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Shivani Khokhar
Department of Entomology, CCS Haryana Agricultural University, Hisar, Haryana, India

Krishna Rolania
Department of Entomology, CCS Haryana Agricultural University, Hisar, Haryana, India

Deepika Kalkal
Department of Entomology, CCS Haryana Agricultural University, Hisar, Haryana, India

Correspondence
Shivani Khokhar
Department of Entomology, CCS Haryana Agricultural University, Hisar, Haryana, India

Influence of weather parameters on seasonal abundance of whitefly on tomato in Haryana

Shivani Khokhar, Krishna Rolania and Deepika Kalkal

Abstract
A field experiment was conducted during *Rabi*, 2016-2017 to ascertain the influence of various meteorological parameters on population fluctuations of Whitefly, *Bemisia tabaci* on tomato at Entomological Research Area, CCS Haryana Agricultural University, Hisar. Whitefly infestation commenced during 9th Standard meteorological week (SMW) *i.e.* first week of March, reaching up to a maximum level (5.78 whitefly adults/ 3 leaves) during 3rd week of April (16th SMW). Whitefly population exhibited significant and negative correlation with evening relative humidity (r= -0.718) whereas it was non-significantly correlated with all other weather parameters *viz.*, maximum and minimum temperature, sunshine hours, rainfall, morning humidity and wind velocity. Multiple linear regression analysis showed that out of total variability in whitefly population due to all weather parameters, 52 per cent (R^2=0.52) variability was accounted by evening relative humidity.

Keywords: *Bemisia tabaci*, population dynamics, weather, correlation, regression

Introduction
Vegetables play an important role in providing nutritional security to population around the world as they are the important source of micro-nutrients, vitamins and minerals. Among different commercially cultivated vegetable crops, tomato (*Solanum lycopersicum)* is grown around the world for fresh market consumption and considered as second most important vegetable crop of the world. It is cultivated throughout the world either outdoors or indoors, majorly in China, India, U.S.A, Turkey, Egypt, Iran, Italy, Spain, Brazil, Mexico etc. India with 19.70 million MT production over an area of 8.09 lakh Ha is the second largest producer of tomato in the world [1]. Climatic variability of India provides huge scope for tomato cultivation due to which it is cultivated all around the year in different parts of the country. Despite this, a considerable amount of tomato produce is destroyed by the attack of a number of insect-pests during different crop growth stages. Among different biotic stresses to tomato crop, white fly (*Bemisia tabaci*) is an important pest causing serious threat to open field vegetable production but crop grown under greenhouses are equally affected [9]. Both nymph and adults of whitefly causes damage to tomato plant in three ways *viz.*, direct damage, indirect damage and virus transmission [2]. It commonly flies early in the morning up to mid-day and the adults have limited ability to direct their flight [3]. The extent of crop losses associated with whitefly and its sudden worldwide dispersal prompted a keen extensive interest in all aspects of its seasonal abundance and its biology. To effectively manage this insect pest, the crop should be visually and meticulously examined for signs of whitefly infestation. Establishment of the link between the populations of a whitefly, time of their appearance and duration for which it is likely to cause damage to the tomato crop at a critical growth stage and the ensuing yield loss by the pest are of paramount importance for working out the economic threshold level for the whitefly. Before developing any insect pest management programme for a definite agro ecosystem, it is crucial to have basic knowledge on abundance and distribution pattern of pest in relation to weather parameters, as it assist in determining suitable time of action and desired effective method of control. Considering the economic importance and nature of damage of this pest, it is a pre requisite to record its seasonal fluctuation and its association with different meteorological parameters for adopting suitable control measures in a particular region. Keeping this in view, the present investigation was carried out with the objective of assessing the seasonal incidence of whitefly on tomato and for assessing its correlation with different abiotic factors prevailing in that particular agro-ecosystem.

Materials and methods

The present investigation was conducted at Research Farm, Department of Entomology, CCS Haryana Agricultural University, Hisar during *Rabi* 2016-17.

Transplanting: Nursery of the tomato crop *cv*. Selection-7 was procured from Department of Vegetable science, CCS Haryana Agricultural University, Hisar and it was transplanted in a flat bed of 100 m^2 by adopting spacing of 60 cm × 45 cm in the second week of February, 2017. The whole bed was divided into 4 replicates of 5 m × 5 m each. All the recommended package of practices was followed to raise the crop except the crop protection measures.

Observations Recorded: Observations on *B. tabaci* population were recorded at weekly interval starting from 15 days after transplanting (DAT) during morning hours between 6.30 AM to 8.00 AM. Whitefly adults were counted by randomly selecting three leaves from top, middle and bottom of the crop canopy of 10 plants per quadrate and population was expressed as whitefly per three leaves. The weekly meteorological data on different weather parameters was procured from Agro meteorological observatory, Department of Agrometeorology, CCS Haryana Agricultural University.

Statistical Analysis: Correlation Co-efficient and regression of whitefly population with different weather parameters was estimated using OPSTAT software.

Results and Discussion

The critical observation of *B. tabaci* population during different standard meteorological weeks (Table 1) clearly showed that whitefly adults were first recorded during first week of March (9th SMW) and it remained active until crop maturity. Maximum population (5.78 whitefly adults/3 leaves) was recorded during 3rd week of April (16th SMW) when maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, sunshine and wind velocity were 42.93 °C, 22.81 °C, 45.29 per cent, 19.00 per cent, 9.90 hrs/day and 4.00 km/hr., respectively (Fig. 1, 2 and 3). Afterwards it showed a declining trend with minimum number (0.24 whitefly adult/3 leaves) during 22nd SMW *i.e.*, last week of May (Table 1). Present findings are in agreement with Subba (2013) who recorded maximum whitefly population during 11th to 18th SMW on tomato crop [4]. Meager information is available in literature regarding population dynamics of whitefly on tomato in Haryana conditions. However, whitefly remained active from November to March until crop harvesting with maximum population (11.85/10 cm twig) during first week of March [5]. During mid February, maximum population density (1.68 whitefly/plant) was recorded and relatively higher infestation of whitefly were maintained during mid February to mid March when favorable temperature (17.07 ˚C), relative humidity (65.29 %) and rainfall (5 mm) for whitefly build up were prevalent [8]. These variations in whitefly population could be due to different set of weather parameters and different growing seasons. Correlation co-efficient: B. tabaci population was found to be non-significantly and positively correlated with maximum temperature and minimum temperature (Table 2). In contrast to this, it exhibited significant and negative correlation with evening relative humidity (r= -0.718). Similarly, it was positively correlated with maximum temperature, minimum temperature and sunshine hours while it was negatively correlated with rainfall and relative humidity [6, 7]. In contradiction to our findings, positive correlation with evening relative humidity and rainfall has also been reported [5]. A negative correlation between whitefly population and morning relative humidity was also recorded [5]. These variations in our experiment might be due to difference in agro-climatic conditions. All the weather parameters when regressed on whitefly population showed that evening relative humidity contributed 52 per cent to whitefly population fluctuation (Table 3 and Figure 4). Similar results were given by some researchers who reported 97.1 and 89 per cent contribution of weather parameters towards the fluctuations in aphids and whitefly population [7].

Table 1: Population build-up of Whitefly, *Bemisia tabaci* during different standard meteorological weeks on tomato crop during *Rabi,* 2016- 17

SMW	Whitefly per three leaves	Maximum Temperature (˚C)	Minimum Temperature (˚C)	Morning relative humidity (%)	Evening relative humidity (%)	Rainfall (mm)	Sunshine hrs./day	Wind velocity (km/hr)
9	1.94	26.90	8.30	92.00	37.00	0.00	9.00	3.00
10	1.98	25.60	9.70	88.90	45.40	1.10	7.60	4.80
11	1.66	25.07	7.36	90.14	39.86	0.00	8.30	2.70
12	3.64	32.01	13.64	90.00	33.71	0.00	9.20	2.80
13	5.52	36.30	16.69	85.00	30.29	0.00	9.64	2.80
14	5.48	35.73	17.47	67.57	27.43	0.00	6.89	7.24
15	5.56	37.19	14.00	59.43	15.71	0.00	10.26	3.16
16	5.78	42.93	22.81	45.29	19.00	0.00	9.90	4.00
17	4.36	38.53	20.71	53.71	23.71	0.14	7.90	4.97
18	3.22	38.87	21.04	57.29	22.71	0.00	8.24	5.00
19	3.48	42.63	24.90	55.14	22.43	0.20	8.17	4.79
20	2.46	41.37	26.03	49.43	23.29	0.00	9.01	5.43
21	1.62	40.86	25.76	57.00	28.71	0.00	8.24	4.40
22	0.24	38.11	24.73	73.71	47.14	4.40	9.09	8.76

Table 2: Correlation of whitefly population with weather parameters

Weather parameter	Number of Whiteflies/3 leaves
Maximum Temperature (^{0}C)	0.331
Minimum Temperature (^{0}C)	0.015
Morning Relative humidity (%)	-0.323
Evening Relative humidity (%)	-0.718**
Sunshine (hours/day)	0.228
Rainfall (mm)	-0.548
Wind velocity (km/hr)	-0.275

** Significant at 1%, *Significant at 5%

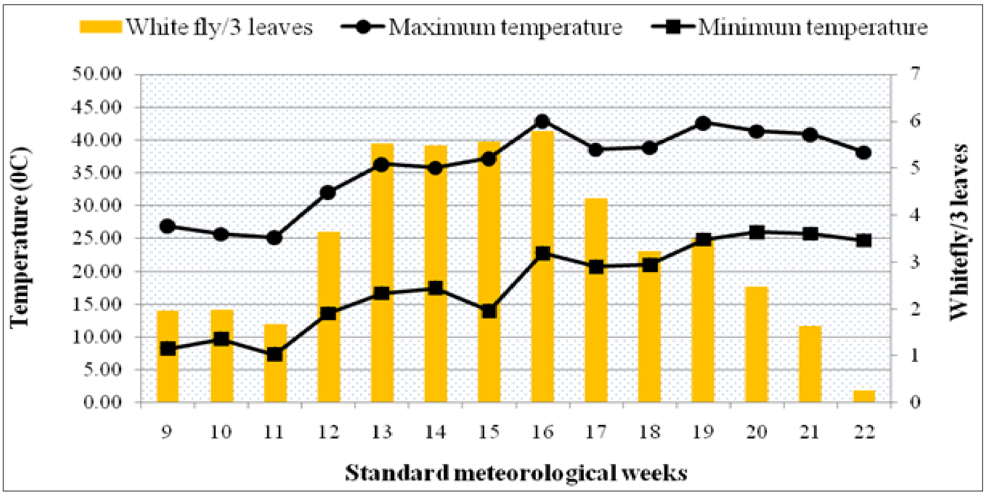

Fig 1: *B. tabaci* adult population in relation to maximum and minimum temperature on tomato during *Rabi*, 2016-17

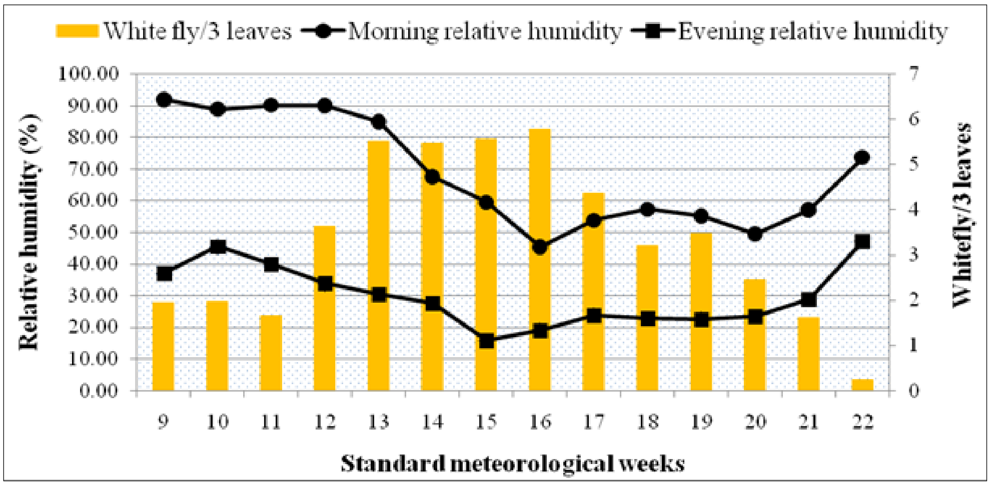

Fig 2: Population of whitefly in relation with relative humidity (morning and evening) on tomato during *Rabi*, 2016-17

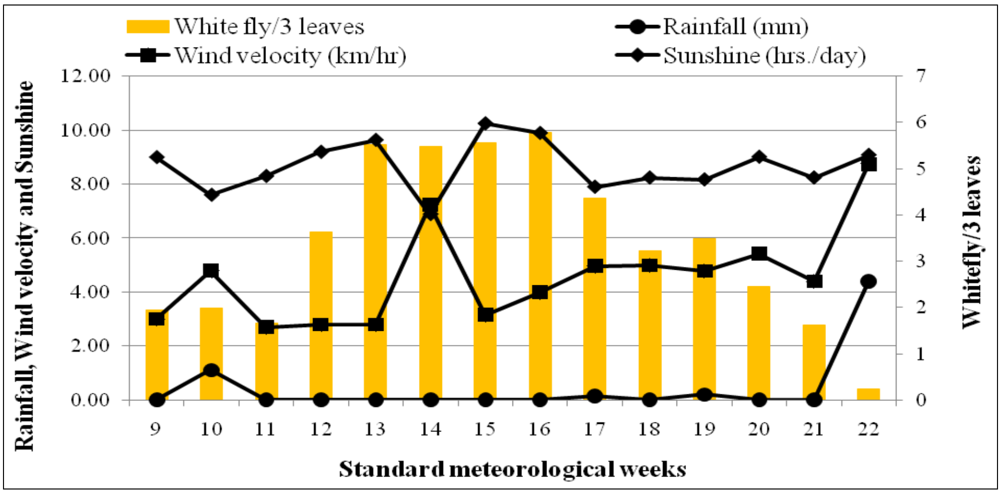

Fig 3: Population dynamics of whitefly in relation to rainfall, sunshine hours and wind velocity on tomato during *Rabi*, 2016-17

Table 3: Regression equation of *B. tabaci* adult population with weather parameters

	Regression equations	R^2
Whitefly	1. Y= 7.287-0.132X	0.52

Y: Whitefly; X: Evening relative humidity (%)

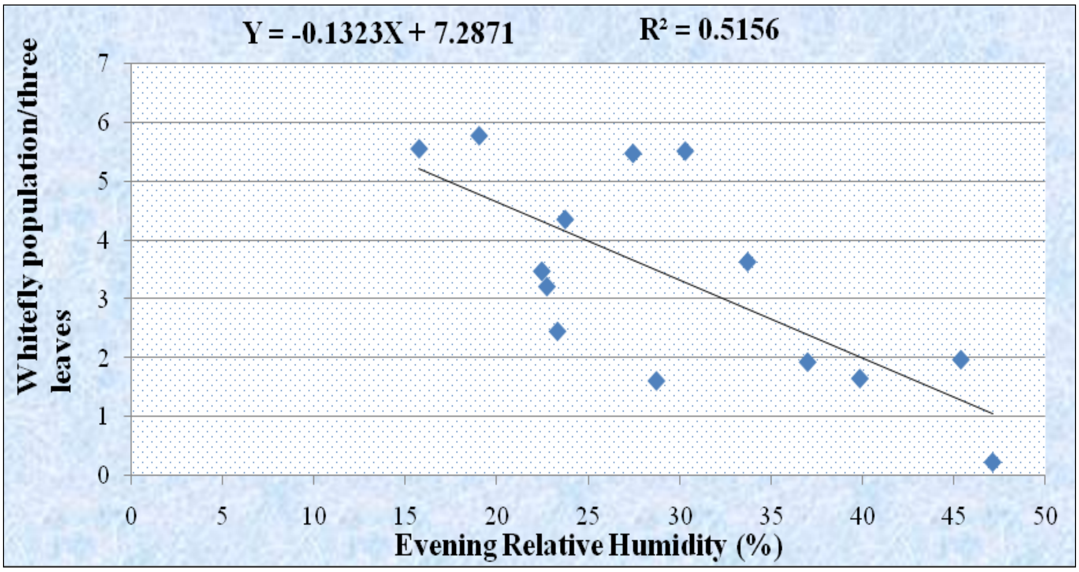

Fig 4: Linear regression equation of *B. tabaci* with evening relative humidity.

Conclusion

Whitefly population was first recorded during 9th SMW and remained active until the crop maturity. Maximum whitefly population was recorded during 16th SMW and thereafter, a declining trend was observed with minimum number during 22nd SMW. Multiple linear regression studies revealed that all the weather parameters accounted for 91 per cent variations in whitefly population and out of this, 52 per cent was contributed alone by evening relative humidity. Population of whitefly had a significant negative correlation with evening relative humidity whereas non-significant positive correlation with sunshine hours, maximum and minimum temperature.

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