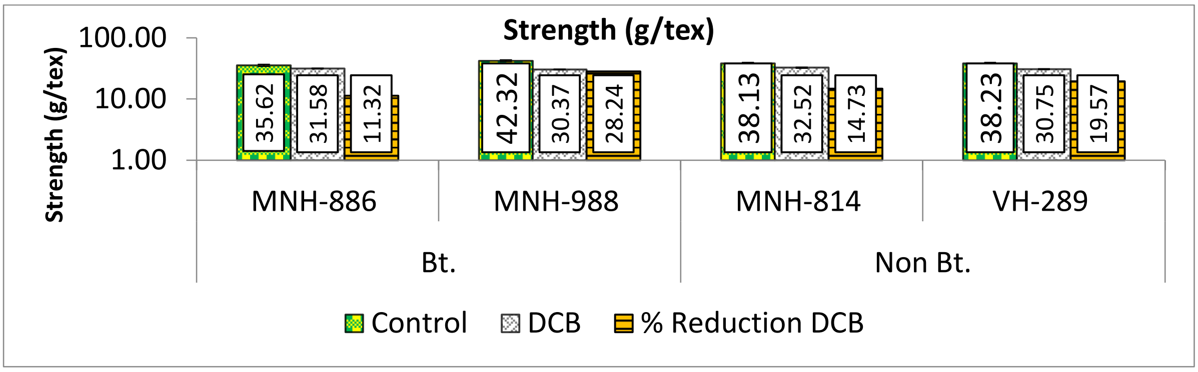

Fig. 6: Graphical representation regarding impact of *O. laetus* on staple strength

Impact of *O. laetus* on Lint Index (%): The graphical representation (Fig. 7) revealed that a significant variation was observed regarding lint index due to feeding of *O. laetus*. The lint index ranged from 4.15 to 5.40 % and percent reduction in lint index increased over control ranged from 8.16 to 15.02 % in both transgenic and non-transgenic genotypes of cotton where 400 numbers of DCB was released/ plant. Among the tested cultivars MNH-886 and VH-289 were highly influenced by density of *O. laetus* as compared with MNH-988 and MNH-814. The lint index in control was 4.88, 5.52, 5.88 and 6.23 % among VH-289, MNH-988, MNH-814 and MNH-886 that was decreased to 4.15, 5.07, 5.30 and 5.40 %, respectively. The percentage reduction in lint index was 15.02, 13.37, 9.92 and 8.16 % among VH-289, MNH-886, MNH-814 and MNH-988, respectively.

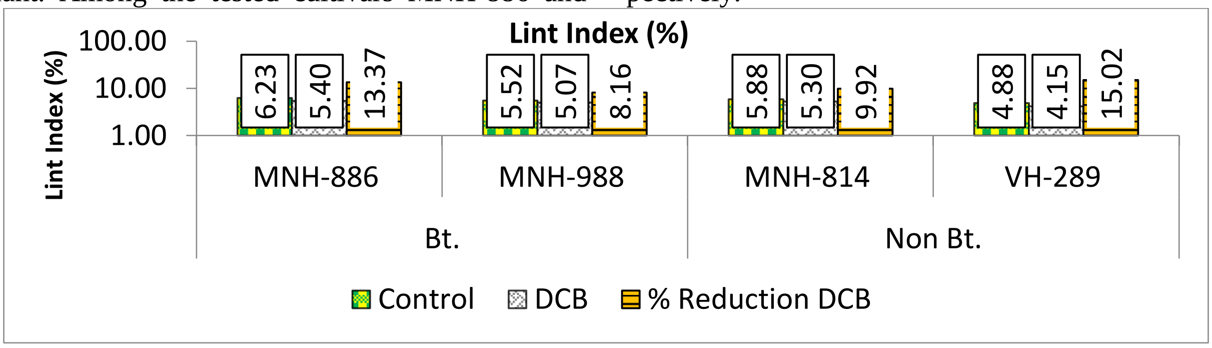

Fig. -7: Graphical representation regarding impact of *O. laetus* on lint index

Impact of *O. laetus* on GOT (%): The graphical representation (Fig. 8) demonstrated that a significant variation was observed regarding GOT percentage due to feeding of *O. laetus*. The GOT ranged from 35.30 to 38.24 % and GOT% reduction increased over control was in a range from 11.43 to 19.39 % in both transgenic and non-transgenic genotypes of cotton where 400 numbers (40/boll) of DCB was released/plant. Among the tested cultivars MNH-988 and MNH-814 were highly influenced by density of *O. laetus* as compared with MNH-886 and VH-289. The GOT in control was 35.30, 37.62, 37.66 and 38.24% among MNH-988, VH-289, MNH-814 and MNH-886 that was increased to 42.02, 41.92, 44.96 and 42.70%, respectively. The percentage reduction in lint index was 19.39, 19.03, 11.43 and 11.67 % among MNH-814, MNH-988, VH-289 and MNH-886, respectively.

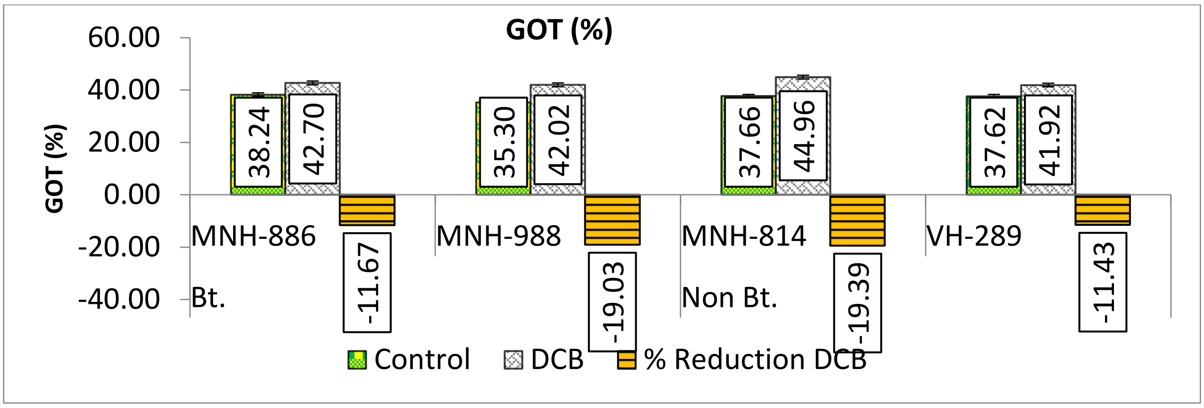

Fig. -8: Graphical representation regarding impact of *O. laetus* on GOT

Regression Model of *O. laetus* with coefficient of determination: Simple regression analysis was performed in order to work out precise access to the relative importance of DCB population in explaining the variations of different qualitative and quantitative parameters (Table 1). Where, DCB population was taken as independent variables and all other parameters were taken as dependent variables. The DCB population exerted a significant variability in all the parameters. In case of transgenic genotypes of cotton, 52.42%, 56.70%, 7.0%, 17.89 %, 67.10%, 85.10%, 19.01% and 87.05% of total variability (R^2) in boll weight, GOT, staple length, mike, staple strength, 100 seed weight, lint index and cotton seed germination, respectively. The entire regression model is statistically significant in all the parameters of cotton except staple length. While, in case of non-transgenic genotypes of cotton coefficient of determination had also significant in all parameters of cotton. It exerted 48.80%, 59.14%, 42.90%, 17.7%, 79.57%, 77.44%, 17.22% and 83.91% of boll weight, GOT, staple length, mike, strength, seed index, lint index and germination, respectively. The regression model significant in all parameters of cotton except mike. If we see the combine effect of coefficient of determination on both transgenic and non-transgenic genotypes of cotton it exerted 45.10% in boll weight, 56.90% in GOT, 5.00% in staple length, 16.5% in mike, 70.9 % in staple strength, 73.20% in seed index, 16.30% in lint index and 84.70% in cotton seed germination. The regression model in combine effect was observed statistically significant to all the parameters of cotton except in case of staple length i.e. 0.12.

Regression model is explained as: $y = \alpha+\beta x+\mathcal{E}i$ where

y = Dependent variable, α =Intercept, β=Slope of model, x= Independent variable, Ɛi= Error term

The data table-1 revealed that in transgenic genotypes of cotton the intercept of the model for boll weight, staple length, mike, staple strength, seed index, lint index and germination was 4.12 g, 31.05 mm, 4.94 µg/Inch, 38.97 g/tex, 10.13 g, 5.88 % and 68.9 % but reduction due to DCB is 1.2 g, 0.65 mm, 0.21 µg/Inch,7.99 g/tex, 3.01 g, 0.64 % and 30.31%, respectively. However, intercept of the model for GOT was 36.77 % but its increased due to DCB i.e., 5.59%. However, in non- transgenic genotypes of cotton the intercept model for boll weight, staple length, mike, strength, seed index, lint index and germination was 3.49 g, 29.69 mm, 4.81µg/Inch, 38.18 g/tex, 8.96 g, 5.38 % and 67.34 % but reduction due to DCB was i.e., 1.05 g, 2.24 mm, 0.23 µg/Inch, 6.55 g/tex, 2.83 g, 0.66% and 24.66%, respectively. The intercept of the model for GOT is 37.64% but it increased up to 5.80% due to feeding of DCB. If we see the combined effect of DCB on both *Bt* and non *Bt* cultivars indicated that boll weight, staple length, mike, staple strength, seed index, lint index and germination was 3.81g, 30.37mm, 4.88µg/Inch, 38.57g/tex, 9.55g, 5.63% and 68.12% but reduction due to DCB was 1.12 g, 1.45 mm, 0.22 µg/Inch 7.27 g/tex, 2.92 g, 0.65% and 27.49%, respectively.

Table: - 1: Regression Model along with coefficient of determination regarding effect of *O. laetus* on studied traits

	Regression Model	100 R2	p-Value
Bt Variety	Boll Weight (g) = 4.12-1.20 DCB	52.42	0
	G.O.T. (%) = 36.77 + 5.59 DCB	56.7	0
	Staple Length (mm) = 31.05 -0.65 DCB	7	0.7
	Mike (µg/Inch) = 4.94 - 0.21 DCB	17.89	0.04
	Strength (g/tex) = 38.97 - 7.99 DCB	67.1	0
	Seed Index (g)= 10.13 – 3.01 DCB	85.1	0
	Lint Index (%) = 5.88- 0.64 DCB	19.01	0.03
	Germination (%) = 68.9- 30.31 DCB	87.05	0
Non Bt Variety	Boll Weight (g) = 3.49-1.05 DCB	48.8	0
	G.O.T. (%) = 37.64+ 5.80 DCB	59.14	0
	Staple Length (mm) = 29.69 -2.24 DCB	42.9	0
	Mike (µg/Inch) = 4.81 + 0.23 DCB	17.7	0.04
	Strength (g/tex) = 38.18- 6.55 DCB	79.57	0
	Seed Index (g) = 8.96 – 2.83 DCB	77.44	0
	Lint Index (%) = 5.38- 0.66 DCB	17.22	0.04
	Germination (%) = 67.34- 24.66 DCB	83.91	0
Combine	Boll Weight (g) = 3.81-1.12 DCB	45.1	0
	G.O.T. (%) = 37.20 + 5.69 DCB	56.9	0
	Staple Length (mm) = 30.37 -1.45 DCB	5	0.12
	Mike (µg/Inch) = 4.88 - 0.22 DCB	16.5	0
	Strength (g/tex) = 38.57 - 7.27 DCB	70.9	0
	Seed Index (g) = 9.55 - 2.92 DCB	73.2	0
	Lint Index (%) = 5.63 - 0.65 DCB	16.3	0
	Germination (%) = 68.12 - 27.49 DCB	84.7	0

DISCUSSION

Likewise, other Boll feeding insects pest's having mouthparts with mode of piercing/sucking i.e. red cotton bug, DCB and stink bugs have become more common cotton pests on *Bt* cotton during recent years. The reduced use of conventional insecticides on transgenic cotton against lepidopterous pests has resulted in less coincidental control of those cotton pests that traditionally have been considered of minor importance. In this scenario the minor pests like DCB has attained the status of major pest of cotton. It was imperative to study the impact of DCB on agronomic and qualitative traits of cotton because farmers complaint for low seed germination and lint staining problems. Present studies revealed significant variation in seed germination and lint quality due to feeding of DCB (*O. laetus*). The results revealed that percent seed germination was declined up to 49.68% due to feeding of *O. laetus*. The results are confirmatory to the findings of (Henry 1983) who reported that DCB reduced cotton seed germination and seeds viability. The results are partially in agreement with the findings of (Srinivas and Patil 2004), who reported that the DCB caused 29–32% reduction in germination of cotton seed. The results revealed that due to feeding of DCB decreased the boll weight up to 39.6%. Similarly, 100 seed weight was also decreesed up to 33.24%. The results are confirmatory to the findings of other researchers who reported that it causes reduction in seed weight. However, the level of loss was variable depending upon the density of bugs (Kirkpatrick 1923). According to (Srinivas and Patil 2004) when the population of DCB was 50 pairs per boll it caused 42.9%, 40.8%, 35.1%, and 29.3% losses in seed cotton weight, 100 seed weight (seed index), oil content, and seed germination, respectively. The results revealed that percentage reduction in staple length was 8.58, 7.61, 6.58 and 3.33% among MNH-814, MNH-886, VH-289 and MNH-988, respectively. The results indicated that feeding of *O. laetus* attributed more effect on transgenic as compared to non-transgenic cultivars of cotton. These results are confirmatory to the finding of Patil *et al*., (2006) who reported that with the introduction of Bt cotton the insecticidal sprays against lepidopterous pests were reduced and minor pests had attained the status of major pests on cotton. The results exhibited that problem of seed germination and lint staining were recorded in both transgenic and non-transgenic genotypes of cotton and dependent variables like boll weight, GOT, Staple length, mike, staple strength, seed index and cotton seed germination were influenced by *O. laetus* feeding on cotton plant. The results are confirmatory to the findings of (Khan *et al.* 2014) who reported that DCB exerted negative effect on cotton seed germination and seed index. They further explained that seed germination and seed index was maximum in control as compared with bug densities. According to (Schaefer and Panizzi 2000) reduction in cotton seed germination and seed weight due to decline in oil contents and shriveling of seed embryos. Similar results were reported by (Srinivas and Patil 2004). Percentage reduction in lint index percentage was 15.02, 13.37, 9.92 and 8.16 % among VH-289, MNH-886, MNH-814 and MNH-988, respectively. Similarly, the percentage reduction in mike was 6.59%, 4.36%, 4.07% and 7.93% among VH-289, MNH-886, MNH-988 and MNH-814, respectively. However, percentage reduction in staple strength was 28.24, 19.57, 14.73 and 11.32% among MNH-988, VH-289, MNH-814 and MNH-886, respectively. The percentage reduction in lint index percentage was 19.39, 19.03, 11.43 and 11.67 % among MNH-814, MNH-988, VH-289 and MNH-886, respectively. These results revealed that *O. laetus* had significant effect on the mike, lint index and strength of fiber. It may be due to crushing of *O. laetus* during ginning process, or its ability for lint staining as reported by Peacock (1913), Misra (192), Pearson (1958), Ananthakrishnan *et al.*, (1982), Hill (1983), Rajashekhargouda *et al.*, (1984), Schaefer and Panizzi (2000), Srinivas and Patil (2004), Khan *et al.*, (2014) and Ahmed *et al.*, (2015). In the light of present studies, it was observed that farmer's complaint regarding lint staining and seed germination problems are accurate and problems is due to *O. laetus*.

Conclusion

Based on the results of present studies it was observed that *O. laetus* has the same effect both on transgenic and non-transgenic genotypes of cotton and there is no significant varietal difference regarding its damage on cotton plant. Because present article proved that *O. laetus* is the main cause of yield losses and seed germination as well as quality of fiber. Therefore, sustainable management of *O. laetus* is very important for improving seed germination and productivity of cotton. It is also notable that its population should be monitored carefully throughout the cotton growing season and controlled with effective insecticides or other control strategies should be adopted well in time.

REFERENCES

Ahmed, R., I. Nadeem, M. J. Yousaf, T. Niaz, A. Ali, and Z. Ullah, Impact of dusky cotton bug (Oxycarenus laetus Kirby) on seed germination, lint color and seed weight in cotton crop (2015).

Ananthakrishnan, T., K. Raman and K. Sanjayan, Comparative growth rate, fecudity and behavioural diversity of the dusky cotton bug, Oxycarenus hyalinipennis Costa (Hemiptera: Lygaeidae) on certain Malvaceous host plants. *Proceedings of the Indian National Science Academy. Part B: Biological sciences* (1982).

Anonymous, Economic Survey of Pakistan, Ministry of Finance, Government of Pakistan (2015-16).

Baranowski, R.M. and J. A. Slater, *Lygaeidae of the West Indies*: Agricultural Experiment Station, Institute of Food and Agricultural Sciences, University of Florida (2005)

Barbour, K.S., J.R. Bradley and J.S. Bacheler, Reduction in yield and quality of cotton damaged by green stink bug (Hemiptera: Pentatomidae). *Journal of Economic Entomology 83*:842-845 (1990).

Bundy, C. and R. McPherson, Dynamics and seasonal abundance of stink bugs (Heteroptera: Pentatomidae) in a cotton–soybean ecosystem. *Journal of Economic Entomology 93*: 697-706 (2000).

Greene, J., S. Turnipseed, M. Sullivan and G. Herzog, Boll damage by southern green stink bug (Hemiptera: Pentatomidae) and tarnished plant bug (Hemiptera: Miridae) caged on transgenic Bacillus thuringiensis cotton. *Journal of Economic Entomology 92*:941-944 (1999).

Greene, J., S. Turnipseed, M. Sullivan and O. May, Treatment thresholds for stink bugs (Hemiptera: Pentatomidae) in cotton. *Journal of Economic Entomology 94*: 403-409 (2001).

Henry, T., Pests not known to occur in the United States or of limited distribution, No. 38: Cotton Seed Bug (1983).

Hill, D.S., *Agricultural insect pests of the tropics and their control*: CUP Archive (1983).

Jackson, R., Bradley Jr, J., Van Duyn, J. and Gould, F., Comparative production of Helicoverpa zea (Lepidoptera: Noctuidae) from transgenic cotton expressing either one or two Bacillus thuringiensis proteins with and without insecticide oversprays. *Journal of Economic Entomology 97*: 1719-1725 (2004).

Khan, M.A., M. D. Gogi, M.H. Bashir, M. Hussain, Z.U. Abdin and M.A. Rashid, Assessment of density-dependent feeding damage by the cotton dusky bug, Oxycarenus laetus Kirby (Hemiptera: Lygaeidae), in cotton. *Turkish Journal of Agriculture and Forestry 38*: 198-206 (2014).

Kirkpatrick, T.W., *The Egyptian Cotton Seed Bug (Oxycarenus Hyalinipennis, Costa).: Its Bionomics, Damage, and Suggestions for Remedial Measures*: Government Press.

Misra, C., Oxycarenus laetus, the dusky cotton bug report. In *Proceedings of the 4th Entomology Meeting, Pusa 1921*:84-94 (1923).

Panizzi, A.R., J. McPherson, D.G. James, M. Javahery and R.M. McPherson, Stink bugs (Pentatomidae). *Heteroptera of economic importance*, 421-474 (2000).

Peacock, A. Entomological pests and problems of southern Nigeria. *Bulletin of Entomological Research 4*:191-220 (1913).

Pearson, E.O., The insect pests of cotton in tropical Africa. *The insect pests of cotton in tropical Africa* (1958).

Rajashekhargouda, R., M. Devaiah and S. Yelshetty, New record of insect pests infesting kasturi bhendi, Hibiscus abelomoschus Linnaeus, a medicinal plant. *Journal of the Bombay Natural History Society 81*: 212-213 (1984).

Roberts, P., C. Bednarz and J. Greene, Impact of boll feeding bugs on lint yield and fiber quality. In *Proc. Beltwide Cotton Conf*, pp. 4-7(*2005*).

Schaefer, C.W. and A.R. Panizzi, *Heteroptera of economic importance*: CRC press (2000).

Shah, A.A., F. Hasan, A. Hameed and S. Ahmed, Biological degradation of plastics: a comprehensive review. *Biotechnology Advances 26*: 246-265 (2008).

Slater, J. A. and R. M. Baranowski, Lygaeidae of Florida (Hemiptera: Heteroptera) (1990).

Slater, J.A. and R.M. Baranowski, The occurrence of Oxycarenus hyalinipennis (Costa) (Hemiptera: Lygaeidae) in the West Indies and new Lygaeidae records for the Turks and Caicos Islands of Providenciales and North Caicos. *Florida Entomologist* Pp. 495-497 (1994).

Smith, T.R. and J.A. Brambila, major pest of cotton, Oxycarenus hyalinipennis (Heterop-tera: Oxycarenidae) in the Bahamas. *Florida Entomologist*, *91*:479-482 (2008).

Srinivas, M. and B. Patil, Quantitative and Qualitative Loss Caused by Dusky Cotton Bug, Oxyacarenus laetus Kirby on Cotton. *Karnataka Journal of Agricultural Sciences 17*: 487-490 (2004).

Williams, M.R., Cotton insect losses. http://www.entomology.msstate.edu/resources/tips/cotton-losses/ data/ (2007).

Willrich, M., B. Leonard, R. Gable and L. Lamotte, Boll injury and yield losses in cotton associated with brown stink bug (Heteroptera: Pentatomidae) during flowering. *Journal of Economic Entomology 97*: 1928-1934 (2004).