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The response of dusky cotton bug (*Oxycarenus laetus*) kirby in Bt. and non-Bt. cotton varieties at agro eco-climatic conditions of District Khairpur, Pakistan

Muhammad Mithal Rind[1], Hakim Ali Sahito[1-2], Rabia Noreen[1], Nadir Ali Rind[3], Nisar Ahmed Jatoi[1], Akhtar Hussain Shar[3], Khalid Hussain Rind[*3]

[1]*Department of Zoology, Faculty of Natural Sciences, Shah Abdul Latif University, Khairpur, Sindh, Pakistan*

[1,2]*Laboratory of Entomology, Date Palm Research Institute, Shah Abdul Latif University, Khairpur, Sindh, Pakistan*

[3]*Department of Molecular Biology and Genetics, Shaheed Benazir Bhutto University, Shaheed Benazirabad, Pakistan*

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Abstract

Dusky cotton bug (DCB) observed throughout the year nearly in all plants and adapted to survive on alternate host plants. In the present research work, different Bt. and non-Bt. cotton varieties were sown at Agro eco-climatic conditions at Cotton Agriculture Research Station Kotdiji (CARSK), district Khairpur, Sindh under field conditions. The first appearance of the DCB on Bt. and non-Bt varieties were recorded in September and the peak population noted during October. The principal component of different Bt. and non-Bt. varieties based on the two groups, the first component accounts for 80.35% of the variance, while, the second component accounts for 7.07% of variance. The results indicated that the optimum humidity (24-32%) and temperature (20-36 °C) for the multiplication of DCB were recorded in Bt. and non-Bt. cotton. It was observed that no variety remained resistance against pest. The DCB population was found in both Bt. and non-Bt. varieties and found no variety resistance against the DCB pest, however, it was also observed that the few varieties were noted with a low DCB population. The regression analysis indicated that the DCB was strongly correlated with humidity and temperature in both Bt. cotton and non-Bt.cotton. Therefore, it is concluded that Bt. cotton varities such as Bt. CIM-602, Bt.-121 and non Bt. cotton varieties Sindh-1 and CRIS-533 cotton varieties considered as more resistant against the DCB pest in agro. eco-climatic region of the district Khairpur Pakistan.

* **Corresponding Author:** Khalid Hussain Rind ✉ khalid.rind@sbbusba.edu.pk

Introduction

Cotton is one of the best fiber crop. It is grown commercially in almost 50 countries of the world (Azad *et al.,* 2011), The cotton is used for fiber, thread, and vegetable oil. It is considered as an important source of foreign exchange in the world including Pakistan (Mallah *et al.,* 1997). In Pakistan, second biggest grown crop is cotton and contributes 1.0% in Gross Domestic Product (GDP) (GoP, 2016). Pakistan ranks the fourth number in the world regarding cotton production (Iqbal *et al.,* 2010; Sahito *et al.*, 2011). United States of America (USA) in 1990, on the other hand, was the first country to test *Bacillus thuringiensis* (Bt). and later on, the Bt. cotton became first genetically engineered crop and most extensively used in the world (Qaim and Zilberman, 2003).

In Pakistan, the Dusky cotton bug (DCB) persists all over the year and can survive on alternate host plants (Shah *et al.,* 2016). DCB mainly damages the cotton bolls mostly in the last days of the cotton, therefore, it causes key economic losses (Brambila, 2010). It is a migratory pest and observed in host plants throughout the year (Holtz, 2006). DCB has been received much attention for its severe attack on cotton crop in recent years (Akin *et al.,* 2010). If the severe attack of this bug happened then reduced the germination percentage of seed, quality of lint, quality of seed and oil contents (Nakache, 1992; Peral, 2006) which present a serious economic risk to cotton (Smith and Brambila, 2008).

Bt-cotton with early sowing pattern reduces the insecticidal applications against bollworms have provided a favorable environment for DCB to became the major and potential threat of economic importance in Pakistan (Shahid *et al.,* 2017). Bt. cotton remained pest resistant except sucking insect pests (Hofs *et al.,* 2004). The temperature and humidity have an important effect on the outbreak of the DCB (Ram and Chopra, 1984; Patil *et al.,* 1992) and are the greatest significant factors that regulate insect growth and population (Beirne, 1970). The most important abiotic factor is the temperature which has a dominant role in pest population variation (Bale *et al.,* 2002).

Therefore, the DCB in the agr eco-climatic region of the study area still it is considered as less the DCB response cotton varieties. It is, therefore, this study aim to evaluate the responses of the Bt. cotton varieties against the DCB pest, also, to compare with non Bt. cotton varieties. The effects of temperature and humidity on the DCB population fluctuation in the Bt. and non Bt. under field conditions were examined.

Material and methods

The present study was carried out to examine the performance of six Bt. (CIM-602, F.H-114, F.H-142, Bt-121, Bt-333, and CIM-598 and six non-Bt (Bakhtawer, Haridost, Sindh-1, CRIS-129, CRIS-533, and Z-33) against DCB at the experimental field of Cotton Agriculture Research Institute Kotdiji, district Khairpur Sindh during cotton crop season, 2018. The trial was laid out in a randomized complete block design and replicated three times to monitor the DCB population in cotton crop. The crop was sown on ridges during the second week of May 2018. For all treatments, all possible agronomic practices were carried out as per routine and the overall cropping period, no application of insecticide was applied. The seed rate was used 20 kg per hectare with line to line and plant to plant distance of 2.5 ft. x 1.0 ft. respectively. In the trial area, the length and width of each treatment were 20 ft. ×10 ft, respectively. The distance between the treatments and replications 2.5 and 3.0 ft. were maintained and crop was raised under canal irrigation conditions.

Dusky Cotton Bug Sampling

The data on DCB was started with the first appearance of pest from the first week of September at weekly intervals up to harvesting in November 2018. There were five plants randomly selected from each treatment. The adults and nymphs of DCB were counted from five bolls randomly selected from each plant; at the bottom, middle and top bolls early in the morning (Sanghi *et al.,* 2014) at weekly intervals until harvesting (Qayyoum *et al.,* 2014). The metrological data regarding weather factors were recorded from Accuweather mobile software.

Statistical Analysis

All the data on the population of pest were analyzed by using the analysis of variance (ANOVA) for significant difference between different cotton followed by Tukey posthoc test (HSD: honestly significant difference) with a significance level of $p < 0.05$ and least significance (LSD) test at 5% probability level and the least regression analysis of the DCB population were checked with statistical software student package Statistics- 8.1 USA. The normality of the data were checked with different parametric tests (D'Agostino-Pearson or Shapiro-Wilk normality test) and for non-parametric tests (Kruskal-Wallis test). Principle component analysis used to explain the similarities among different cotton varieties based on the presence of the DCB (Pearson correlation).

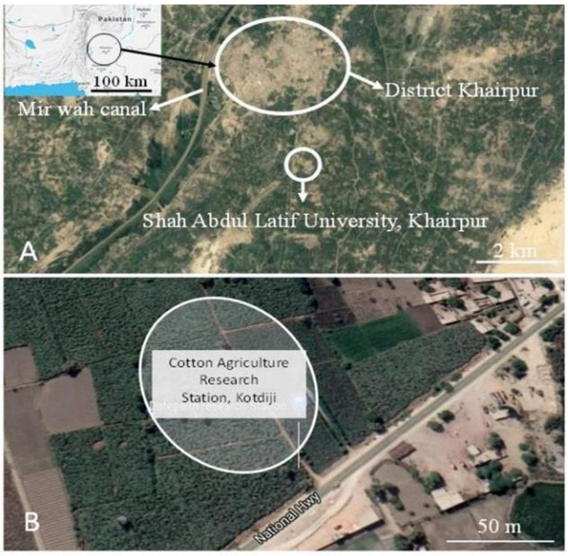

Fig. 1. Map of the district Khairpur and laboratory Shah Abdul Latif University (A) and experimental field area cotton agriculture research station, Kotdiji (B).

Results and discussions

The DCB in Bt. and non Bt. cotton varieties were observed abundantly in the month October. In Bt. varieties, the F.H-142 (22.25/plant) and the F.H-114 (22/plant), whereas, in non-Bt. varieties, Z-33 (26.25/plant) and Haridost (24.25/plant) varieties were with the most number of the DCB pests recorded at 20-36°C temperature and 29% of humidity. The DCB was once considered a minor pest, but now, it has been considered as a major economic inset pest (Henry, 1983). This pest remained in the field throughout the year in various alternate hosts plant including cotton crop (Derksen *et al.,* 2009). In light of the present investigation that cotton was the most preferred host of this pest (Shah *et al.,* 2016). It was found that the overall the peak population of the DCB pest was observed in the October which is in confirmation with previously reported research studies (Shahid *et al.,* 2014) with increased numbers in the October (Shahid *et al.,* 2014; Shah *et al.,* 2016; Iqbal *et al.,* 2017; Khan, *et al.,* 2017) and it could be due to the availability of food, migration from the alternate host and optimal environmental conditions (Srinivas and Patil, 2004). The reason for the peak population might be the breeding of DCB that takes place on open bolls when the temperature is slightly lower during these months (Schaefer and Panizzi, 2000; Qayyoum *et al.,* 2014). It has already been reported that the high incidence of DCB could be due to plenty of food and the migration from other alternate hosts to the major host like cotton crop (Srinivas and Patil, 2004).

Table 1. DCB population fluctuations in Bt. cotton varieties under field conditions.

Months	CIM-602	F.H-114	F.H-142	Bt.121	Bt.333	CIM-598	Averages	Temp. (°C) (Min-Max)	Humidity (%)
September	2.07	3.83	2.60	2.40	2.41	2.20	2.59±0.26	27-48	54
October	17.50	22.00	22.25	18.00	16.50	21.00	19.54±1.02	20-36	29
November	7.00	18.00	8.00	9.00	13.00	20.00	12.50±2.23	18-30	24
Average ±S.E.M	8.86±4.55	14.61±5.51	10.95±5.86	9.80±4.52	10.64±4.24	14.40±6.11	11.54±0.57	21.67±2.73-38.00±5.29	35.67±9.28

Table 2. DCB population fluctuations in Non-Bt. cotton varieties under field conditions.

Months	Bakhtawer	Haridost	Sindh 1	CRIS 129	Z 33	CRIS 533	Averages	Temp. (°C) (Min-Max)	Humidity (%)
September	2.29	3.32	1.99	3.57	1.72	2.63	2.59±0.30	27-48	54
October	22.75	24.25	16.25	17.75	26.25	15.75	20.50±1.83	20-36	29
November	12.00	14.00	11.00	20.00	19.00	10.00	14.33±1.73	18-30	24
Average ±S.E.M	12.35±5.91	13.86±6.04	9.75±4.16	13.77±5.14	15.66±7.28	9.46±3.80	12.47±0.49	21.67±2.73-38.00±5.29	35.67±9.28

Principal component analysis (PCA) of Bt and non-Bt. varieties suggested two groups based on a similar infestation pattern. There were five cotton varieties, among them the F. H142, CIM-602, and Bt-121 were Bt. cotton, and two non Bt. Z-33 and Haridost were grouped. Similarly, the rest of all Bt. and non-Bt. cotton varieties were group together. In the PCA, the first component accounts for 80.35% of the variance, whereas, the second component accounts for 7.07% of the variance.

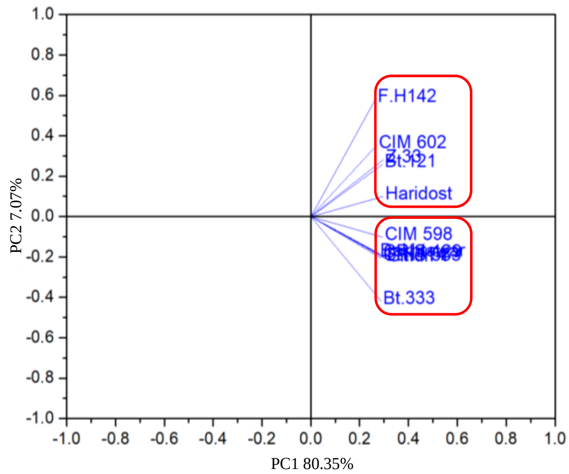

Fig. 2. Principle component analysis of different Bt. and non-Bt. Varieties.

The temperature and humidity, on the other hand, are considered as a key environmental parameter, results were indicated that the population of DCB pest increased surprisingly more than 30 DCB pest per plant at 29% humidity in the non- Bt. cotton varieties. Whereas, in the Bt. cotton varieties, the DCB pest observed less than that of Non-Bt. that was less than 28 per plant (Fig. 3A). However, for temperature, the presence of DCB per plant was observed more than 35 DCB per plant in the non-Bt. cotton variety at 35 °C, while, for Bt. variety, less than 27 DCB pest per plant observed in the Bt. cotton varieties (Fig. 3B).

The regression analysis between Bt. and non- Bt. varieties with temperature and humidity displayed a negative correlation among them. It was observed that the temperature and humidity have significantly effected the DCB pest population of both Bt. (X= 63.1017;Y= -1.76456;R-square= 0.5385;F= 9.33;p= 0.0157; and X= 29.0347;Y= -0.45809;R-square= 0.7446;F= 23.32; P= 0.0013) and non- Bt. cotton (X= 74.3548;Y= -2.11068;R-square= 0.6102;F= 12.53;P= 0.0076; and X= 32.6709; Y= -0.52514;R-square 0.7750;F= 27.56;P= 0.0008) respectively. The weather and climatic conditions, more specifically, the temperature and humidity are considered as a key player in shaping the animal population (Bale *et al.,* 2002). Pest numbers and population density depend upon abiotic factors. Among abiotic factors, the temperature is considered the most limiting factor which effects on the growth and development of insects and therefore plays an important role in population buildup of the pest (Weisser *et al.,* 1997). The humidity may affect the population growth of pest (Beirne, 1970).

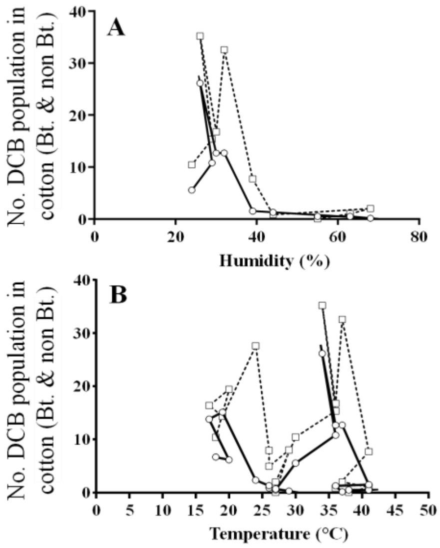

Fig. 3. Observations of the DCB pest in the cotton varieties of Bt. and non-Bt. at different humidity (A) and different temperatures (B).

The Khairpur in the agro eco-climatic region, both the temperature and humidity fluctuates throughout the year. The DCB population of the Bt. and non- Bt. cotton varieties depend on temperature and humidity. Interestingly, this is the first study of DCB in this ecological zone. However, the temperature and humidity vary in Pakistan. Other studies on the DCB population on non-Bt. and transgenic cotton varieties are in line with our studies (Qayyoum *et al.,* 2014; Shah, *et al.,* 2016; Iqbal, *et al.,* 2017).

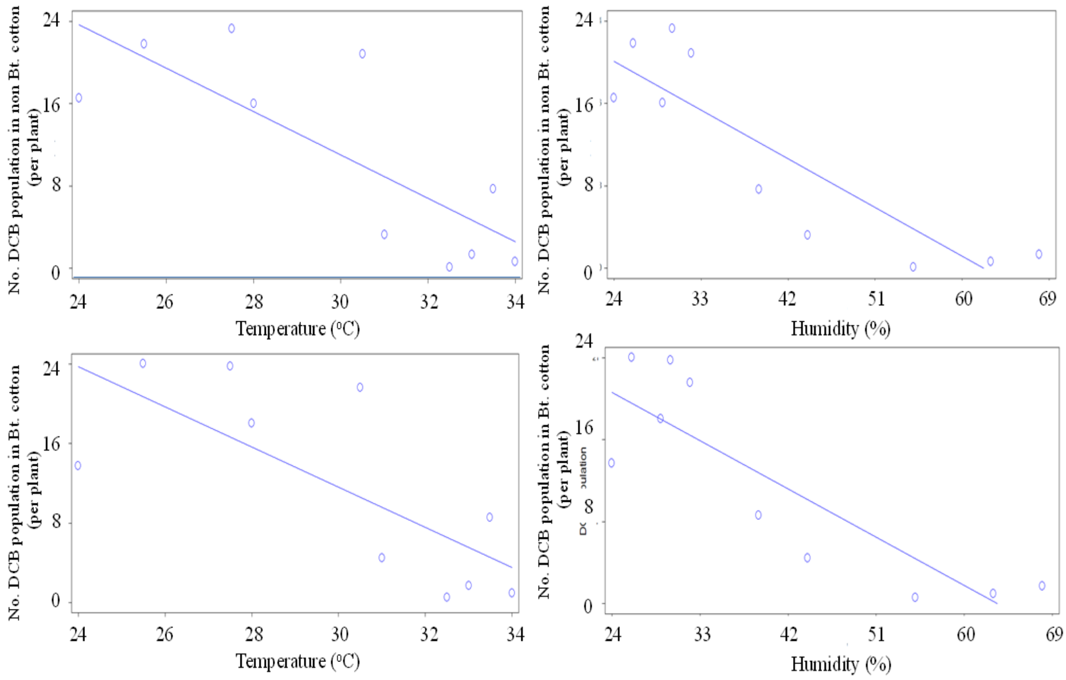

Fig. 4. Scattered plot of DCB population with temperature and humidity.

Conclusion

It was found that the first appearance of DCB was observed during the first week of September but small in number could be because of the higher environmental humidity and temperatures, as the temperature and humidity lower down to certain levels, the number of the DCB pest observed increased in numbers. However, the peak population of the DCB pest noted during the October and maximum numbers recorded in Bt. F.H-142, F.H-114, CIM-598, and non-Bt. Z-33, and Haridost.

The principal component of different Bt. and non-Bt. varieties based on the two groups, the first component accounts for 80.35% of the variance, while, the second component accounts 7.07% of variance. The overall data showed that there was comparatively less population of DCB recorded in Bt. CIM.-602, Bt.-121, Bt.- 333 and-non Bt. Sindh-1, and CRIS-533. The optimum humidity (24-32%) and temperature (20 to 36 °C) were suitable for pest multiplication. The regression analysis of DCB was shown a significantly negative correlation with temperature and humidity.

Recommendation

It is suggested that the growers may cultivate the cotton varieties of less response to DCB under field conditions. It will be helpful further to understand the DCB population throughout the Province, Moreover, the molecular level research and effects of the DCB on fiber quality could be interesting to evaluate in future research. The weather forecasting would be helpful to the growers for making future planning and time reducing the DCB population under field conditions.

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