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EFFECT OF NITROGEN FERTILIZERS ON THE POPULATION DYNAMICS OF WHITEFLY *BEMESIA TABACI* (GENNADIUS) IN BT, NON-BT AND DESI COTTON

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ABSTRACT

Studies were conducted to investigate the effect of different levels of nitrogen fertilizer on the incidence of whitefly in six Bt cotton cultivars, namely, Ankur 3028, NCS 855, RCH 776, RCH 650, RCH 773, Bioseed 6588 and one each of American cotton LH2108 and desi cotton cultivar FDK 124 at the Entomological Research Farm, Department of Entomology, PAU, Ludhiana during 2014 and 2015. The study revealed that incidences of whitefly were higher during 2015 than 2014 during the course of study. During both years, significantly higher incidence of whitefly was recorded at higher dose of nitrogen fertilizer (325 kg/ acre) as compared to lower doses (165 and 250 kg/ acre). Among different cultivars, whitefly was significantly higher on Bt cotton cultivars as compared to non-Bt and desi cotton cultivar. Whitefly population was significantly higher on Bt cotton cultivar, Bioseed 6588 (6.10 and 8.84/ 3 leaves) during 2014 and 2015, respectively. However, lower population of whitefly was recorded on the desi cotton cultivar, FDK 124 (3.54 and 2.95/ 3 leaves) during 2014 and 2015, respectively. The correlation coefficient studies with weather parameter revealed that adults showed significant positive correlation with maximum and minimum temperature, evaporation and sunshine hours.

Key words: Bt cotton, non-Bt cotton, desi cotton cultivar, whitefly, *Bemisia tabaci*, nitrogen fertilizer, population, correlation, evaporation, temperature, sunshine hours

Cotton (*Gossypium* spp.) is the most important fibre crop in the world including India (Lee and Fang 2015). Cotton is attacked by various insect pests like lepidopteran pests (American bollworm, pink bollworm), sucking insect pests (thrips, jassid, whitefly, mealybug, red cotton bug) throughout the growing period. One of the major management methods of IPM is the use of non-chemical methods viz., resistant host plants to control pests. Ever since 2002, when the first Bt cotton was introduced, the bollworm complex had been able to be managed (Arshad et al., 2009) but the non-target sucking insect pests such as jassids (*Amrasca biguttula biguttula* Ishida), aphid (*Aphis gossypii* Glover), whitefly (*Bemisia tabaci* Gennadius) and thrips (*Thrips tabaci* Lind.) have remained unharmed (Tian et al., 2015). Considerable efforts have been made to determine the effects of Bt crops on non-target arthropods. Owing to the reduction in the application of broad-spectrum insecticides in transgenic *Bt* cotton, these non-target pests with piercing-sucking mouthparts survive better and occasionally reach a pest status (Shivanna et al., 2011). Cotton crop was seriously affected by the whitefly epidemic in the entire north zone of India during the year 2016 (Anonymous, 2016). Whiteflies are very destructive pests during seedling and vegetative phase of cotton. They suck the sap of the plant, leading to wilting and shedding of leaves (Abro et al., 2004), thereby resulting in up to 50% reduction in boll production (Ahmad et al., 1997). Whitefly causes indirect damage to cotton by excreting honeydew, which promotes sooty mould growth, thus interfering with photosynthesis, besides acting as a vector of cotton leaf curl virus disease (Malik et al., 1999). The incidence of whitefly was directly related with the application of high dose of nitrogen in Bt cotton. Application of nitrogen nutrient to the plant directly affects vegetative growth. Increasing levels of nitrogen allow the plant to change its physiological characteristic resulting in profuse growth and more succulence. This leads to decrease in resistance of plants against pest and attract more insects. Andrew et al. (2000) reported positive correlation between insect pests of cotton and nitrogen fertilizer. Keeping these points in view, the present study was carried out to evaluate the influence of nitrogenous fertilizer doses on the incidence of *B. tabaci* on Bt, non-Bt and desi cotton cultivars.

MATERIALS AND METHODS

Six Bt cotton cultivars, namely Ankur 3028, NCS 855, RCH 776, RCH 650, RCH 773, Bioseed 6588 which is approved by the Genetic Engineering Appraisal Committee (GEAC), India and one each of American cotton (LH2108) and desi cotton cultivar (FDK 124) which is recommended by the Punjab Agricultural University, Ludhiana, were used. The seeds were sown at the Entomological Research Farm of Department of Entomology, PAU, Ludhiana (30.9041° N, 75.8066° E) during second week of May 2014 and 2015. Four applications of 2% potassium nitrate (13:0:45) were given at weekly intervals starting from flowering stage of the crop. The plots were divided into subplot treatments with nitrogen fertilizer @ 162.50, 250 and 325 kg/ ha (in two splits). The crop was raised as per the recommended package of practices, PAU, Ludhiana (Anonymous, 2014). The observations on incidence of whitefly on different Bt, non Bt and desi cotton cultivars were recorded at weekly interval from 10 randomly selected cotton plants throughout the crop season in 3 replications. The obtained data were presented as number of insects/ three leaves/ plant. The observations on various weather parameters, like temperature (maximum and minimum), relative humidity, sunshine hours, rainfall were obtained from the School of Climate Change and Agricultural Meteorology, PAU, Ludhiana. The data were statistically analyzed with ANOVA in split plot design. The different means were separated by critical difference (LSD) at p = 0.05 (Gomez and Gomez, 1984). DMRT method was used to compare each treatment mean with every other treatment mean. The correlation coefficient with weather parameters were worked out.

RESULTS AND DISCUSSION

Whitefly incidence was recorded in Bt, non-Bt and desi cotton cultivars at weekly interval. The results revealed that it varied among Bt, non-Bt and desi cotton cultivars. The first appearance was recorded on 27th SMW (Standard Meteorological Week) (Fig. 1 and 2) with the highest whitefly population on Bt cotton cultivar, Bioseed 6588 (16.90 whiteflies/ 3 leaves) and lowest was on desi cotton cultivar, FDK 124 (1.65 whiteflies/ 3 leaves) and Bioseed 6588 (30.14 whitefly/ 3 leaves) and desi cotton cultivar, FDK 124 (4.5 whitefly/ 3 leaves), respectively during 2014 and 2015. The populations showed two peaks were on 28th and 30th SMW (Bt cotton cultivar, Bioseed 6588) during 2014, however during 2015, two peaks on 28th and 29th SMW (Bt cotton cultivar, Bioseed 6588). Whitefly populations was recorded throughout the growing

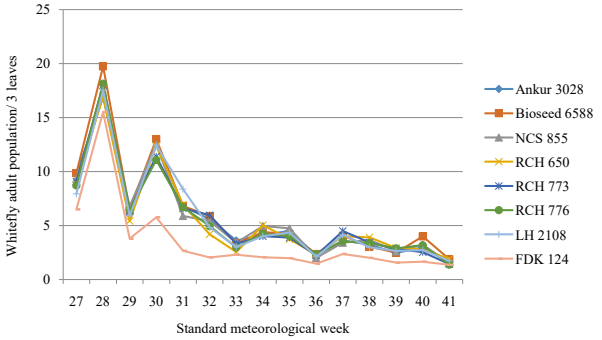

Fig. 1. Incidence of *B. tabaci* adult on *Bt*, non-*Bt* and *desi* cotton cultivar (2014)

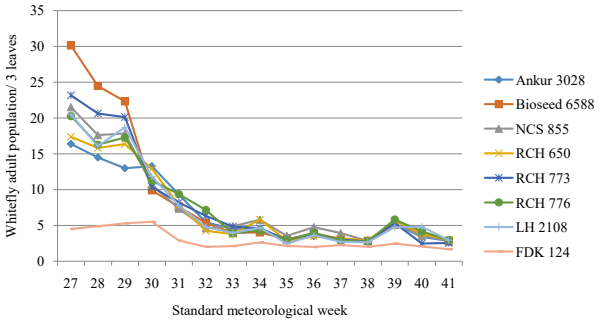

Fig. 2. Incidence of *B. tabaci* adult on *Bt*, non-*Bt* and *desi* cotton cultivar (2015)

season of 2014. The maximum dose of N (325 kg/ ha) recorded maximum incidence (9.60) on 27th SMW as compared with 162.5 (7.99) and 250 (8.65) kg/ ha of N. Similar results were found during 2015 were maximum dose of N (325 kg/ ha) recorded maximum incidence (27.07) on 27th SMW as compared with 162.5 (13.99) and 250 kg (16.64). The incidence decreases as the plant matured. Among the Bt, non-Bt and desi cotton cultivar, incidence was significantly lower in desi cotton cultivar, FDK 124 (3.54 and 2.95) during 2014 and 2015, respectively. However, among the Bt and non-Bt cultivars of American cotton, it significantly higher in Bt cotton cultivar, Bioseed 6588 (6.10) and lower on RCH 776 (5.59) during 2014. During 2015, the population was significantly higher in bioseed 6588 (8.84) and lower in Ankur 3028 (6.98). The interaction between the different nitrogen levels and cotton cultivars, were found to be non-significant (Table 1). In the Table 2 adult counts showed significantly positive correlation with maximum and minimum temperature for all the Bt and non-Bt cotton and desi cotton cultivars. Correlation with rainfall showed highly significant positive correlation with Bt cotton Ankur 3028 (r=+0.679) RCH 773 (r= +0.612), non-Bt cotton cultivars LH 2108 (r= +0.596) and with desi cotton cultivar FDK 124 (r = +0.679). Evaporation has positive significant correlation with Bt cotton Ankur

3028, RCH 773 and desi cotton FDK 124 cultivars. Present results are in agreement with the findings of Balabantaray et al. (2021) who reported that increased nitrogen fertilizer application is positively correlated Patel et al. (2015) reported that higher dose of nitrogen fertilizer increases the incidence; but Watson et al. (1994) denied the role of nitrogen fertilizer. The present study was in accordance with the finding of Sharma and Sharan (2016) who reported that mean temperature had positive and significant correlation while relative humidity (%) and rainfall had no significant role. Whitefly population displayed significant positive correlation with minimum temperature and relative humidity. Chaman et al. (2021) and Abbas et al. (2023) reported significant positive correlation with temperature and relative humidity, while rainfall did not display any significant relation. Jalal et al. (2006) reported that whitefly incidence has positive correlation with the rainfall whereas the finding of Bashir et al. (2001) showed that rainfall has negative correlation. Bashir et al. (2022) observed a non-significant positive correlation with relative humidity. Khaliq et al. 2023 and Patel et al. (2021) also reported positive correlation with maximum temperature whereas Soujanya et al. (2010) reported that the total influence of all weather parameters such as temperature, rainfall and relative humidity was non-significant.

Table 1. Effect of nitrogen on *B. tabaci* incidence

Nitrogen / Cultivar	Whitefly counts/ 3 leaves *							
	2014				2015			
	65 kg	100 kg	130 kg	Mean	65 kg	100 kg	130 kg	Mean
Ankur 3028	4.91 (2.33)	5.71 (2.49)	6.65 (2.67)	5.76 (2.49)^{bc}	5.45 (2.44)	6.63 (2.67)	8.86 (3.06)	6.98 (2.70)^{b}
Bioseed 6588	5.05 (2.36)	6.04 (2.56)	7.22 (2.78)	6.10 (2.55)^{c}	6.11 (2.57)	7.95 (2.91)	12.45 (3.60)	8.84 (2.88)^{c}
NCS 855	4.95 (2.33)	5.51 (2.45)	6.89 (2.72)	5.78 (2.50)^{bc}	5.91 (2.53)	7.78 (2.88)	9.73 (3.20)	7.81 (2.82)^{bc}
RCH 650	4.73 (2.29)	5.63 (2.48)	6.44 (2.63)	5.60 (2.46)^{b}	5.85 (2.52)	7.14 (2.76)	8.80 (3.05)	7.26 (2.73)^{b}
RCH773	4.77 (2.30)	5.62 (2.47)	6.73 (2.69)	5.71 (2.48)^{b}	6.35 (2.62)	7.38 (2.81)	10.49 (3.32)	8.08 (2.83)^{bc}
RCH 776	4.46 (2.23)	5.62 (2.47)	6.71 (2.69)	5.59 (2.46)^{b}	5.68 (2.49)	6.85 (2.71)	10.54 (3.32)	7.69 (2.79)^{bc}
LH 2108 (non-Bt)	4.72 (2.28)	5.49 (2.45)	6.72 (2.69)	5.64 (2.47)^{b}	5.67 (2.48)	6.99 (2.74)	9.77 (3.20)	7.48 (2.75)^{bc}
FDK 124 (Desi)	2.71 (1.79)	3.48 (1.99)	4.42 (2.22)	3.54 (2.02)^{a}	2.12 (1.62)	3.04 (1.88)	3.70 (2.05)	2.95 (1.95)^{a}
Mean	4.54 (2.25)^{a}	5.39 (2.42)^{b}	6.46 (2.62)^{c}		5.39 (2.42)^{a}	6.72 (2.65)^{b}	9.29 (2.97)^{c}	
LSD (p=0.05)	Nitrogen = 0.10, Cultivar = 0.06 Nitrogen x Cultivar = NS				Nitrogen = 0.19, Cultivar = 0.14 Nitrogen x Cultivar = NS			

Figures in parentheses indicate $\sqrt{n+1}$ square root transformed values *Mean of 3 replications

Table 2. Correlation- adult counts vs weather parameters in Bt, non-Bt and desi cotton cultivars (pooled 2014, 2015)

Cultivar	Correlation coefficient						
	Temperature		Relative humidity		Rainfall	Evaporation	Sunshine hr
	Maximum	Minimum	Morning	Evening			
Ankur 3028	0.417	0.563*	-0.048	0.337	0.679**	0.256	0.564*
Bioseed 6588	0.691**	0.658**	-0.114	0.044	0.326	0.674**	0.404
NCS 855	0.531*	0.643**	-0.202	0.198	0.431	0.548	0.499
RCH 650	0.674**	0.704**	-0.104	0.230	0.430	0.487	0.348
RCH773	0.328	0.450	-0.106	0.192	0.612*	0.269	0.666**
RCH 776	0.630*	0.669**	-0.110	0.110	0.374	0.603*	0.399
LH 2108(non-Bt)	0.541*	0.586*	-0.137	0.220	0.596*	0.385	0.408
FDK 124 (*Desi*)	0.417	0.563*	-0.048	0.337	0.679**	0.256	0.564*

* Significant at ($p<0.05$); ** Significant at ($p<0.01$)

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AUTHOR CONTRIBUTION STATEMENT

V K and H S B conceived the research work plan. Y K D and V K conducted the experiment. IYL and YKD analyzed data. IYL wrote the manuscript. All authors approved the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

REFERENCES

Abro G H, Syed T S, Tunio G M, Khuhro M A. 2004.Performance of transgenic *Bt* cotton against insect pest infestation. Biotechnology 3: 75-81.

Abbas Q, Hameed A, Karar H, Ali Q, Muhammad N, Hussain M, Faheeem U, Muhammad T, Ahmad A, Shahid M, Hameed A, Iqbal M. 2023. Seasonal abundance and population dynamics of cotton whitefly (*Bemisia tabaci* L.) under spatio-temporal environment of South Punjab, Pakistan. Journal of Pure and Applied Agriculture 8(1): 24-33

Ahmad M, Arif M I, Attique M R. 1997. Pyrethroid resistance of *Helicoverpa armigera* (Lepidoptera: Noctuidae) in Pakistan. Bulletin of Entomological Research 87: 343-47.

Andrew G L, Cooke G, Meeks R D, Dugger P, Richter D. 2000. The interaction of nitrogen fertilization and insect populations. Proceedings of the 2000 Beltwide Cotton Conferences, USA 2: 993-96.

Anonymous. 2016. Final Report – *Bt* Cotton. http://www.nfsm.gov.in. 2016.

Anonymous. 2014. Package of Practices for Kharif Crops. Punjab Agricultural University, Ludhiana, 2014.

Arshad M, Suhail A, Arif M J, Khan M A. 2009. Transgenic *Bt* and non-transgenic cotton effects on survival and growth of *Helicoverpa armigera*. International Journal of Agriculture and Biology 11: 473-476.

Bashir M H, Afzal M, Sabri A M, Raza A B M. 2001. Relationship between sucking insect pests and physio-morphic plant characters towards resistance/ susceptibility and some new genotype of cotton. Pakistan Entomology 23: 75-78.

Bashir M A M, Batool M, Khan H, Nisar S M, Farooq H, Hashem M, Tahir M. 2022. Effect of temperature & humdity on population dynamics of insects‟ pest complex of cotton crop. PloS One 17, e0263260.

Balabantaray S, Jaglan R S, Dahiya K K. 2021. Evaluation of varied nitrogen dosages onpopulation build up of cotton whitefly (*Bemisia tabaci*, Gennadius). Journal of Entomology and Zoology Studies 9: 1367-1370.

Chaman K, Pankaj K, Vikas, Amrendra K. 2021. Population dynamics of whitefly of mung bean (*Vigna radiata* (L.) Wilczek) during summer 2018. The Pharma Innovation Journal 10(10): 1121-1122.

Gomez A K, Gomez A A. 1984. Statistical procedure for agricultural research. J. Wiley and Sons. Singapore, 1984.

Jalal A M, Gogi M D, Mirza M, Zia K, Hafeez F. 2006. Impact of plant spacing and abiotic factors on population dynamics of sucking insect pests of cotton. Pakistan Journal of Biological Science 9: 1364-69.

Khaliq N, Shankar U, Rather B A. 2023. Seasonal incidence of whitefly *Bemisia tabaci* (genn.) on mungbean. Indian Journal of Entomology 85: 487-489

Lee J A, Fang D D. 2015 Cotton as a world crop: origin, history and current status. Cotton, 2nd Edn, Fang R G P D D (ed). Madison, W I, American Society of Agronomy, Inc. 2015. pp. 1-23.

Malik A K, Mansoor S, Saeed N A, Asad S, Zafar Y, Stanely J, Markham P. 1999. Development of CLCV resistance cotton varieties through genetic engineering. A monograph: Director of Agricultural Information, Punjab, Pakistan. 1999. p. 3.

Patel C K, Bharpoda T M, Zala M B, Shah K D. 2015. Impact of plant spacing and nitrogenous fertilizer on incidence of sucking pests in *Bt* cotton. International Journal of Plant Protection 8: 34-40.

Patel R, Marabi R S, Nayak M K, Tomar D S, Srivastava A K. 2021. Population dynamics of major sucking insect pests of mungbean [*Vigna radiata* (L.) Wilczek] in relation to weather parameters. Journal of Entomology and Zoology Studies 9(2): 324-328.

Sharma R, Sharan L. 2016. Impact of abiotic factors on seasonal incidence of sucking pests in transgenic cotton ecosystem. International Journal of Current Advanced Research 5: 1268-69.

Shivanna B K, Naik G B, Basavaraja M K, Nagaraja R, Swamy K C M, Karegowda C. 2011. Impact of abiotic factors on population dynamics of sucking pests in transgenic cotton ecosystem. International Journal of Science and Nature 2: 72-74.

Soujanya P L, Prasad N V, Rao P A. 2010. Population dynamics of sucking pests and their relation to weather parameters in *Bt*, stacked *Bt* and non-*Bt* cotton hybrids. Trends Bioscience 3: 15-8.

Tian J C, Yao J, Long L P, Romeis J, Shelton A M. 2015. *Bt* crops benefit natural enemies to control non-target pests. *Science Report* 5:16636.

Watson T F, Silvertooth J C, Tellez A. 1994. Varietal and nitrogen level effects on sweet potato whitefly population in cotton. In: Proceeding Beltwide Cotton Conference, 1994, pp. 868-69.

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