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Influence of weather factors on the incidence of whitefly, *Bemisia tabaci* Genn. on tomato in Chhattisgarh plain

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Abstract
A experiments on incidence of whitefly, *Bemisia tabaci* (Gennadius) in Tomato, (*Solanum lycopersicum* Mill) was studied during 2016-17 and 2017-18 at the area of Horticulture Research cum instructional farm of vegetable science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. On the basis of pooled mean various abiotic parameters *viz.* Maximum temperature and minimum temperature *viz.* whitefly were showed negative highly significant impact on the population of whitefly but in case of rain fall, evening relative humidity and wind velocity show negative non-significant impact were shown. During this period, pooled two year mean maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, rainfall, wind velocity and sunshine was 29.2 ^{0}C, 10.9 ^{0}C, 85%, 24.5, 0 mm, 1.7 Km hr-^{1} and 8.7 hr day-^{1} respectively. The maximum whitefly was noticed during third week of January (3rd SMW) with 4.62 adult plant^{-1}. There was a non-significant negative trend of correlation between the adult population and rain fall, wind velocity and evening relative humidity with 'r' value of -0.053, -0.431 and -0.002 at 5 per cent level of significance but in case of morning relative humidity (r = 0.396) and sunshine (r = 0.001) positive correlation was observed. But in case of maximum (-0.643**) and minimum (-0.729**) temperature negative highly significant correlation with whitefly was observed and regression line was worked out for no. of whitefly laid $Y= 15.26-0.43X_1$ and $Y=7.36-0.38X_2$, R^2 0.41 and 0.53.

Keywords: Tomato, whitefly, abiotic factors, correlation, non-significant.

Introduction
Tomato (*Solanum lycopersicum* Mill) is one of the most important vegetables in the world, ranking second in importance to potato in many countries. It is a warm season crop. It is grown as an off-season vegetable in the hill of India and farmers fetch good income after sending their produce in the plains from June to September. Tomato provides vitamins C and adds variety of colours and flavors to the foods. Large quantities of tomatoes are used prepare soup, juice, ketchup, puree, pickle, paste and powder (Choudhary 2002) [3]. Vegetable production can be adopted as a strategy for improving livelihood and alleviating status of the people. Tomato is a rich source of vitamins A, C and E and minerals that are very good for health (Olaniyi 2010) [2]. Tomato (*Solanum esculentum* Mill.) is a popular and widely grown vegetable in the world. Among the various sucking insect-pests, whitefly (*Bemesia tabaci* Genn.) is one of the destructive pests causing serious damage to tomato crop and is responsible for lowering its yield (De Barro *et al*., 2011) [1]. In sucking up the insect pest complex, the whitefly is important as it provides direct damage to the crop. The yield losses due to direct and indirect damage caused by whitefly have been recorded as a percentage of 20 to 100 per cent (Rapisarda and Garzia, 2002) [4].

Material and Methods
Population of tomato whitefly, *Bemesia tabaci* Genn. Adult were recorded during the year 2016-17 and 2017-18 at Raipur districts of Chhattisgarh. The population of whiteflies, *Bemesia tabaci* Genn. adult was observed on 5 randomly selected plants. Population of whitefly were taken on 6 leaves per plant *viz.* (two upper, two middle and two lower plant canopies). For the case of study and findings, meteorological data were pooled out at weekly interval". Among weather parameters relative humidity (morning and evening), maximum temperature, minimum temperature and rainfall were considered for correlating with occurrence of the insects pests of tomato (Shukla *et al*., 2005, Meena *et al*., 2010) [12, 13].

To work out the relationship between the occurrence of the insect pests of tomato and the weather parameters, correlation and multiple linear regressions (MLR) method was adopted (Panse and Sukhatne, 1985) [14].

Results and Discussion

The data on infestation of whitefly, *Bemisia tabaci* was first appeared in first week of December with 1.20 whitefly plant^{-1}. Maximum whitefly were (5.56 adult plant^{-1}) noticed during third week of January (3rd SMW) (Table 2 & Fig. 2); during this period rainfall (0 mm), maximum (28.9 ^{0}C) and minimum (11.8 ^{0}C) temperature, morning relative humidity (85%), evening relative humidity (27%), wind velocity (1.2 Km/h) and bright sunshine hours (8 hours/day) prevailed during 2016-17 (Table 1). Thereafter, the whitefly was gradually decreased and reached 0.12 whitefly plant^{-1} during first week of March. The numbers of whitefly was correlated with prevailing rainfall, temperature, relative humidity, sunshine hours and wind velocity. There was a non-significant negative correlation between the whitefly population and wind velocity and sunshine with 'r' value of -0.419 and -0.344, respectively (Table 3) but in case of maximum (-0.671**) and minimum (-0.641**) highly significant negative correlation with whitefly observed and regression line was worked out for no. of whitefly laid Y= 12.52-0.32X_1 and Y=6.21-0.26X_2, R^2 0.27 and 0.25 (Table 4). Where, 'Y' was estimated number of whitefly which explained by regression equation for any value of independent variable (X_1= Maximum temperature and X_2= Minimum temperature) and R^2 was number of whitefly population which explained by regression equation. Rain fall (0.044), morning (0.402) and evening (0.251) relative humidity was observed non-significant positive trend of correlation.

However, during the year 2017-18 the number of whitefly population was first appeared in first week of December (0.53 whitefly plant^{-1}). The maximum no. whitefly (4.62 adult plant^{-1}) were noticed during last week of January (5th SMW) (Table 2 & Fig. 2). During this period rainfall, maximum and minimum temperature, morning relative humidity, evening relative humidity, wind velocity and bright sunshine hours were recorded 0.0 mm, 30.8 ^{0}C, 11.0 ^{0}C, 80%, 17%, 2.6Km/h & 9.8 hours/day, respectively (Table 1). Thereafter, the no. whitefly laid gradually decreased 0.23 adult plant^{-1} during last week of February. Similarly, there was a non-significant negative trend of correlation was found between the adult population and rain fall, evening relative humidity and wind velocity with 'r' value of -0.128, -0.359 and -0.309, respectively at 5 per cent level of significance but in case of morning relative humidity (r = 0.327) and sunshine (r = 0.336) positive trend of correlation was observed (Table 3). But in case of maximum (-0.525*) negative significant and minimum (-0.715**) highly negative significant correlation with whitefly observed and regression line was worked out for no. of whitefly laid Y= 11.28-0.31X_1, Y=5.95-0.32X_2, R^2 0.27 and 0.51 (Table 4). Where, 'Y' was estimated number of whitefly which explained by regression equation for any value of independent variable (X_1= Maximum temperature and X_2= Minimum temperature) and R^2 was number of whitefly population which explained by regression equation Where, 'Y' was no. of adult and X was prevailing weather parameters (Table 4).

On the basis of pooled mean of the number of adult of whitefly, *Bemisia tabaci* was first appeared in first week of December with 0.87 adult plant^{-1}. The peak population (4.62 adult plant^{-1}) was observed during third week of January (3rd SMW) (Table 2 & Fig. 2). During this period the pooled rainfall (0 mm), maximum (29.2 ^{0}C) and minimum (10.85 ^{0}C) temperature, morning relative humidity (85%), evening relative humidity (24.5%), wind velocity (1.7 Km/h) and bright sunshine hours (8.65 hours/day) prevailed (Table 1 & Fig. 1). Thereafter, the adult number gradually decreased & reached 0.06 adult plant^{-1} during first week of March. There was a non-significant negative trend of correlation between the adult population and rain fall, wind velocity and evening relative humidity with 'r' value of -0.053, -0.431 and -0.002 at 5 per cent level of significance but in case of morning relative humidity (r = 0.396) and sunshine (r = 0.001) positive correlation was observed. (Table 3). But in case of maximum (-0.643**) and minimum (-0.729**) temperature negative highly significant correlation with whitefly was observed and regression line was worked out for no. of whitefly laid Y= 15.26-0.43X_1 and Y=7.36-0.38X_2, R^2 0.41 and 0.53 (Table 4) Where, 'Y' was estimated number of whitefly which explained by regression equation for any value of independent variable (X_1= Maximum temperature and X_2= Minimum temperature) and R^2 was number of whitefly population which explained by regression equation Where, 'Y' was no. of adult and X was prevailing weather parameters (Table 4).

Present findings are in confirmation with those of Arnal *et al.* (1998) [5]; Chaudhuri *et al.* (2001) [6] and Reddy and Kumar (2004) respectively. They also reported that white flies, *Bemisia tabaci* Genn to be an important sucking pest of tomato and were present throughout the growing period of the crop. Similarly Arnal *et al.* (1998) [5] and Barde (2006) [8] also reported that peak activity of the pest was observed during 6th SMW to 9th SMW (*i.e.* second week of February to first week of March). Weather parameters played a key role in the development of whitefly (*B. tabaci*) population on tomato. *Bemisia tabaci* population expressed was positive correlation with rainy days (0.389), relative humidity evening (0.275) and maximum temperature (0.106). Also found negative with minimum temperature (-0.193) and relative humidity morning (-0.060). These findings are in agreement with that of Abdel *et al.* (1998) [9]. Similarly Kaur *et al.* (2010) [10] and Anzola and Lastra (2008) [11] also reported that the correlation between meteorological parameters and whitefly population was negatively correlated with total rainfall might be due to destruction of eggs, nymphs and pupae of whitefly during continuous rains.

Table 1: Weekly meteorological data recorded during the crop growth period 2016-17 and 2017-18 IGKV, RAIPUR

Meteorological Week No.	Month	Date	Max. Temp (^{0}C)	Min. Temp (^{0}C)	Rainfall (mm)	Relative humidity (%) Morning	Relative humidity (%) Evening	Wind Velocity	Sun shine (hr day^{-1})
48	November	26-02	30.2	12.5	0.0	86.0	26.5	1.5	8.7
49	December	03-09	28.7	13.7	0.0	87.5	34.5	1.9	8.0
50	December	10-16	29.3	12.1	0.0	84.0	29.0	2.0	8.3
51	December	17-23	28.2	9.9	0.0	86.5	26.5	1.7	8.2
52	December	24-31	28.3	9.7	0.0	85.5	26.0	1.5	8.1

1	January	01-07	28.0	11.1	0.0	80.0	29.0	1.8	7.1
2	January	08-14	27.7	11.0	2.8	82.5	29.0	2.3	7.7
3	January	15-21	29.2	10.9	0.0	85.0	24.5	1.7	8.7
4	January	22-28	29.3	12.3	0.0	83.0	27.0	2.1	8.1
5	January	29-04	30.6	11.5	0.0	74.5	21.5	2.1	9.6
6	February	05-11	31.8	15.2	0.0	79.5	30.0	2.2	7.8
7	February	12-18	29.7	15.2	8.2	84.5	36.0	3.3	7.4
8	February	19-25	33.8	15.6	0.0	73.0	19.5	2.4	9.8
9	February	26-04	34.9	16.5	0.0	74.5	18.5	2.3	9.6
10	March	05-11	33.9	19.4	2.8	67.0	29.0	3.4	7.1
11	March	12-18	33.6	18.7	0.6	65.5	25.5	3.7	7.6

Table 2: Seasonal weekly incidence of whitefly, *Bemisia tabaci* during the crop growth period of tomato at weekly interval during *rabi* 2016-17 and 2017-18

SMW	DATE	Whitefly plant^{-1}		
		2016-17	2017-18	Pooled
48	26 Nov-02 Dec	0.00	0.00	0.00
49	03 Dec-09 Dec	1.20	0.53	0.87
50	10 Dec-16 Dec	2.12	1.12	1.62
51	17 Dec-23 Dec	3.10	1.30	2.20
52	24 Dec-31 Dec	3.60	2.96	3.28
1	01 Jan-07 Jan	4.52	2.68	3.60
2	08 Jan-14 Jan	5.21	3.21	4.21
3	15 Jan-21 Jan	5.56	3.68	4.62
4	22 Jan-28 Jan	3.12	4.02	3.57
5	29 Jan-04 Feb	3.36	4.62	3.99
6	05 Feb-11 Feb	2.86	2.12	2.49
7	12 Feb-18 Feb	2.71	1.15	1.93
8	19 Feb-25 Feb	1.80	0.72	1.26
9	26 Feb-04 March	0.53	0.23	0.38
10	05 March-11 March	0.12	0.00	0.06
11	12 March-18 March	0.00	0.00	0.00
Seasonal Mean		2.49	1.77	2.13

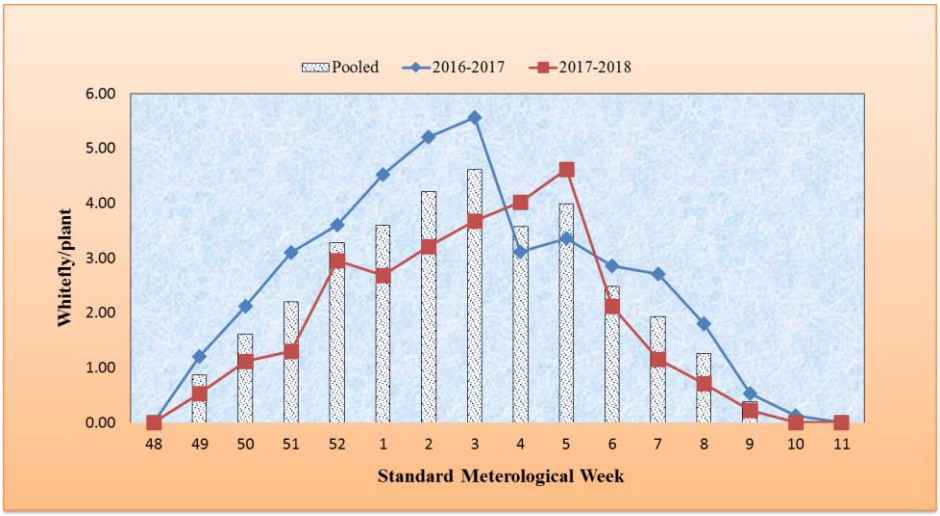

Fig 1: Whitefly population on tomato during 2016-17 and 2017-18

Table 3: Correlation coefficient on the incidence of whitefly, aphid and jassid of tomato with weather parameters

Correlation coefficient (r)			
Weather parameter	Whitefly		
	2016-17	2017-18	Pooled
Maximum Temperature (^{0}C)	-0.671**	-0.525*	-0.643**
Minimum Temperature (^{0}C)	-0.641**	-0.715**	-0.729**
Rain fall (mm)	0.044	-0.128	-0.053
Morning relative humidity	0.402	0.327	0.396
Evening relative humidity	0.251	-0.359	-0.002
Wind velocity (km/h)	-0.419	-0.309	-0.431
Sunshine hours (hours)	-0.344	0.336	0.001

*: Significant (5%)
**: Highly significant (1%)

Table 4: Regression line analysis for whitefly with maximum temperature and minimum temperature during 2016-17 and 2017-18:-

Regression equation			R^2		
2016-17	**2017-18**	**Pooled**	**2016-17**	**2017-18**	**Pooled**
$Y= 12.52-0.32X_1$	$Y=11.28-0.31X_1$	$Y=15.26-0.43X_1$	0.27	0.27	0.41
$Y=6.21-0.26X_2$	$Y=5.95-0.32X_2$	$Y=7.36-0.38X_2$	0.25	0.51	0.53

Where,
Y= Estimated of whitefly
X_1= Maximum temperature (^{0}C)
X_2= Minimum temperature (^{0}C)
R^2= Coefficient of Determination

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