Environment and Ecology 42 (3B) : 1358—1363, July—September 2024
Article DOI: https://doi.org/10.60151/envec/ZFSU4861
ISSN 0970-0420

Impact of Weather Parameters on the Incidence of Major Insect Pests of Tomato (*Lycopersicon esculentum* Mill.) in Varanasi Region

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Received 15 September 2023, Accepted 10 May 2024, Published on 4 September 2024

ABSTRACT

A field experiment was conducted at the Agricultural Research Farm, Institute of Agricultural Sciences, BHU, Varanasi during *rabi* season 2021- 2022 with cultivar Kashi Aman to study the impact of weather parameters on incidence of major pests infesting tomato. The first appearance of aphid (0.10 aphids/plant), thrips (0.50 thrips/plant), whitefly (0.62 whitefly/plant) and fruit borer (0.10 borer/plant) was observed during 47th, 51st, 49th, and 51st SMW respectively. However, the highest incidence of major insect pests of tomato such as aphids (25.95 aphids/ plant), thrips (8.90 thrips/plant), whitefly (7.37 whitefly/plant) and fruit borer (4.31 larvae/plant) was noticed from mid of February to mid of March. The correlation coefficient of aphids and thrips with weather parameters revealed a non-significant positive correlation with rainfall, and relative humidity, while whitefly population revealed a positive non-significant correlation with relative humidity and temperature. The correlation between the weather factors and *H. armigera* larvae revealed a non-significantly positive correlation with rainfall, morn, even, avg, relative humidity (r = 0.048, r = 0.014, r = 0.180) respectively. But we also noticed negative non-significant correlation with max, min, and avg temperature (r = -0.038, r = -0.023 and r = -0.033). Thus, their timely and appropriate management strategies would be helpful for the farmer who are engaged in tomato cultivation and this work also developed ideas to initiate management tactics when they really need to control economic damage pest below economic threshold level (ETL).

Keywords Weather parameter, Insect pest, Incidence, Tomato, Correlation coefficient.

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INTRODUCTION

Tomato (*Lycopersicon esculentum*) first reported in western South America. This crop also known as the poor man's apple, (Maurya *et al.* 2022) is the 3rd most important vegetable crop after the potato and onion in India. It is practically grown every country

of the world in open as well as protected areas. In Uttar Pradesh, it is grown in an area of 0.458 million hectares with an annual production of 7.27 million tonnes (Pandey *et al.* 2017). In tomato fruit contain vitamins like 'A' and 'C' and antioxidant in abundance quantity. Due to the unique properties contained in its fruit, tomato demand remains almost the same throughout the year (Roberts and Matoo 2018). Tomato crop is succulent and susceptible to various biotic and abiotic stresses throughout the cropping season. Among them insect pests and diseases are major biotic stresses that can affect tomato crop during the stage of development. About 41 insect-pest species belonging to 21 families cause significant loss in the tomato crop, including defoliators (*Monolepta andrawesi, Spodoptera litura, Atractomorpha crenulata,* and *Poekilocerus pictus*), sucking pests (*Aphis gossypii, Myzus persicae, Bemisia tabaci*), leaf miners (*Liriomyza trifolii*), fruit borers *Helicoverpa armigera* and fruit sucking moth *Othreis fullonica* (Reddy and Kumar 2004). Due to variability in the agro-climatic conditions of different regions, there are various factors play an important role in the abundance of insect pests, their nature, and the extent of crop damage (Wade *et al.* 2020). Furthermore, some known and unknown weather factors also helps in occurrence in the form of sometime shown dominance of a specific pest complex. Pest abundance and distribution changes with abiotic factors and therefore meteorological parameters play a pivotal role in the biology of any pest (Mathur *et al.* 2012). Tomato are attacked by a large number of insects, but only a small number of these are capable of causing economic losses. Oriented basis estimation would thus provide an idea about the peak period of pest activity and also beneficial in the development of management strategies for studying insect pest abundance in the region. There is significantly less information about the major insect pests, their relationship with weather parameters. As a result, the present studied were carried out with the population buildup of major insect pest of tomato in relation to these abiotic factors in the Varanasi region.

MATERIALS AND METHODS

The experiment was conducted at the Agricultural Research Farm, Institute of Agricultural Sciences, BHU, Varanasi during *rabi* season 2021- 2022 with cultivar Kashi Aman. The experimental design was Randomized Block Design with 7 treatments, including control, replicated thrice in plot. All the agronomic practices and plant protection measures are timely adopted for better growth and development of crop. The observations on major insect pests (Fig.1) were recorded on 5 randomly selected plants of the crop in a standard week from transplanting to till the availability of insects. Observations on sucking and major insect pests population (nymphs and adults) of aphid, thrips, whitefly and fruit borer were taken on 9 leaves plant viz. (three upper, middle and lower plant canopies) was recorded by gently tapping over a sheet of white paper and in case of fruit borer, per cent fruit infestation was recorded on plant as per the method proposed by Kumar (2008). The influences of differ-

Fig. 1. Damage symptoms of major insect pests recorded on tomato (a) Adult of whitefly feeding underside the leaf, also causing vector of viral diseases, (b) Fruit borer feeding by inserting head on fruits causing economic losses of tomato crop, (c) Active aphid sucking sap from tender shoots and leaves.

Table 1. Weekly meteorological data and incidence of major pests infesting tomato during *rabi* 2021-2022.

Month	Date	Standard metrologica week (SMW)	Rainfall (mm)	Relative humidity (%)		Wind speed (km/hr)	Temperature (°C)			Aphid	Thrips	Whitefly	Fruit borer
				Mor.	Even.		Max	Min	Avg				
Nov	19-25	47	0	90	40	1	28.7	12.2	20.4	0.10	0	0	0
Nov/Dec	26-2	48	0	97	51	0.4	26.7	10.6	18.6	0.15	0	0	0
Dec	3-9	49	0	97	54	0.6	26.8	12.8	19.8	1.70	0	0.62	0
Dec	10-16	50	0	94	44	0.5	24.6	8.6	16.6	5.10	0	1.10	0
Dec	17-23	51	0	91	53	1.1	22.3	7.2	14.7	9.50	0.50	0.40	0.10
Dec	24-31	52	8.6	97	72	1	21.9	10	15.9	7.79	1.10	1.27	0.50
Jan	1-7	1	1.2	98	75	0.9	19.2	8.8	14	14.12	0.80	2.36	1.17
Jan	8-14	2	5.4	96	74	1.4	22.1	11.8	16.9	16.9	1.10	2.40	1.90
Jan	15-21	3	0	93	70	1.6	18.5	6.7	12.6	17.10	3.50	1.12	1.09
Jan	22-28	4	49	94	68	3.1	20	9.8	14.9	15.70	4.10	1.32	1.88
Jan/Feb	29-04	5	4.3	94	61	3.7	22.7	8.6	15.6	20.10	6.80	3.25	1.86
Feb	5-11	6	0	94	57	2.9	22.6	9.6	16.1	25.95	5.60	5.15	2.10
Feb	12-18	7	0	92	47	2.6	25	7.9	16.4	24.12	7.80	5.32	3.30
Feb	19-25	8	0.3	90	59	3.7	26.7	12.3	19.5	21.30	7.92	6.86	4.15
Feb /Mar	26-04	9	0.4	95	53	1.9	28.6	12.5	20.5	22.28	8.90	7.37	3.79
Mar	5-11	10	0	89	54	2.4	29.7	13.5	21.6	22.90	6.20	6.92	4.31
Mar	12-18	11	0	89	53	2.4	32.9	16.6	24.75	15.25	3.80	4.62	2.10
Mar	19-25	12	0	85	49	2.3	36.5	19.3	27.9	3.70	1.70	2.35	0.40
Mar	26-31	13	0	79	39	3.1	38	18.6	28.3	0.13	0.08	0.25	0

ent meteorological parameters on major insect pest population were studied by graphical super imposition technique. The data has been analyzed statistically along with the tables and graphs mentioned in Tables 1 – 2 and Fig. 2. The percentage of infestation was calculated by the following formula-

$$\text{Percent fruit damage} = \frac{\text{Number of damage fruits}}{\text{Total number of fruits}} \times 100$$

RESULTS AND DISCUSSION

Present investigation carried out with impact of weather parameters on the incidence of major insect pests of tomato in Varanasi region during *rabi* season 2021- 2022. Lots of insect pest were associated with the tomato crop, out of which only four insects were observed viz., the aphids (*Aphis gossypii*), thrips (*Frankiniella schultzei*), whitefly (*Bemisia tabaci*), and tomato fruit borer (*Helicoverpa armigera*) and correlation coefficient of insect population with abiotic factor (weather parameters) are mentioned in (Tables 1–2) and their association with weather factors are representation in Fig. 2.

Aphid

The incidence of aphid was noticed from 13th standard metrological week (SMW) to 47th SMW. Initially the aphid population was noticed with 0.10 aphids/plant at 7 DAT. After that their population steadily increased and reached its peak value (25.95 aphids/ plant) during 6th SMW followed a remarkable decrease after 10th SMW. The correlation between the population of aphids and weather parameters revealed a non-sig-

Table 2. Correlation coefficient of weather parameters with major insect population during *rabi* 2021-2022.

Factor	Rainfall	Mor RH	Eve RH	Wind speed	Max temp	Min temp	Avg. temp
Aphid	0.087^{NS}	0.194^{NS}	0.393^{NS}	0.564*	-0.368^{NS}	-0.334^{NS}	-0.361^{NS}
Thrips	0.054^{NS}	-0.001^{NS}	0.080^{NS}	0.698**	-0.058^{NS}	-0.115^{NS}	-0.082^{NS}
Whitefly	-0.161^{NS}	-0.033^{NS}	0.046^{NS}	0.545*	0.111^{NS}	0.097^{NS}	0.108^{NS}
Fruit borer	0.048^{NS}	0.014^{NS}	0.180^{NS}	0.589**	-0.038^{NS}	-0.023^{NS}	-0.033^{NS}

*Significant at 0.01 level, ** Significant at 0.05 level, NS- Non-significant.

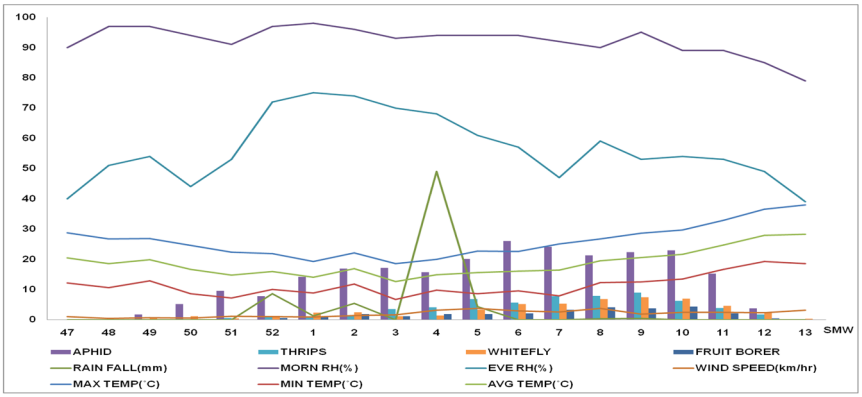

Fig. 2. Interaction of weather parameters and abundance of the major insect pests population in tomato during 2021-22.

nificant positive correlation with rainfall, and relative humidity (r = 0.087, r = 0.194 and r =0.393 respectively). However, it showed a negatively non-significant correlation with temperature (r = -0.368, r = -0.334, r = -0.361 respectively) while remaining environmental factors play significantly role in aphids multiplication presented in Table 2. The pest multiplied at a faster rate during last of January to mid of February, after that aphid intensity gradually decrease till to maturity of tomato crop. Similar trend of observation were reported by Singh *et al.* (2021) the highest population of aphids viz., 117.6, 102.2, 109.2 and 91.8/plant were recorded during all SMW of February. During this period, the crop was in vegetative phase with succulence, which provide better feeding condition for aphids. Our findings also justified (Mandloi *et al.* 2015) reported that peak population of the aphid seen during the February and March SMW with a negative and non-significant correlation with minimum, maximum and average temperature while positive and non- significant with rainfall, morning and evening relative humidity.

Thrips

The first occurrence of *F. schultzei* was during 51st SMW with 0.50 thrips/plant at 31 DAT, when the rainfall, max, min, avg, temperature, morn, even, avg relative humidity, and wind speed were 0.00 mm, 22.3°C, 7.2°C, 14.7°C, 91.00%, 53.00%, 72.00%, and 1.1 km/hr, respectively. The number of insects had steadily increased afterwards and reached its peak (8.90 thrips/ plant) at 106 DAT in the 9th SMW (rainfall, max, min, avg temp, morn, even, average RH, wind speed was 0.4 mm, 28.6°C, 12.5°C, 20.5°C, 95.00%, 53.00%, 74.00%, 1.9 km/hr., respectively) followed by a gradual decrease in population (Table 1). The correlation analysis between the weather factors and number of thrips revealed a positively non-significant correlation with rainfall, evening RH (r = 0.054, r = 0.080 respectively), yet it showed negatively non-significant correlation with maximum temperature minimum temp, average temp and morning relative humidity (RH) (r= -0.058, and r = -0.115, r= -0.082, r= -0.001 respectively) (Table 2). Present observations were more or less similar with the results of earlier workers Sri *et al*. (2017) and Mondloi *et al*. (2015) who reported that the peak incidence of thrips has been found to take place during 7th SMW with maximum, minimum and average relative humidity was significant negatively correlated with thrips population.

Whitefly

The incidence of whitefly was recorded from 49th SMW to 13th SMW,, while during 47th and 48th SMW there are no incidence of whitefly population due to unfavorable abiotic condition. The initial population of pest was 0.62 whiteflies/plant when rainfall, max., min., avg. temperature, morn. even. avg. relative humidity, and wind speed were 0.00 mm, 26.8°C, 12.8°C, 19.8°C, 97.00%, 54.00%, 75.5%, and 0.6 km/hr. respectively. The number of whitefly incidence

was steadily increase and at the 9th SMW their population was on peak level (7.37 whiteflies/plant) (rainfall, max., min., avg. temp., morn., even., avg relative humidity, and wind speed were 0.4 mm, 28.60°C, 12.50°C, 20.5°C, 95.00%, 53.00%, 74.00.%, 1.9 km/hr respectively). After that, the number of whiteflies slowly decreased. The correlation analysis between whitefly population and weather parameters revealed a positive non-significant correlation with even RH, max temp, min temp, avg temp (r = 0.046, r = 0.111, r = 0.097 and r =0.108, respectively). Nevertheless, it showed a non-significantly negative correlation with rainfall and morning relative humidity (r = -0.161 and r = -0.033 respectively) has been shown in Fig. 2 through the interaction with weather parameters. Similar, finding have been represented by Mandloi *et al.* (2015) and Sri *et al.* (2017) the activity period of *B. tabaci* was observed from 45th to 12th SMW with two distinct peak during 7th and 9th SMW (9.84 and 11.85 whiteflies/10 cm twig). The highest peak was observed 9th SMW (11.85 flies/10 cm twig). During this period maximum and minimum temperature favor the incidence and correlation coefficient between various weather parameters and *B. tabaci* population expressed no significant relationship. Whitefly is a very harmful pest on tomato; it is responsible for transmits leaf curl virus. It sucks food form leave, so deformation of young leaves observes. Whiteflies also excrete honeydew, causing sooty molt.

Tomato fruit borer

The fruit borer incidence recorded throughout the cropping season. There are no fruit borer occurrence pointed from 47th to 50th and 13th SMW. The first appearance of fruit borer larvae recorded with mean number of 0.10 larvae/plant during 51st SMW, when the abiotic factors were favor for growth and development of fruit borer occurrence. The number of *Helicoverpa armigera* larvae population gradually increased and its peak period (4.31 larvae/plant) at 110 DAT in the 10th SMW (rainfall, max., min., avg. temperature, morn, even, avg relative humidity, and wind speed were 0.00 mm, 29.70 °C, 13.50 °C, 21.6 °C, 89.00%, 54.00%, 71.50%, and 2.4 km/hr respectively) followed by a steady population decreased during 11th and 12th SMW. The correlation between the weather factors and number of larvae revealed a non-significantly positive correlation with rainfall, morn, even, avg, relative humidity (r = 0.048, r = 0.014, r = 0.180 respectively) but we also noticed negative non-significant correlation with max, min, and avg temperature (r = -0.038, r = -0.023 and r = -0.033 respectively) (Table 1). According to Singh *et al.* (2021) fruit borer infestation appeared from mid of the December to last of the March. The highest infestation of *H. armigera* was recorded during January-February. However, correlation coefficient (r) of weather parameters revealed that significant positive impact with relative humidity and rainfall. These results also supported by Sharma *et al.* (2012) and Kharpuse and Bajpai (2006) exhibited significant positive correlation with temperature, but positive and non-significant with rainfall.

CONCLUSION

Tomato is an economic important vegetable crop after potato, growing by many farmers. It is hampered by several biotic, physico-chemical and abiotic factors. Among them biotic factors i.e., sucking pests and fruit borers are the most devastating constraints in tomato crop. This crop having carotenoids like lycopene, zeaxanthin and beta-carotene that helps in procured risk of heart disease is an area of health benefits. The production and quality of tomato fruits are considerably affected by array of insect pests infesting at different stages of crop growth. The population of aphids appeared on the crop a week after transplanting from November and attained their peak population during 2nd week of February. Whiteflies started to appear from first week of December and maximum population recorded during 4th week of February. The population of thrips and fruit borer appeared in the 3rd week of December. However, the maximum activity of major insect pests of tomato such as aphids, thrips, whiteflies and fruit borer was noticed from mid of February to mid of March. The population fluctuation was correlated with the abiotic factors (temperature, relative humidity, precipitation, wind speed, and dew). Weather parameters play an important role in the occurrence and distribution pattern of major pests of tomato. Thus, their timely and appropriate management strategies would be helpful for the farmer who are engaged in tomato cultivation and this work

also developed ideas to initiate management tactics when they really need to control economic damage pest below economic threshold level (ETL).

ACKNOWLEDGMENT

I behalf of first author extend my sincere gratitude to the Dr. R. S. Meena, Assistant Professor Dept. of Entomology and Agricultural Zoology BHU, Varanasi, India, for his valuable suggestion, fathomless inspiration, keen interest, constant encouragement, immense help and guidance throughout the entire course of investigation and preparation of this manuscript.

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