Journal of Agrometeorology 21 (4) : 515-519 (December 2019)

Short communication

Effect of weather factors on the population dynamics of sucking insect pests and their natural enemies in transgenic and non-transgenic cotton

JAGDEEP KAUR*, NAVEEN AGGARWAL and J.S. KULAR

Department of Entomology, Punjab Agricultural University, Ludhiana, 141004

**Corresponding author's email:jagdeepchahal327@gmail.com*

Cotton (*Gossypium* spp.) is the principal cash crop cultivated in both temperate and tropical regions of the world. India is the only country where all the four cultivated species of cotton *viz. Gossypium arboretum* L., *G. hirsutum* L., *G. herbaceum* L. and *G. barbadense* are grown (Sen, 2004). Globally, an area of 33.4 million ha was under cotton cultivation in the year 2017, with India as the leading producer, having area and productivity of 12.3 million ha and 28.5 million bales, respectively (USDA, 2018). During the year 2017, in Punjab, the area under cotton was about 3.85 lakh ha with production of 12.0 lakh bales and cotton lint yield up to 529 kg/ha (AICCIP, 2018). The insect pests are of major concern in the low productivity of cotton. The insect pests in cotton can be divided as sucking pests, foliage feeders and bollworms. Among these categories of insect pests, bollworms have been effectively controlled with the cultivation of dual gene transgenic BG II cottons. But planting of Bt cotton on large area has altered the pest scenario with increased population of sucking insect pests like whitefly, *Bemisiatabaci* (Gennadius) (Hemiptera: Aleyrodidae), cotton leafhopper, *Amrascabiguttula biguttula* (Ishida) (Hemiptera: Cicadellidae), thrip, *Thripstabaci* Lindemann and aphid, *Aphis gossypii* Glover (Homoptera: Aphididae) (Vennila, 2008). During the year 2015-16, severe incidence of whitefly occurred on the cotton crop in the entire cotton growing belt of North India, which led to biggest drop in area from 5.27 lakh ha to 2.56 lakh ha under cotton cultivation of the past six decades in Punjab (AICCIP, 2016). Nymphs and adults of both whitefly and leaf hopper suck sap from the plants and cause reduction in growth and vigor of the plants by transmitting plant viruses including cotton leaf curl virus and shedding of leaves and young bolls (Ratanoara *et al.,* 1994). Similarly, Cotton thrips and aphids also damage the leaf tissue either by lacerating or sucking the sap, respectively and cause direct damage by reducing yield of the plant and indirect damage by aphid through lint contamination (Patel and Patel, 2014).Various meteorological parameters like temperature, relative humidity and rainfall have influence on the population dynamics of these insect pests. Moreover, these meteorological parameters play an important role in developing weather based pest forecasting system (Fand *et al.,* 2018). In addition to this, knowledge of the population dynamics of the insect pest population will help in framing integrated pest management techniques effectively (Fakhri and Jamal, 2012; Fand *et al.,* 2014). Apart from this, as the area under transgenic BG II cotton have increased to more than 95 per cent, very few studies on population dynamics of sucking insect pest communities in BG II cotton have been conducted under Punjab conditions. Keeping these points in view, the present study on population dynamics of insect pests and their correlation with weather parameters was carried out.

A field experiment was conducted during the *kharif* seasons of 2015 and 2016 at the Entomological Research Farm with Bt and non-Bt cultivars. The Bt-transgenic cotton hybrids, Ankur 3028 (BGII) expressing Cry1Ac & Cry2Ab gene and the non-Bt counterpart were sown at a row spacing of 67.5 cm and with plant to plant spacing of 75 cm for both Bt and non-Bt cotton on May 12 during year 2015 and on May 7, during 2016. The crop was raised as per PAU recommendations (Anonymous, 2018). The experiment was carried out in a randomized block design with four treatments comprising of non-transgenic cotton with no insecticide treatment (Non-Bt +UP), non-transgenic cotton with insecticide treatment (non-Bt +P), transgenic cotton with no insecticide treatment (Bt + UP) and transgenic cotton with insecticide treatment (Bt +P). Each treatment was replicated five times in plots measuring 500 m^2. Each plot was having 75 rows of 10 m each and a plant density of 13 plants/ row in case of both Bt and non-Bt cotton. A five m gap was left between the plots to avoid influence of treatments on arthropods in neighboring plots. Insecticides were sprayed in the respective treatments of both Bt and non-Bt cotton whenever economic threshold (ETL) for any pest was exceeded as per PAU recommendations (Anonymous, 2018). The unsprayed treatments were not protected against sucking insect pests. During 2015, three sprays were done for whitefly and during 2016, two sprays against whitefly and two sprays against jassid were given. The population of non-target pests of cotton *viz.* whitefly, jassid and thrips were recorded from three fully formed leaves in the upper canopy of the plants. Whereas, the

Table 1: Partial regression coefficient (b value) of different insect pests on weather parameters

Insect -pests/Treatments	Max. temp. (X_1)	Min. temp (X_2)	Rainfall (X_3)	Mean RH (X_4)	R^2	F value
Whitefly						
Non-Bt+ UP	-1.455	1.153	0.349	-0.252	0.629	7.62 *
Non-Bt + P	-0.254	0.520	0.188	-0.061	0.532	5.11*
Bt+UP	-1.955	1.715	0.498	-0.381	0.603	6.79*
Bt+P	-1.711	1.338	0.402	-0.340	0.648	8.23*
Jassid						
Non-Bt+ UP	-0.202	0.431	0.006	0.133	0.797	17.63*
Non-Bt + P	-0.120	0.321	0.009	0.101	0.803	18.35*
Bt+UP	-0.033	0.257	0.007	0.114	0.768	14.88*
Bt+P	-0.114	0.284	0.006	0.084	0.785	16.38*
Thrips						
Non-Bt+ UP	0.512	-0.202	0.122	0.073	0.437	3.49*
Non-Bt + P	0.364	-0.120	0.076	0.046	0.297	1.90
Bt+UP	0.538	-0.223	0.115	0.086	0.434	3.45*
Bt+P	0.563	-0.250	0.103	0.082	0.411	3.14*
Aphids						
Non-Bt+ UP	-0.716	-0.696	-0.003	-0.124	0.883	33.88*
Non-Bt + P	-0.621	-0.654	-0.003	-0.107	0.895	38.35*
Bt+UP	0.084	-0.114	-0.006	0.032	0.552	5.55*
Bt+P	0.074	-0.084	-0.004	0.027	0.473	4.04*
Chrysoperla eggs						
Non-Bt+ UP	-0.132	0.084	0.001	0.011	0.720	4.83*
Non-Bt + P	-0.110	0.068	0.001	0.011	0.760	6.16*
Bt+UP	-0.152	0.099	0.001	0.012	0.762	5.02*
Bt+P	-0.125	0.084	0.000	0.010	0.722	4.89*
Coccinellids						
Non-Bt+ UP	0.473	-0.235	-0.010	0.150	0.433	1.03
Non-Bt + P	0.103	-0.049	0.002	0.031	0.458	1.19
Bt+UP	0.277	-0.130	-0.003	0.085	0.404	0.87
Bt+P	0.155	0.075	0.001	0.047	0.409	0.90

* Significant at p= 0.05

population count of nymphs and adults of aphids was taken from the three leaves in the upper and middle canopy of plant. All these observations were recorded at weekly interval from 100 randomly selected plants from each replication during six growth phases of the crop: vegetative at 15 days after planting (DAP), beginning of reproductive phase (30 DAP), flowering (60 DAP), fruiting (80 and 100 DAP), boll development phase

In jassid population, maximum temperature had a non-significant negative effect on population in all the four treatments. Whereas, the other three weather parameters were having positive effect on population (Table 1). These weather parameters explain variations up to the extent of 79.7%, 80.3%, 76.8% and 78.5% in all the four treatments, respectively. The step down regression analysis revealed that

Table 2: Multiple regression equation of insect pest population by step wise analysis

Insect-pests	Treatments	Regression equation	R^2
Whitefly	Non-Bt+ UP	$Y=1.732+0.394X_3$	0.597
	Non-Bt + P	$Y=1.159+0.213X_3$	0.500
	Bt+UP	$Y=2.543+0.562X_3$	0.568
	Bt+P	$Y=1.351+0.448X_3$	0.614
Jassid	Non-Bt+ UP	$Y=-16.920+0.365\ X_2+0.179X_4$	0.787
	Non-Bt + P	$Y=-13.094+0.297\ X_2+0.134X_4$	0.788
	Bt+UP	$Y=-11.992+0.262\ X_2+0.127X_4$	0.761
	Bt+P	$Y=-11.285+0.253\ X_2+0.113X_4$	0.774
Thrips	Non-Bt+ UP	$Y=-0.413+0.117X_3$	0.422
	Non-Bt + P	$Y=-0.113+0.073X_3$	0.281
	Bt+UP	$Y=-0.416+0.110X_3$	0.417
	Bt+P	$Y=-0.419+0.096X_3$	0.386
Aphids	Non-Bt+ UP	$Y=26.952-0.988X_2$	0.847
	Non-Bt + P	$Y=24.757-0.908\ X_2$	0.862
	Bt+UP	$Y=2.699-0.092\ X_2$	0.429
	Bt+P	$Y=1.858-0.062\ X_2$	0.339
Chrysoperla eggs	Non-Bt+ UP	$Y= -0.999+0.019X_4$	0.496
	Non-Bt + P	$Y=-0.730+0.014X_4$	0.500
	Bt+UP	$Y=-1.178+0.023X_4$	0.502
	Bt+P	$Y=-0.875+0.017X_4$	0.487

variables retained were only minimum temperature and mean RH that explained a considerable amount of total variations explained by all the four weather parameters (Table 2). So from the multiple R^2 values of 78.7%, 78.8%, 76.1% and 77.4%, it can be concluded that the two weather parameters viz. minimum temperature and RH explain a considerable amount of variations explained out of the four weather parameters in four treatments, respectively. Hussain *et al.* (2014) have also observed negative relation between leafhopper population and maximum temperature and significant positive effect of minimum temperature and relative humidity on jassid population. Whereas, Kumar *et al*. (2012) have observed positive association of jassid population with maximum temperature, minimum temperature and relative humidity.

Similarly, in case of thrip population except minimum temperature all the other three weather parameters viz. maximum temperature, rainfall and mean RH were having positive effect on population (Table 1). These weather parameters collectively explained variations of 43.7%, 29.7%, 43.4% and 41.1% in four treatments of Non-Bt+UP, Non-Bt+P, Bt+UP and Bt+P, respectively. Further, the step down regression analysis showed that variable retained was only rainfall that explained a considerable amount of total variations explained by all the four weather parameters (Table 2). So the multiple R^2 values of 42.2%, 28.1%, 41.7% and 38.6% explained the extent of variation contributed by single weather parameter of rainfall in four treatments of Non-Bt + UP, Non-Bt+P, Bt+UP and Bt+ P, respectively. Panwar *et al.* (2015) also reported positive influence of the maximum temperature, rainfall and relative humidity on thrip population in both Bt and non-Bt cotton.

In aphid population, in Non-Bt cotton under both unprotected and protected treatments all the four weather parameters had negative influence on population with variations of 88.3% and 89.5%, respectively (Table 1). And the step down regression analysis revealed that variable retained was only minimum temperature that significantly affected the population with multiple R^2 being 84.7% and 86.2 % in both the treatments respectively (Table 2). Whereas, in Bt cotton both under unprotected and protected conditions, only maximum temperature and mean RH showed positive effect on population and rest of the two parameters of minimum temperature and rainfall showed negative effect on population with variations of 55.2 % and 47.3 %, respectively. Again the step down regression analysis revealed that variable retained was only minimum temperature that significantly affected the population with multiple R^2 being 42.9% and 33.9 % respectively in both the treatments indicating that out of four weather parameters only minimum temperature had explained a considerable amount of total variation explained by all the four weather parameters. Laxman *et al.* (2014) have also found the negative effect of minimum temperature and rainfall on aphid population. Similarly, Muchhadiya *et al*. (2014) have observed negative relation between aphid population and minimum temperature, relative humidity and rainfall in Bt cotton.

In case of *Chrysoperla* population except maximum temperature all the other three weather parameters i.e. minimum temperature, rainfall and mean R.H. were having positive effect on population (Table 1). These weather parameters collectively explained variations of 72.0%, 76.0%, 76.2% and 72.2% in four treatments of Non-Bt+UP, Non-Bt+P, Bt+UP and Bt+P, respectively. Further, the step down regression analysis showed that variable retained was only mean R.H that explained a considerable amount of total variations explained by all the four weather parameters (Table 2). So the multiple R^2 values of 49.6%, 50.0%, 50.2% and 48.7% explained the extent of variation contributed by single weather parameter of rainfall in four treatments of Non-Bt + UP, Non-Bt+P, Bt+UP and Bt+ P respectively. However, Boda and Ilyas (2017) have reported contrasting results with negative effect of minimum temperature, rainfall and relative humidity on *Chrysoperla* population in BG-II cotton.

In case of coccinellids, except minimum temperature all the three weather parameters of maximum temperature, mean R.H and mean RF was having positive influence on the population in all the three treatments of non-Bt+UP, non-Bt+P, Bt+UP (Table 1). However, in Bt+P treatment, all the four parameters were having positive effect on the population. The multiple R^2 values of 43.3%, 45.8%, 40.4% and 40.9% explained the extent of variation contributed by all the weather parameters in the four treatments. In coccinellids population none of the weather parameter showed significant effect on the population. Gurung *et al.* (2018) also observed that weather parameters like maximum temperature, minimum temperature and rainfall have non-significant effect on coccinellid population in brinjal.

ACKNOWLEDGEMENT

The authors would like to gratefully acknowledge the help rendered by the Head, Department of Entomology, Punjab Agricultural University, Ludhiana, Punjab (India) for providing the necessary facilities during the period of study.

REFERENCES

AICCIP (2016). ICAR-All India Coordinated Cotton Improvement Project. Annual report 2015-16.pp1-15. Central Institute for Cotton Research, Regional Station, Coimbatore.

AICCIP (2018). ICAR-All India Coordinated Cotton Improvement Project. Annual report 2017-18.pp1-21. Central Institute for Cotton Research, Regional Station, Coimbatore.

Anonymous (2018). Package of Practices for Kharif Crops. pp 39-57. Punjab Agricultural University, Ludhiana.

Boda, V. and Ilyas, M. (2017). Population dynamics of predatory insects in cotton ecosystem and their correlation with abiotic factors.*Bull. Environ. Pharmaco. Life Sci*., 6(1): 164-166

Fakhri, M.S.A. and Jamal, K. (2012). Population dynamics of major insect-pests of cotton in relation to abiotic factors. *Int. J. Adv. Biol. Res.*, 2(3): 500-505.

Fand, B.B., Tonnang, H.E.Z., Bal, S.K. and Dhawan, A.K. (2018). Shift in the Manifestations of Insect Pests Under Predicted Climatic Change Scenarios: Key Challenges and Adaptation Strategies. In: "Advances in Crop Environment Interaction". (Eds. S.K. Bal *et al.*). pp.389-404, Springer Nature Singapore Pte Ltd.

Fand, B.B., Tonnang, H.E.Z., Kumar, M., Bal, S.K., Singh, N.P., Rao, D.V.K.N., Kamble, A.L., Nangare, D.D. and Minhas, P.S. (2014). Predicting the impact of climate change on regional and seasonal abundance of the mealybug *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) using temperature-driven phenology model linked to GIS. *Ecol. Modelling,* 288: 62-78.

Gurung, B., Ponnusamy, N. and Pal, S. (2018) Effect of weather parameters on population dynamics of Coccinellids on different crop ecosystems. *J. Agrometeorol.,* 20 (3): 254-255.

Halder, J., Kushwaha, D., Deb, D., and Rai, A.B. (2019).

Abundance and distribution of sucking pest complex of okra in relation to meteorological parameters. *J. Agrometeorol.,* 21(2): 227-229.

Hussain, M., Akram, M., Abbas, Q., Ahmad, S., Babar, T.K., and Karar, H. (2014). Impact of environmental factors on the population dynamics of leaf hopper A*mrasca biguttula* ishida (homoptera: jassidae) on various transgenic cotton genotypes in Multan. *Academic. J. Ent.,* 7(1): 27-31.

Janu, A. and Dahiya, K.K. (2017). Influence of weather parameters on population of whitefly, *Bemisiatabaci* in American cotton (*Gossypium hirsutum*). *J. Ent. Zool. Studies*., 5(4): 649-654.

Laxman, P., Samantha, S. and Sammaiah, S. (2014). Study on infestation of sucking insect pests on Bt-cotton and non Bt- cotton fields in warangal –Telangana. *Int. J. Adv. Biol. Res.,* 4(2): 172-177.

Kumar, N., Niwas, R., Khichar, M.L., Saini, R.K., and Biswas, B. (2012) Sucking pest population of cotton crop in relation to agrometeorological parameters and spectral indices. *J. Agrometeorol.,* 14(2): 170-172.

Muchhadiya, D.V., Damasia, D.M., Saradava,. D.A. and Kabaria, B.B. (2014) Seasonal incidence of sucking insect pests of Bt cotton in relation to different weather parameters. *J. Agrometeorol.,* 16(2): 227-229.

Panwar, T.S., Singh, B.S. and Garg, V.K. (2015). Influence of meteorological parameters on population dynamics of thrips (*Thripstabaci* Lindeman) and aphid (*Aphis gossypii* Glover) in Bt and non-Bt cotton at Malwa region of Madhya Pradesh. *J. Agrometeorol*., 17(1): 136-138.

Patel, Y and Patel, P. (2014).Evaluation of cotton (*Gossypium hirsutum*L.) genotypes for their reaction to *Thripstabaci* Lindemann. *Res. Environ. Life Sci*., 7(4): 267-270.

Ratanoara, A., Sheikh, M., Patel, J.R., Patel, N.M. (1994).Effect of weather parameter on brinjal leaf hopper (*Amrasca biguttula*) Ishida. *Gujarat Agril. Uni. Res. J.,* 19: 39-43.

Sen, A. (2004). Cotton scenario in India. (http://www.indiaonestop.com/cotton/cotton.htm).

SPSS (2007). SPSS Inc. Released, SPSS for windows, version 16.0, Chicago, SPSS Inc.

USDA (2018). "World Agricultural Production". pp1-18. United States Department of Agriculture.

Venilla, S. (2008). Pest management for cotton ecosystem or ecosystem management for cotton production. *Curr. Sci.,* 94:1351-1352.

Received : August 2018 ; Accepted : October 2019