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Effect of variable weather parameters with special reference on whitefly in tomato ecosystem under new gangetic alluvial zone

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Abstract
Tomato (*Solanum lycopersicum* L.) is one of the most economically important vegetables in India among the small-scale farmers of India. Whitefly is the most vital sucking pest of tomato that causes severe damage throughout the crop season. Whiteflies secret a sticky substance known as honeydew, that causes sooty mould on plant. Minimum numbers of whiteflies are not generally harmful and adults will not cause significant damage indirectly they are transmitting plant viruses. The whitefly population went up to the highest extent of 3.24/ three leaves (Av. 0.76/ three leaves) on winter- spring crop during crop season 2013-14. During 2014-15 also, the winter-spring crop only harboured the maximum whitefly population, 8.00/three leaves (av.1.58/three leaves). Peak whitefly populations during the two crop growing seasons were recorded to occur within the 3rd to 10th standard week when weekly minimum and maximum temperature, minimum and maximum relative humidity, minimum and maximum sunshine hour per day and minimum and maximum total rainfall range were 7.61- 32.07 °C, 43.43- 94.86%, 3.20-10.17 hour/day and 9.00- 28.5 mm respectively over the two experimental years. Population of whitefly revealed that maximum temperature and average temperature had negative significant correlation (r=-0.569* and r=-0.557*) but minimum relative humidity and average relative humidity(r=0.625* and r=0.601*) showed positive significant correlation for winter-spring crop. There was no significant correlation found with other weather parameters during 2014-15 crop seasons.

Keywords: Tomato, hemiptera, whitefly, population dynamics, weather parameters

1. Introduction
Tomato (*Solanum lycopersicum* L.) is one of the most economically important vegetables in India among the small-scale farmers of India. It is now available throughout the year. It is the second vegetable crop (after potatoes) of higher consumption and more popular as garden crop in the world [3]. It is an excellent source of phosphorus, iron and vitamin A, B and C [2-7]. In developing countries, it constitutes an important component in human diet. Even though large amount of cultivars of tomato has been generated and marketed. Tomato plants are host for many insects. All parts of the plant use for shelter, food and reproduction sites for the insects. Whitefly (*Bemisia tabaci* Gennadius) Hemiptera: Aleyrodidae is the most vital sucking pest of tomato that causes severe damage throughout the crop season. Whiteflies secret a sticky substance known as honeydew, that causes sooty mould on plant. Minimum numbers of whiteflies are not generally harmful and adults will not cause significant damage indirectly they are transmitting plant viruses. Virus symptoms are irregular ripening in tomatoes and blanching in carrots and broccoli. When present in large numbers, whitefly feeding can affect on plant growth causing distortion, discoloration, yellowing or silvering of leaves. Some species of whitefly have a wide host range and the silver leaf whitefly attacks more than 500 species.
Pest phenology of tomato is the occurrence and succession of insect populations, its synchronization with different growth stages of tomato crop relating to the different weather parameters. Therefore, correlation and regression analysis were computed to quantify the strength of the relationship between abundance of insect populations with weather parameters on different staggering tomato crops grown throughout the crop growing seasons of 2013-14 and 2014-15.

2. Material and Methods

2.1. Location of study

The field experiments were carried out at the Central Research Farm of the university, Gayeshpur, Nadia, West Bengal (Geographical location- Latitude 23°N, Longitude 89°E, Altitude 9.75m msl). The meteorological data were collected from AICRP on Agrometrology, Directorate of Research, BCKV, Kalyani, and Nadia.

2.2. Experimental practices & Data recording

The experiment was laid out in Randomized Block Design (RBD) with three replication and recommended agronomical practices were followed except the use of any plant protection chemicals. The experiment of tomato was done in both the crop seasons of 2013-14 and 2014-15 in three different growing seasons *viz.* early sowing, standard sowing and late sowings crop. In this experiment the variety, 'Trishul' has been raised successively one month interval starting from 5th November, 2013 during first season and 3rd November, 2014 during second season.

Thirty days old seedlings were transplanted in 10m x 10m plot size with 60 cm x 70 cm spacing. Recommended agronomic practices Occurrences of the sucking insect pests of tomato were recorded at weekly interval in the early morning starting from one week after transplanting in all three replications. The observations on whitefly population were recorded from three leaves per plant *i.e*., from top, middle and bottom portion of the plants from 20 randomly selected tagged plants from the plot. Observations on aphid were recorded from one square centimeter area from top, middle and bottom portion of the 20 randomly selected tagged plants from the each plot.

2.3. Statistical analysis

Data were analyzed and correlation between insect's population and weather parameters was done by using SPSS version 16.0 software analysis of variance following Randomized Block Design (RBD).

3. Results and Discussion

3.1 Whiteflies (*Bemisia tabaci* Gennadius)

The insect population went up to the highest extent of 3.24/ three leaves (Av. 0.76/ three leaves) on winter- spring crop during crop season 2013-14. During 2014-15 also, the winter-spring crop only harboured the maximum whitefly population, 8.00/three leaves (av.1.58/three leaves). Peak whitefly populations during the two crop growing seasons were recorded to occur within the 3rd to 10th standard week (SW) (Table 1 and 2) when weekly minimum and maximum temperature, minimum and maximum relative humidity, minimum and maximum sunshine hour per day and minimum and maximum total rainfall range were7.61- 32.07 °C, 43.43-94.86%, 3.20-10.17 hour/day and 9.00- 28.5 mm respectively over the two experimental years. (Table 1and 2; Fig1and 2).

Present findings were in proximity to the findings that high infestation levels of whitefly population were maintained from mid-February (5th-6th SW) to mid-March (9th-10th SW) when temperature, relative humidity (RH), sunshine hour/day and rainfall were 17.07-22.13 °C, 65.29-72.78%, 7.79-8.9 hour/day and 5 mm, respectively [1]. However, the peak population of whiteflies was observed when maximum temperature ranged from 32 °C to 35 °C and minimum temperature ranged from 23 °C to 26 °C, morning relative humidity 84 to 93 per cent and evening relative humidity 58 to 67 per cent, wind velocity 4.7 to 6.3 kmph, sunshine hours 6.5 to 8.9 hrs and zero rainfall was favourable for multiplication of whiteflies [5].

Our observations had few differences with that of these authors during 2013-14 correlation coefficient between different weather parameters and population of whitefly revealed that maximum temperature and average temperature had negative significant correlation (r=-0.569* and r=-0.557*) but minimum relative humidity and average relative humidity (r=0.625* and r=0.601*) showed positive significant correlation for winter-spring crop. There was no significant correlation found with other weather parameters during 2014-15 crop seasons. [6] Reported negative correlation with maximum and average temperature [4] noted negative significant correlation for maximum and minimum temperature but positive correlation with morning and evening relative humidity.

The multiple regression analysis between occurrences of whitefly and the weather parameters showed that all the parameters together were responsible for population variation of the whitefly population with R2 value ranging from 0.311 to 0.533 in different crop season.

Table 1: Pattern of occurrence and phenology of whitefly population recorded on autumn-winter, winter and winter-spring crops of tomato during 2013-14

Standard week	Population of Whitefly/three leaf			Temperature (^{0}C)			Relative Humidity (%)			Total Rainfall (mm)	Sunshine (hour/day)
	Autumn-Winter Crop	Winter Crop	Winter-Spring Crop	Max.	Min.	Average	Max.	Min.	Average		
46	0.54	-	-	29.20	20.10	24.65	96.51	66.86	81.69	42.40	5.40
47	0.69	-	-	30.10	16.90	23.50	93.71	51.29	72.50	0.00	7.90
48	0.75	-	-	30.00	17.00	23.50	89.14	47.86	68.50	0.00	7.20
49	0.66	-	-	28.60	11.70	20.15	91.57	41.86	66.72	0.00	8.10
50	0.60	-	-	29.00	10.70	19.85	90.86	42.57	66.72	0.00	8.00
51	1.26	0.15	-	27.40	16.00	21.70	96.29	68.29	82.29	7.30	3.70
52	1.29	0.24	-	24.00	12.20	18.10	98.29	61.14	79.72	0.00	5.20
1	0.84	0.30	-	20.00	8.70	14.35	96.71	71.57	84.14	0.00	3.10
2	1.20	1.59	-	24.90	11.00	17.95	95.43	54.00	74.72	1.90	4.10
3	0.39	0.54	0.63	23.00	7.61	15.31	94.29	48.57	71.43	0.00	5.17
4	0.96	2.40	3.24	27.71	12.29	20.00	90.86	53.71	72.29	0.00	4.59
5	0.54	1.86	2.28	24.31	8.23	16.27	94.86	43.43	69.15	0.00	8.43
6	0.75	1.59	1.17	26.79	9.57	18.18	92.00	47.14	69.57	0.00	5.14
7	0.99	1.41	0.39	29.16	13.31	21.24	90.43	44.43	67.43	0.00	7.29
8	1.35	1.80	0.54	28.16	13.29	20.73	89.00	47.14	68.07	0.00	6.40
9	0.60	0.36	0.21	29.63	13.37	21.50	94.00	43.00	68.50	9.00	9.47

10	0.99	0.80	0.54	32.07	14.34	23.21	90.14	34.71	62.43	0.00	10.17
11	0.60	0.40	0.20	35.61	16.61	26.11	88.00	30.43	59.22	0.00	9.17
12	-	0.50	0.24	35.96	22.86	29.41	89.86	41.29	65.58	0.00	5.99
13	-	-	0.15	37.59	20.81	29.20	91.14	33.71	62.43	0.00	8.44
14	-	-	0.20	37.76	22.66	30.21	84.14	32.57	58.36	0.00	7.30
15	-	-	0.15	39.37	24.21	31.79	84.43	26.29	55.36	0.00	9.19
Mean ±SD	0.83 ±0.29	1.00 ±0.75	0.76 ±0.95	-	-	-	-	-	-	-	-

Table 2: Pattern of occurrence and phenology of whitefly population recorded on autumn-winter, winter and winter-spring crops of tomato during 2014-15

Standard week	Population of Whitefly/three leaf			Temperature (^{0}C)			Relative Humidity (%)			Total Rainfall (mm)	Sunshine (hour/day)
	Autumn-Winter Crop	Winter Crop	Winter-Spring Crop	Max.	Min.	Average	Max.	Min.	Average		
45	2.85	-	-	31.00	19.30	25.15	89.86	60.43	75.15	0.00	8.40
46	0.84	-	-	29.80	15.10	22.45	81.00	50.14	65.57	0.00	9.50
47	0.66	-	-	29.20	15.00	22.10	80.71	52.14	66.43	0.00	7.60
48	0.81	-	-	29.50	15.80	22.65	80.29	60.29	70.29	0.00	6.70
49	1.40	0.60	-	27.90	13.90	20.90	83.14	57.43	70.29	0.00	7.60
50	2.16	0.65	-	27.30	12.80	20.05	84.00	56.86	70.43	0.00	6.20
51	2.31	1.00	-	27.50	11.40	19.45	82.43	60.29	71.36	0.00	4.70
52	1.50	1.40	-	26.30	12.50	19.40	86.71	58.71	72.71	0.00	6.10
1	1.10	0.50	-	24.70	10.20	17.45	84.71	57.43	71.07	0.00	7.00
2	0.90	0.60	0.39	24.01	8.77	16.39	82.57	59.86	71.22	0.00	5.43
3	0.99	0.50	0.39	22.31	11.90	17.11	91.14	70.57	80.86	0.00	3.20
4	0.90	1.10	0.09	25.80	11.67	18.74	86.57	63.71	75.14	0.00	6.83
5	0.69	0.80	1.00	24.90	9.50	17.20	87.71	58.86	73.29	0.00	7.44
6	0.21	1.50	1.50	29.13	11.44	20.29	85.86	48.14	67.00	0.00	8.27
7	0.60	2.50	8.00	29.03	14.14	21.59	81.43	47.86	64.65	0.00	6.94
8	0.60	1.60	5.50	26.20	13.04	19.62	85.86	59.14	72.50	28.50	7.70
9	0.21	0.21	2.20	29.66	17.01	23.34	86.71	56.14	71.43	0.00	6.43
10	-	0.06	1.20	30.11	15.59	22.85	85.00	50.43	67.72	0.00	8.09
11	-	-	1.59	33.50	17.69	25.60	84.29	43.57	63.93	0.00	7.19
12	-	-	1.41	35.83	19.33	27.58	83.43	40.43	61.93	0.00	9.01
13	-	-	0.21	35.76	22.37	29.07	91.00	53.14	72.07	0.00	7.91
14	-	-	0.00	37.19	23.50	30.35	86.00	40.14	63.07	0.00	9.06
15	-	-	0.21	38.64	24.54	31.59	87.29	37.57	62.43	0.00	8.66
16	-	-	0.00	39.50	24.73	32.12	85.29	37.57	61.43	0.00	8.34
Mean ±SD	1.10 ±0.73	0.93 ±0.65	1.58 ±2.26	-	-	-	-	-	-	-	-

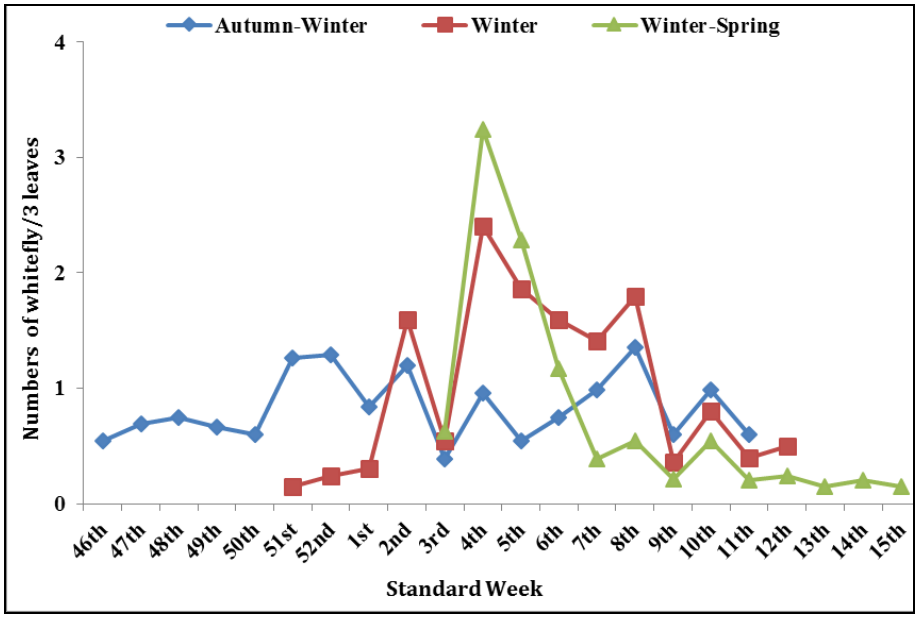

Fig 1: Natural occurrence and population fluctuation of whitefly as recorded during 2013-14

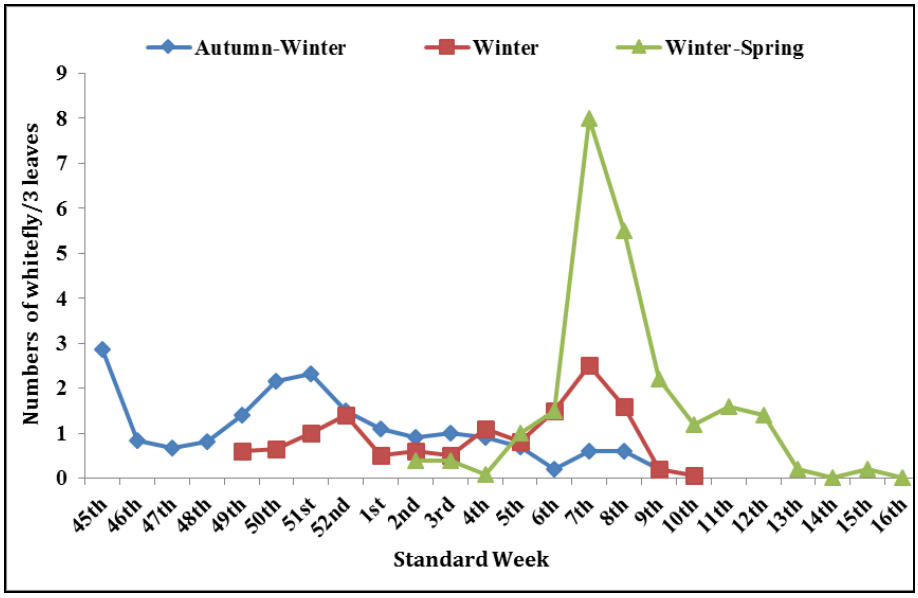

Fig 2: Natural occurrence and population fluctuation of whitefly as recorded during 2014-15

4. Conclusion

The whitefly population went up to the highest extent of 3.24/ three leaves (Av. 0.76/ three leaves) on winter- spring crop during crop season 2013-14. During 2014-15 also, the winter-spring crop only harboured the maximum whitefly population, 8.00/three leaves (av.1.58/three leaves). Peak whitefly populations during the two crop growing seasons were recorded to occur within the 3rd to 10th standard week when weekly minimum and maximum temperature, minimum and maximum relative humidity, minimum and maximum sunshine hour per day and minimum and maximum total rainfall range were 7.61- 32.07 °C, 43.43- 94.86%, 3.20-10.17 hour/day and 9.00- 28.5 mm respectively over the two experimental years. Population of whitefly revealed that maximum temperature and average temperature had negative significant correlation (r=-0.569* and r=-0.557*) but minimum relative humidity and average relative humidity (r=0.625* and r=0.601*) showed positive significant correlation for winter-spring crop. There was no significant correlation found with other weather parameters during 2014-15 crop seasons.

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