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PCRA based study for influence of weather parameters on incidence of whitefly, *Bemisia tabaci* (Gennadius) in brinjal

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Abstract
The present investigation was carried out during the *Kharif* crop season 2017-18 and 2018-19 at the Vegetable Research Centre, GBPUA&T, Pantnagar. The incidence of *B. tabaci* on brinjal was slightly higher in 2018-19 (8.00±0.18 adults/three leaves) as compared to 2017-18 (7.79±0.19 adults/three leaves). Brinjal whitefly populations showed a strong negative correlation with maximum temperature, minimum temperature, wind velocity, and evaporation while being positively correlated with morning relative humidity. Major factors *viz*., temperature (maximum and minimum), evening relative humidity, wind velocity, and evaporation influencing the *B. tabaci* population build-up were predicted using the PCRA technique with reasonable accuracy (R^2 =0.82).

Keywords: Abiotic factors, *B. tabaci*, brinjal, PCRA, population

Introduction
Brinjal is important solanaceous crop primarily grown by small farmers and holds a coveted position as they are the prime source of income for their livelihood (Gowda, 2016) [1]. The yield of both the crop suffers a major loss due to the attack of whitefly (*Bemisia tabaci* Genn.) as it causes serious infestation by feeding on their phloem (De Barro *et al.* 2011) [2]. This insect is a paramount vector for numerous viral diseases in both crops and causes severe monetary losses (Fariña, *et al.*, 2019) [3]. Brinjal crops serve as important reproductive hosts for *B. tabaci* from egg to adult stage (Shah and Liu, 2013) [4]. The cultivation brinjal in tropical countries is totally dependent on insecticide usage and as insecticides are hazardous to mankind and the environment, alternative measures are needed to be formulated (Broekgaarden *et al.* 2011) [5]. In this context, it has become important to study the impact of abiotic factors on whitefly in brinjal ecosystem (Sushmetha and Hariprasad 2020) [6].
The outbreak of whitefly under the influence of favourable weather conditions was also reported earlier by several workers (Das *et al.* 2011) [7]. The present investigation aims to investigate the influence of weather parameters on the population dynamics of *B. tabaci* on brinjal crops, which helps in providing the baseline information for the prediction of *B. tabaci* seasonal population build-up and their management.

Materials and Methods
The present investigation on seasonal incidence of whitefly on brinjal was conducted during the *Kharif* season of 2017-18 and 2018-19 at the Vegetable Research Centre, Govind Ballabh Pant University of Agriculture and Technology (29.50°N, 79.30°E). To study the seasonal incidence of whitefly, brinjal crop was transplanted on 25th September of the year 2017-19 on a plot size of 5 X 3 m^2. The recommended practices were followed to raise a healthy crop and insecticide application was avoided. Data on whitefly incidence was recorded at a weekly interval starting just after transplanting. For ascertaining the population of whitefly, ten plants were selected randomly and three leaves (upper, middle, and lower) were observed during the early morning hours when insects have minimum activity. Simultaneously, weather parameters *viz*., temperature, humidity, wind speed and, sunshine hours (Fig. 1a & 1b) were recorded during the entire period of the experiment and correlated with population build-up of *B. tabaci*. Principal Component Regression Analysis (PCRA) was used to develop the regression equation for prediction of *B. tabaci* population is done by using SPSS (Version 20, SPSS, Inc. Chicago, II, USA) and R program.

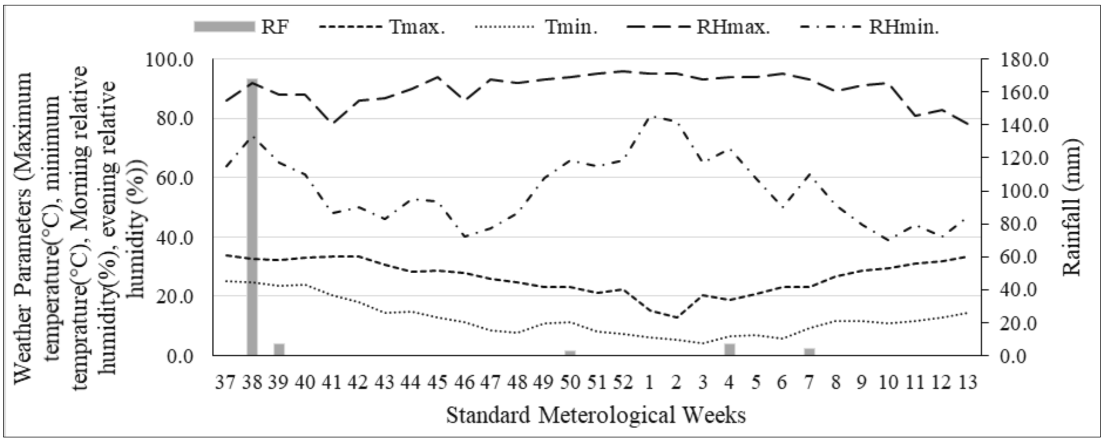

Fig 1a: Weekly weather parameters during 2017-18

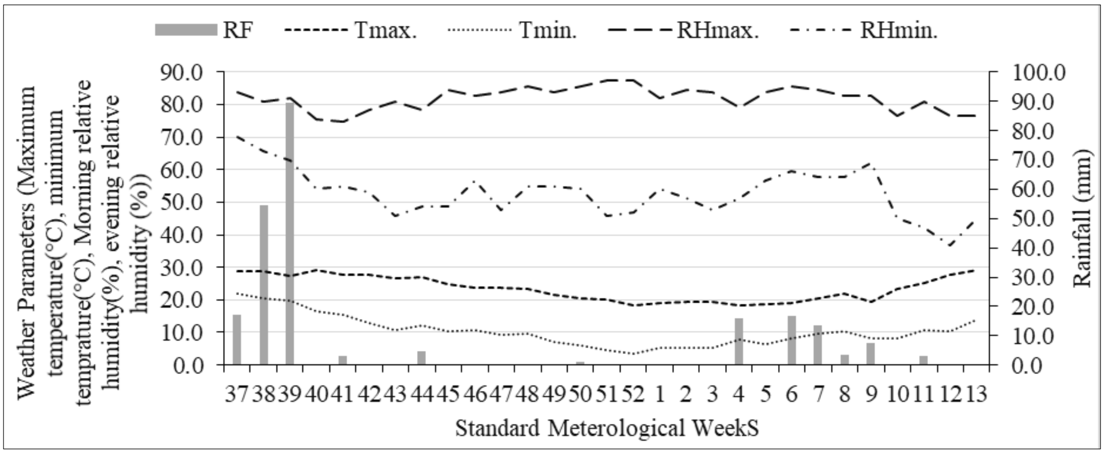

Fig 1b: Weekly weather parameters during 2018-19

Results and Discussion

Incidence of B. tabaci in brinjal and correlation with abiotic factors

During the years 2017-2019, the whiteflies were first appeared on brinjal during the 38th and 39th SMW and their population gradually increased with the advancement of the crop stages. The findings agreed with that of Deb and Bharpoda (2017) [8] since whitefly adults remain active on one or the other alternate hosts (crops and weeds) throughout the year before shifting to transplanting crops. The population of *B. tabaci* adults on the brinjal crop, ranged from 0.00 to 7.79±0.19 and 0.00 to 8.00±0.18 adults per three leaves (mean ± SE; N = 10), during 2017-18 and 2018-19 (Fig. 2). During both the years, the population attained its peak on brinjal during 51st SMW (7.79 adults per three leaves) and 50th SMW (8 adults per three leaves). These results followed the findings of Kataria and Pal (2014) [9] and Berragini *et al.* (2015) [10], who also recorded that during this period, maximum temperature (range: 21 to 26 °C) and minimum temperature (range: 6.60 to 10.90 °C), morning relative humidity (range: 92 to 95%) and evening relative humidity (range: 48 to 64%) are favorable for the multiplication and spread of *B. tabaci* in brinjal and that this could be due to the differences sowing time and prevailing climatic conditions.

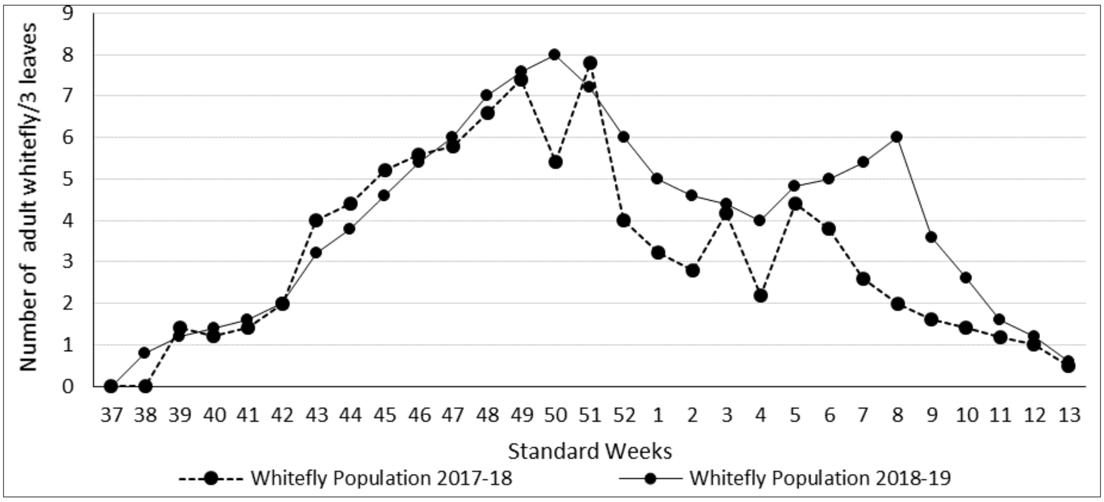

Fig 2: Seasonal incidence of *B. tabaci* on brinjal in relation to climatic factors during 2017–2019

The correlation studies in brinjal (Table 1) revealed that whitefly exhibited a significant negative correlation with Tmax. (r = -0.63), Tmin. (-0.67) and Evap. (r = -0.76) (Fig. 3a & 3b). Similar results were also obtained by Indirakumar *et al.* (2016) [11]. However, contrary to this, Janu and Dahiya (2017) [12], reported that the maximum temperature, minimum temperature and, morning relative humidity were significantly and positively correlated with the *B. tabaci* population, which might be due to different ecological conditions and their interaction with the insect. The findings of present studies indicated that low rainfall had no or very little adverse effect on adult whitefly which is well supported by the finding of Sitaramaraju *et al.* (2010) [13]. Whitefly adult population in brinjal showed a significant negative correlation with wind speed (r =-0.61). Khan *et al.* (2010) [14] also reported that wind speed adversely affected the whitefly adult population and blown off or the whitefly may move to the lower canopy.

Table 1: Correlation matrix (Pearson's) for weather-based observations with *B. tabaci* population in brinjal from 2017–2019

Variables	BWf	Tmax.	Tmin.	RHmax.	RHmin.	RF	SSH	WS
Tmax.	**-0.63****							
Tmin.	**-0.67****	0.87**						
RHmax.	**0.70****	-0.77**	-0.58*					
RHmin.	**NS**	NS	NS	0.44*				
RF	**NS**	NS	0.52**	NS	0.48**			
SSH	**NS**	0.70**	NS	-0.61**	-0.72*	NS		
WS	**-0.61****	NS	0.57**	NS	NS	0.62**	NS	
Evap.	**-0.76****	0.88**	0.69**	-0.82**	0.41*	NS	0.74**	0.46*

BWf: whitefly adult population/3 leaves on brinjal; Tmax: maximum temperature (°C); Tmin: minimum temperature (°C); RHmin: minimum relative humidity (%); RHmax: maximum relative humidity (%); RF: rainfall (mm); SSH: sunshine (Hrs.); WS: wind velocity (Km-h) and Evap.: evaporation(mm). Bold digits in the table indicate the "–" correlation data; data followed by '*' indicates their significant correlation at $P< 0.05$ and data followed by '**' indicate their significant correlation at $P< 0.01$; NS: not significant

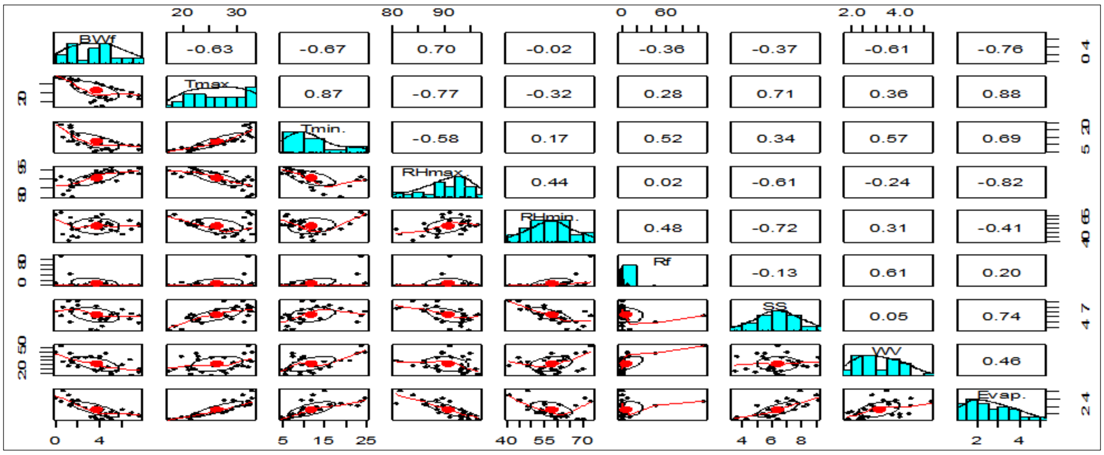

Fig 3: Correlation coefficient between weather parameters and number of populations build of *Bemisia tabaci* per three leaves in brinjal during 2017-19

PCRA based prediction of B. tabaci population in brinjal

Principal component regression analysis indicated that 82.36% variability was shown by the two PCs (Principal Components) *viz.* PC-1 (Tmax., Tmin., RHmax., SSH, and Evap.) and PC-2 (RHmin., RF and WS). The variation expressed by PC-1 and PC-2 was found to be 52.64 and 29.71%, respectively (Table 2). In brinjal crop RHmin., RF and SSH were not considered by PC-1 to develop principal component regression (PCR) due to the non-significant or slight correlation with the whitefly population. In brinjal crop RHmin., RF and SSH showed non-significant correlation hence, in PC-1 and PC-2 having SSH and RHmin., RF respectively, were not used for PCR. Similar results were observed by Shera *et al.* (2013) [15]. As a result, a strategy should be devised to reduce pest and disease attacks through agronomic manipulation.

Y_1= 0.349 Tmax. - 0.147 Tmin. + 0.275 RHmax. -0.263 WS - 1.342 Evap. (at $P< 0.05$; $R^2 = 0.82$).

Y_1 = adults whitefly/3 leaves in brinjal

Table 2: Principal components (PCs) with Eigen values and variances in *B. tabaci* population in brinjal

PCs	Variables	Eigen value %	Variance	Cumulative % of Variance
1.	Tmax., Tmin., Rhmax., SSH, Evap.	4.21	52.64	52.64
2.	RHmin., RF, WS	3.38	29.71	82.36

Conclusion

This study revealed that whitefly population build-up is high during November and December months and it spreads very fast during these months. Thus, during this period the scheduling and executing management strategies can play a crucial role in sustainable vegetable cultivation. The involvement of abiotic factors for the prediction or development of a Decision Support System for infestation and dynamics of whitefly play a significant role in pest management.

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