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Incidence of major pests of tomato in southern agro-climatic zone of Tamil Nadu

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Abstract
The study carried out in the southern zone of Tamil Nadu covering three districts showed that the fruit borer and leaf miner as serious pests and found to cause severe damage in tomato crop. The occurrence of *Helicoverpa armigera* started eight weeks after transplantation and lost up to the final harvesting. Tomato leaf miner, the recent invasive pests drastically damage the crop. In *Rabi* season, fruit borer and leaf miner larvae showed positive correlation with temperature, rainfall and wind velocity and negative correlation with relative humidity. In *Kharif* season, rainfall and relative humidity greatly influenced the attack of fruit borer and leaf miner with high significant positive correlation during 2019. The aim of the study is to establish correlation between weather parameter and incidence of fruit borer and leaf miner to take necessary control measures in ecological point of view.

Keywords: *Helicoverpa armigera*, seasonal incidence, tomato fruit borer, pinworm

Introduction
Tomato (*Lycopersicon esculentum* Mill), an important source of minerals and vitamins, nutritive vegetable is commercially important vegetable crop cultivated throughout the India. Tomato is a premier vegetable crop round the year and one of the prominent eco-industrial crops of India generating sizeable employment. In India, productivity of tomato is very low as compare to its production potential of the developed countries.
In India, it occupies an area of 0.88 million hectares with an annual production of 18.7 million MT. There are many factors for low production potential, among them insect-pests infestation is one of the major factors that is responsible for reduction in productivity. It attacked by various insect pests in India. Among the pests the fruit borer, *Helicoperaarmigera* (Hubner) is a key pest and cause upto 40-50 per cent damage to the tomato crop (Pareek and Bhargava 2003) [10]. Being a polyphagous, *H. armigera*distributed throughout the Indian subcontinent (Singh and Narang 1990) [12]. Incidence of fruit borer is dependent on weather parameters; therefore the present study was carried out to see the effect of weather parameters on incidence of tomato fruit borer.
After 2014, the tomato has been the victim with the invasion of tomato leaf miner, *Tutaabsoluta.* Tomato leafminer or tomato pin worm, *T. absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is a serious pest on tomato (*Lycopersicumesculentum*) cultivation in several countries in Latin America and Mediterranean basin (EPPO, 2005) [4]. The pest has been spreading fast and devastating tomato crop both in protected and open fields. It is a Neotropical oligophagous pest mainly on solanaceous crops. Its primary host is tomato although potato, brinjal, common bean and various wild solanaceous plants are also suitable hosts (Desneux *et al.*, 2010) [3]. The main reason for the spread of this pest is through infested fruits and packing material. The aggressive nature of the pest, multivoltine character, short generation time, high biotic potential and increased resistance to insecticide use are the reasons for its key pest status in the new localities (Potting, 2009). The tomato leaf miner can cause crop losses up to 100% and it is considered a key pest of greenhouse and open-field tomato. Introduced populations are probably resistant to the various group of insecticides and basic studies like invasion dynamics, life history, and reproductive biology are need of the hour to provide the information for its management (Kaleshwaraswamy *et al.*, 2015). Geographical location may also influence the other aspects of biology, diversity of insects in tomato ecosystem, potential natural dispersal and resistance to insecticides (Arturo *et al.*, 2012) [1].
The occurrence of climate change is evident from increase in global average temperature, changes in the rainfall pattern. The seasonal and long term changes would affect the fauna, flora and population dynamics of pests. The abiotic parameters are known to have direct impact on insect population dynamics. Therefore, keeping in view the economic importance of the crop and the magnitude of the damage caused by various insect pests, the present study was carried out to study the population buildup of major insect pests on tomato in relation to the abiotic factors (Muhammad *et al.*, 2014) [9].

Materials and Methods
The study was carried out in farmer's field in southern zone of tamil nadu covering three districts namely, Madurai, theni and dindugal during *Kharif* and *Rabi* season of 2019. The tomato variety Sivam was grown over an area of 1 ha in each district and seedlings were transplanted with a spacing of 60×45 cm. All the recommended cultivation practices were followed during the period of investigation except plant protection measures. To calculate the number of larvae and mines of *T. absoluta*, in a selected field, four quadrates of 5 m2 area was selected. Weekly sampling was done from two weeks after transplanting untill harvest (17 weeks). For recording leaf infestation, from each quadrate, five plants were randomly selected. In each selected plant, five leaflets were collected each from the top, middle and bottom, then individually packed in labeled plastic bags and then transported to the laboratory. In laboratory, with the aid of binocular microscope, the observations on per cent leaf

infestation, number of eggs per plant, number of mines per plant and number of larvae per plant were recorded at weekly intervals during each season. In both season per cent fruit infestation was also recorded during each picking.

Fruit infestation (%) = (No. of infested Fruits ÷ Total No. of Fruits) × 100

Besides this, correlation analysis between abiotic factors and the shoot and fruit damage on were also carried out (Gomez, 1984) [5].

Results and Discussion

In Tomato, the incidence of tomato fruit borer and leaf miner were documented in the southern zone of TN. Percent fruit damage concerned with fruiting stage of the crop was peak on 14th standard week (43.40%), when maximum and minimum temperature, RH, Rainfall and Wind velocity were 37.2^{0}C, 24.5^{0}C, 48.9%, 1.36 mm and 1.57 Km/hr respectively. The level of infestation was in the range between 13.20% and 43.40%. The minimum fruit damage of 13.20% was reported on 9th standard week, when maximum and minimum temperature, RH, Rainfall and wind velocity were 32^{0}C, 17.5^{0}C, 56.2%, 0.07 mm and 2.42 Km/hr respectively. Leaf miner larval population fluctuates between 0 and 3.17 larvae/ plant. The Maximum of 3.17 larvae / plant was observed on 14th standard week. The larval count was zero in the establishment stage of the crop (1 to 3rd standard week). The larval count of 0-1 larvae / plant in five standard week and 1-3 larvae/ plant in eleven standard weeks were recorded. Seasonal incidence of tomato fruit borer and leaf miner during rabi season were observed. The fruit borer infestation documented from 35th standard week and lasts upto 43rd standard week (till the end of the harvesting). The infestation range was 12.13% to 36.13%. Based on the observation, percent fruit damage was maximum on 41st standard week (36.13%), when maximum and minimum temperature were 30.87℃ and 23.13℃ respectively. The minimum of 12.13% was noted on 35th standard week. The leaf miner larvae was in abundant (2.87 larvae/ plant) during 39th standard week, when maximum and minimum temperature, RH, rainfall and wind velocity were 32.73℃, 25℃, 60.87%, 13.06mm and 3.23 Km/hr respectively. There was no occurence of larvae in the first three standard week (27th to 29th) of the observation. Out of 17 standard weeks, the larval count crossed 2 per plant in five standard week, 1-2 per plant in seven standard week and in the remaining weeks, it was less than 1 per plant.

Simple correlation analysis carried out between percent fruit damage and weather parameter during the crop growing period, *viz.*, maximum (r = 0.9415) and minimum (r = 0.9012) temperature and rainfall(r = 0.5168) showed positive correlation. Vikram *et al.* (2018) also reported temperature [maximum (r = 0.625) and minimum (r = 0.668)], wind velocity (r=0.527) and sunshine hours (r=0.722) showed significant positive correlation with larval population. They were highly significant. However, relative humidity (-0.6986) showed negative significant correlation with fruit borer. Present findings were in accordance with Mandal (2012) [8] during rabi season. The correlation between no. of leaf miner larvae with weather variables showed positive correlation and were highly significant in case of temperature. Whereas, relative humidity showed negative correlation (-0.8321) and was highly significant.

During Kharif season, the relationship between fruit borer incidence and maximum and minimum temperature and wind velocity were negatively correlated with high significancy. Our findings were contradicted with Chula *et al.* (2017) [2], who has reported that, the maximum and minimum temperature and wind velocity showed significantly positive correlation with the occurrence of fruit borer. This is vice- versa of our result. Similarly, the correlation between leaf miner larvae showed negative correlation with temperature and wind velocity. This showed that when temperature was high, the larval incidence was low. The present study was partially supported by the previous workers (Lacordaire and Feuvrier, 2010) [7]. The positive correlation was obtained with relative humidity and rainfall. It showed very high positive significant correlation.

Table 1: Seasonal incidence of major pests of tomato- (Rabi season) 2019.

Standard week	Minimum temperature (℃)	Maximum temperature (℃)	Relative humidity (%)	Rainfall (mm)	Wind velocity (Km/hr)	Pest incidence	
						Tomato	
						Fruit borer	Leaf miner
						Percent fruit damage	No. of larvae/ plant
1	17.6	29.2	66.4	0.65	0.61	0.00	0.00
2	17.2	28.5	66.0	3.11	1.87	0.00	0.00
3	18.0	29.5	67.2	2.86	1.85	0.00	0.00
4	18.9	29.9	68.2	1.99	2.25	0.00	0.43
5	18.7	29.6	66.5	1.09	1.52	0.00	0.67
6	16.9	31.8	55.1	0.00	1.68	0.00	1.16
7	17.4	31.0	54.8	0.09	2.21	0.00	1.67
8	17.3	32.1	55.9	0.51	1.84	0.00	1.65
9	17.5	32.0	56.2	0.07	2.42	13.20	2.11
10	22.1	33.2	58.8	8.45	1.27	23.20	1.87
11	21.4	32.9	58.5	11.60	1.68	24.13	2.40
12	22.8	33.7	59.1	9.11	1.74	33.40	2.42
13	23.3	33.9	59.0	11.28	1.99	35.33	2.53
14	24.5	37.2	48.9	1.36	1.57	43.40	3.17
15	24.0	36.1	48.4	3.94	2.02	39.47	2.83
16	25.2	37.6	48.5	2.95	2.10	37.07	2.30
17	26.1	37.8	49.2	2.91	1.43	33.67	2.19
						0.94156	0.73100
						0.90126	0.85818
						-0.69864	-0.83210
						0.51682	0.39022
						0.03526	0.23012

Table 2: Seasonal incidence of major pests of tomato (Kharif season) 2019.

Standard week	Minimum temperature (°C)	Maximum temperature (°C)	Relative humidity (%)	Rainfall (mm)	Wind velocity (Km/hr)	Pest Incidence	
						Tomato	
						Fruit borer	Leaf miner
						Percent fruit damage	No. of larvae/ plant
27	25.40	34.73	52.93	7.49	4.73	0.00	0.00
28	24.40	33.20	51.93	6.04	4.37	0.00	0.00
29	26.07	35.33	53.60	6.74	4.52	0.00	0.00
30	25.07	34.40	52.53	5.29	4.66	0.00	0.35
31	25.73	33.33	57.80	9.20	3.20	0.00	0.57
32	24.73	32.60	56.93	10.47	3.06	0.00	0.76
33	26.40	34.07	58.47	11.29	3.43	0.00	1.34
34	25.40	33.53	57.53	8.94	2.94	0.00	1.66
35	25.67	33.33	57.60	7.37	2.43	12.13	1.79
36	24.87	32.73	61.27	11.54	2.76	21.73	1.69
37	24.00	31.73	60.47	10.57	3.06	27.13	1.97
38	25.27	33.13	61.53	11.34	3.27	33.20	2.53
39	25.00	32.73	60.87	13.06	3.23	34.33	2.89
40	24.00	31.08	65.40	22.29	2.07	34.40	2.57
41	23.13	30.87	64.67	19.56	2.65	36.13	2.44
42	24.13	32.20	66.07	19.72	2.73	31.80	2.11
43	24.27	31.73	65.47	20.24	2.96	29.27	1.65
						-0.65607	-0.42287
						-0.77417	-0.70724
						0.86754	0.83989
						0.78198	0.68123
						-0.61995	-0.79167

Conclusion

Thus the present study revealed that the incidence *H. armigera* was started during the fruiting stage of the crop and continues till the end of the harvesting. Weather parameters, temperature (maximum and minimum), wind velocity and sunshine hours had significant positive correlation with larval population and negative correlation with relative humidity during Rabi season. Whereas, in kharif season, there was significant positive correlation with rainfall and relative humidity and negative correlation in case of temperature. In tomato leaf miner, relative humidity had a significant negative influence and their decrease lead to affect the larval population. It was more evident in Rabi season than in Kharif season. Not much influence of weather parameters on the indigence was observed during Kharif season. It indicates that crop phenology had much influence on *T. absoluta* population than weather parameters. Based on the results it is inferred that, management should be initiated based on the phenological cycle of the crop and weather parameter.

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