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Influence of meteorological parameters on population dynamics of thrips (*Thrips tabaci* Lindeman) in BT cotton

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Abstract
Studies were carried out to explore population dynamics and the impact of abiotic factors like maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, average weed speed, sunshine hours and rainfall on the population of thrips, (*Thrips tabaci* Lindeman) on twenty Bt cotton genotypes at Research Farm, Cotton Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar during *kharif* 2014 and 2015. Regression analysis was carried out with SPSS v19 software. In present studies, R^2 was found with a range of 0.00 to 0.73 i.e. population of thrips was influenced up to 73.00 per cent by the simple, multiple, hierarchical and stepwise linear regression models under Hisar conditions. Simple linear regression model during 2014 and 2015 revealed that minimum temperature (T_{min}) and evening relative humidity (RH_e) had higher impact (17.20 and 46.10 per cent) on the incidence of thrips, respectively. In multiple linear regression models, the impact of weather factors on the thrips in Bt cotton during 2014 exerted 58.20 per cent, 71.60 per cent during 2015 role in the thrips population fluctuation. Hierarchical linear regression models revealed that the impact on the fluctuation of thrips population increases with the addition of the influence of weather parameters in both the years. No stepwise linear regression model was observed during 2014. While, two stepwise linear regression models are developed during 2015. The evening relative humidity and rainfall exerted (58.20 per cent) impact in the fluctuation of thrips population in the combination while, evening relative humidity alone explained (46.10 per cent) role in the variation of thrips population on Bt cotton.

Keywords: Bt cotton, Regression Analysis, *Thrips tabaci*, weather parameters

Introduction
Thrips tabaci Lindeman (Thysanoptera: Thripidae) had recently attained the status of a regular pest on cotton in the Haryana. Thrips is the most important early season sucking pest on cotton [1]. Both the nymphs and adults lacerate the tissue and suck the sap from upper and lower surfaces of leaves, flowers and stem. In heavy thrips infestation, the leaves became slivery due to the formation of white patches or streaks which finally caused scarring and distortion of leaves and cup upward [2]. Thrips, a highly polyphagous pest, is a notable pest of the cotton crop in India, Sudan, Egypt, etc and of onions all over the world [3]. They are susceptible to environmental changes and because of the polyphagous nature of species, one can determine their abundance by the types of plant formations. They are also essential elements of the soil, occurring at depths of 10-30 cm in the soil [4]. Due to variation in the agro climatic conditions in every year, insects show varying trends in their incidence also in nature and extent of damage to the crop. Besides, some known and unknown factors also play a key role in determining the incidence and dominance of a particular pest or pest complex. Available scientific literature shows that not much information is available especially on the relation between the influences of various environmental factors on the fluctuation of thrips on cotton under Hisar region conditions of Haryana. Hence a region oriented study on thrips population in relation to the influence of weather parameters may be helpful in developing pest management strategy.

Materials and Methods
A field experiment was carried out during *kharif* 2014 and 2015 at Cotton Section, Department of Genetics and Plant Breeding, Hisar. The plots of 5 rows of 5 m of 21 genotypes were raised under unprotected conditions following recommended agronomic practices to study the seasonal incidence of thrips. The population of thrips was recorded at weekly intervals with the

initiation of pest and continued till the end of crop growth from 5 randomly selected plants with three replicates. Thrips were counted from three leaves, each from the top, middle and bottom canopies of the plant. Weather parameters like maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, average wind speed, sunshine hours and rainfall recorded in the meteorological observatory, CCS HAU, Hisar. Both years' data regarding thrips and weather were subjected to different regression analysis by using SPSS v19 to know the relationship between pest incidence and weather parameters.

Results and Discussion

In order to understand the relative importance of selected weather parameters in explaining the fluctuation of thrips population on Bt cotton, the partial regression coefficients of pest population on weather parameters were computed taking population of thrips as dependent variables and maximum temperature (T_{max}), minimum temperature (T_{min}), morning relative humidity (RH_m), evening relative humidity (RH_e), average wind speed (WS), sunshine hours (SS) and rainfall (RF) as independent variables. In simple regression analysis (table 1) the impact of weather factors on the population of thrips in Bt cotton genotypes during 2014 showed that minimum temperature exerted 17.20 per cent role in the thrips population variation which was highest than any other factors and which was followed by evening relative humidity (17.00 per cent). Whereas, the evening relative humidity contributed 46.10 per cent to the increment of thrips population, which was followed by morning related humidity (45.80 per cent) and maximum temperature (35.20 per cent). Similarly, in the pooled analysis, evening relative humidity was most important factor which contributed maximum i.e. 55.20 per cent in the fluctuation of thrips population followed by morning relative humidity (33.60 per cent) and sunshine hours (32.10 per cent). The impact of morning & evening relative humidity and minimum temperature were positive while maximum temperature had the negative impact on thrips population during both the years.

The multiple linear regression analysis presented in table 2 indicated that the total influence of all the weather parameters was high as compared to individual parameters on the population of thrips. It was upto 71.60 per cent of the population of thrips during the 2015 and upto 58.20 per cent during 2014. In pooled an analysis, all weather parameters exerted 73.00 per cent of variation in the thrips population.

The hierarchical linear regression analysis indicated that the relative importances of weather parameters in explaining the variation of thrips population are presented in table 3. The impact of weather factors on the population of thrips in Bt genotypes during 2014 showed that maximum temperature exerted 5.80 per cent influence on thrips population. This fluctuation was increased and reached up to 36.10 per cent when the influence of minimum temperature was added. When morning and evening relative humidity, average wind speed, sunshine hours and rainfall added, than the impact was 36.10, 45.00, 45.00 53.40 and 58.20 per cent on the thrips population fluctuation with the addition of weather parameters. Whereas, during 2015 the maximum temperature exerted 35.20 per cent impact on the variation on thrips and increase upto 57.20, 57.90, 59.00, 59.40, 61.20 and 71.60 per cent on addition on the influence of minimum temperature, morning and evening relative humidity, average wind speed, sunshine hours and rainfall, respectively. Similarly, the weather parameters explained 24.10 to 73.00 per cent role in fluctuation of thrips population under pooled analysis.

The stepwise linear regression model regarding the impact of weather factors on thrips population in Bt genotypes is showed in the table 3. There was none of the stepwise linear regression models were observed during 2014. While, during 2015 two stepwise linear regression models was determined. The first model explained 46.10 per cent of the variation in thrips population under the influence of evening relative humidity. The second model was the combination of evening relative humidity and rainfall, which exerted 58.20 per cent of fluctuation in thrips population.

The present findings are inline with the [5] who founded that the combination of all the weather parameters under hierarchical linear regression explained 75.60 per cent role in fluctuation of thrips population on Bt cotton. The results are also supported by [6] who reported that the variation of thrips population was explained upto 62.00 per cent in the influence of all-weather parameters. Similarly, the present findings are in agreement with finding of [7] who reported that the total influence of all-weather variables accounted for 69.70 per cent variation in thrips population. [8] also observed that the total population variation in thrips due to all weather variables was 70.00 per cent in cotton hybrids. However, these findings are not in conformity with [9] who concluded that the population of thrips can be explained upto 36.8 per cent under the influence of all the weather factors.

Table 1: Simple regression models along with coefficient of determination of individual weather factor on the population fluctuation of thrips on Bt genotypes

Year	Regression Equation	100 R^2
2014	Y = 38.41 – 0.81Tmax	5.80
	Y = -30.04 + 1.50Tmin	17.20
	Y = -7.18 + 0.21RHm	6.90
	Y = -5.89 + 0.31RHe	17.00
	Y = 3.86 + 0.67WS	1.50
	Y = 16.60 – 1.14SS	7.30
	Y = 9.21 – 0.08RF	3.20
2015	Y = 90.61 – 2.32Tmax	35.20
	Y = -41.14 + 2.00Tmin	29.40
	Y = -49.05 + 0.70RHm	45.80
	Y = -12.99 + 0.40RHe	46.10
	Y = -3.48 + 1.73WS	13.40
	Y = 18.77 – 1.51SS	19.70
	Y = 8.31 – 0.03RF	0.60
Pooled	Y = 83.34 – 2.06Tmax	24.10
	Y = -39.61 + 1.91Tmin	27.90
	Y = -40.39 + 0.62RHm	33.60
	Y = -20.64 + 0.59RHe	55.20
	Y = -1.77 +1.50WS	6.00
	Y = 27.55 – 2.68SS	32.10
	Y = 9.14 – 0.07RF	1.70

Table 2: Multiple regression models along with coefficient of determination of individual weather factor on the population fluctuation of thrips on Bt genotypes

Year	Regression Equation	100 R^2
2014	Y = 26.11 – 3.51Tmax + 4.11Tmin – 0.12RHm – 0.01RHe + 0.15WS + 2.46SS – 0.15RF	58.20
2015	Y = -51.73 – 1.03Tmax + 2.42Tmin + 0.47RHm – 0.06RHe + 0.59SS – 0.14RF	71.60
Pooled	Y = -17.91 – 1.49Tmax + 2.38Tmin + 0.20RHm + 0.10RHe + 0.14WS + 0.34SS – 0.18RF	73.00

Table 3: Hierarchical regression models along with coefficient of determination of individual weather factor on the population fluctuation of thrips on Bt genotypes

Year	Regression Equation	100 R^2
2014	Y = 38.41 – 0.81Tmax	5.80
	Y = 11.92 – 1.57Tmax + 2.16Tmin	36.10
	Y = 6.68 – 1.48Tmax + 2.15Tmin + 0.02RHm	36.10
	Y = 2.94 – 2.85Tmax + 4.33Tmin + 0.48RHm – 0.75RHe	45.00
	Y = 2.52 – 2.85Tmax + 4.33Tmin + 0.49RHm – 0.76RHe + 0.03WS	45.00
	Y = 77.65 – 4.92Tmax + 5.10Tmin – 0.33RHm – 0.17RHe – 0.82WS + 2.89SS	53.40
	Y = 26.11 – 3.51Tmax + 4.11Tmin – 0.12RHm – 0.01RHe + 0.15WS + 2.46SS – 0.15RF	58.20
2015	Y = 90.61 – 2.32Tmax	35.20
	Y = 39.37 – 2.08Tmax + 1.75Tmin	57.20
	Y = 13.15 – 1.59Tmax + 1.54Tmin + 0.17RHm	57.90
	Y = 9.91 – 1.97Tmax + 2.26Tmin + 0.29RHm – 0.20RHe	59.00
	Y = 3.36 – 1.90Tmax + 2.16Tmin + 0.36RHm – 0.24RHe + 0.43WS	59.40
	Y = 10.43 – 2.20Tmax + 2.19Tmin + 0.27RHm – 0.11RHe + 0.06WS + 0.77SS	61.20
	Y = -51.73 – 1.03Tmax + 2.42Tmin + 0.47RHm – 0.06RHe + 0.59SS – 0.14RF	71.60
Pooled	Y = 83.34 – 2.06Tmax	24.10
	Y = 43.26 – 2.53Tmax + 2.29Tmin	63.20
	Y = 4.52 – 1.81Tmax + 2.17Tmin + 0.20RHm	63.90
	Y = 2.05 – 2.11Tmax + 2.76Tmin + 0.30RHm – 0.18RHe	64.30
	Y = 6.63 – 1.99Tmax + 2.62Tmin + 0.20RHm – 0.06RHe – 0.66WS	64.80
	Y = 22.12 – 2.60Tmax + 2.96Tmin – 0.07RHm + 0.22RHe – 1.46WS + 1.49SS	67.00
	Y = -17.91 – 1.49Tmax + 2.38Tmin + 0.20RHm + 0.10RHe + 0.14WS + 0.34SS – 0.18RF	73.00

Table 4: Stepwise regression models along with coefficient of determination of individual weather factor on the population fluctuation of thrips on Bt genotypes

Year	Regression Equation	100 R^2
2014	-	-
2015	Y = - 12.99 + 0.40RHe	46.10
	Y = -14.59 + 0.48RHe – 0.12RF	58.20
Pooled	Y = -20.64 + 0.59RHe	55.20
	Y = -21.48 + 0.69RHe – 0.20RF	67.70

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