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Studies on population dynamics of major insect pests of tomato

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Abstract
The experiment was carried out under polyhouse condition, College of Horticulture, Mudigere, University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka, India. The incidence of whitefly, *T. vaporariorum* nymphs and adults population occurred from 3rd SMW, peak population were noticed during 16th SMW, (2.10 nymphs/ 2cm^2 and 4.00 adults/ leaf, respectively). Leaf miner, *L. trifolii* incidence occurred from 5th SMW and peak population were observed on 16th SMW (4.70 live mines/ leaf). Tomato pin worm, *T. absoluta* incidence occurred from 9th SMW, peak population were noticed during 18th SMW (5.39 mines/ leaf). The whitefly nymphs, adult whiteflies and tomato pin worm showed positive correlation with maximum temperature (r= 0.384, 0.202 and 0.237, respectively). Whereas, leaf miner had significant positive correlation with maximum temperature (r= 0.729). Minimum temperature showed positive correlation with whitefly nymphs, adults and tomato pin worm (r= 0.180, 0.297 and 0.138, respectively) and negative correlation with leaf miner (r= -0.034). Maximum relative humidity showed positive correlation with whitefly nymphs, adult whiteflies, leaf miner and tomato pin worm (r= 0.203, 0.005, 0.392 and 0.047, respectively). Whereas, minimum relative humidity was negatively correlated with whitefly nymphs, adult whiteflies and tomato pin worm (r= -0.060, 0.255 and 0.233, respectively).

Keywords: Tomato, whitefly, leaf miner, tomato pin worm, temperature, relative humidity

1. Introduction
Tomato is a rich source of vitamin A and C, also known as "poor man's orange" it adds a variety of colours to the food. Lycopene imparts red colour to the ripe tomatoes. It is also reported to possess anti-cancerous properties. Tomato fruit contain water 93 per cent, protein 1.9 per cent, fat 0.3 g, fibre 0.7 per cent, carbohydrates 3.6 per cent, calorie 23, vitamin 'A' 320 IU, vitamin 'B1' 0.07 mg, vitamin 'B2' 0.01 mg, vitamin 'C' 31 mg, nicotinic acid 0.4 mg, calcium 20 mg, phosphorus 36 mg and iron 0.8 mg. (Kachave *et al.*, 2020) [6]. The major insect pests includes whitefly, *Trialeurodes vaporariorum* (Westwood), serpentine leaf miner, *Liriomyza trifolii* (Burgess), South American leaf miner *Tuta absoluta* (Meyrick), thrips, *Scirtothrips dorsalis* (Hood), aphid *Aphis gossypii* (Glover), jassid, *Amrasca devastans* (Distant) and fruit borer, *Helicoverpa armigera* (Hub.) are major species according to Mandloi *et al.* (2015) [8]. Among the key insect pests, whitefly (*T. vaporariorum*), leaf miner (*L. trifolii*) and tomato pin worm (*T. absoluta*) are the most dangerous pests having a pandemic distribution and damaging many vital crops including vegetables, tubers, fiber crops and ornamentals from tropics and sub-tropics to temperate climates in crops grown under open and protected environment (Anu *et al.*, 2020) [2].
The wide range of geographical distribution with varieties of host range make them difficult to control. *T. vaporariorum*, which sucks the phloem sap of growing tomato plant, also transmits tomato yellow curl viruses. The larvae of *L. trifolii* feed on mesophyll and reduce chlorophyll content of leaves. Adults puncture leaves to feed and oviposit (Zhang *et al.*, 2017) [13]. Tomato pin worm has been responsible for losses of 80-100 per cent in tomato under both protected cultivation and open fields. Yield and fruit quality are both considerably impacted by direct feeding of the pest as well as secondary pathogens entering host plants through wounds made by the pest (Michailidis *et al.*, 2019) [9]. The occurrence of the above pests is related with the weather parameters, therefore the present investigation was carried out to know the how these parameters effect the incidence of major pests that infest tomato.

2. Materials and Methods

The study was conducted during 2019-20 at College of Horticulture, Mudigere under polyhouse conditions. To record the population dynamics of major insect pests on tomato, popularly growing tomato variety (Arka Samrat) was raised in a nursery bed. Twenty-eight days old tomato seedlings were transplanted in the main field of 10 m^2 area in the polyhouse with a spacing of 40 × 60 cm. The observations were recorded on 20 randomly selected plants at weekly intervals starting from 30 days after transplanting (DAT) till the last harvest. Both nymphs and adults of whitefly was counted on fully opened randomly selected top, three leaves. Observation on whitefly adults were recorded in early morning hours, whereas, the nymphal population was counted per unit area (2 cm^2) under a stereo-zoom binocular microscope at 10 X magnification. In case of leaf miner and tomato pin worm number of mines per leaf was counted on fully opened randomly selected three leaves at weekly intervals. Finally, the insect pest populations were correlated with weather parameters like minimum, maximum temperature and relative humidity. A simple correlation was worked out between the population of pests and abiotic environmental factor using the following formula.

$$r_{xy} = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{n}\right]\left[\sum Y^2 - \frac{(\sum Y)^2}{n}\right]}}$$

r_{xy} = Simple correlation coefficient
x = Variable *i.e.*, abiotic component (maximum & minimum temperature, relative humidity)
Y = Variable, *i.e.*, the mean number of insect pests
N = Number of observations

3. Results and Discussion

3.1 Incidence of whitefly (*Trialeurodes vaporariorum* Westwood) and its correlation with weather parameters

The incidence of whitefly, *T. vaporariorum* nymphs and adults population occurred from 3rd SMW (January) with an initial population of 0.11 nymphs/ 2cm^2 and 0.20 adults/ leaf that went on increasing up to 16th SMW (April) which was the peak incidence with 2.10 nymphs/ 2cm^2 and 4.00 adults/ leaf. Whereas, the population of whiteflies were decreased from 17th SMW onwards and reached to 1.42 nymphs/ 2cm^2 and 3.28 adults/ leaf by the end of 18th SMW (May) (Fig.1). The present findings are in line with Subba *et al.* (2017) [11] who reported that maximum population of whitefly was noticed during 2nd to 3rd week of March. The present findings are also in conformity with Harshita (2019) [5], who reported that whitefly population reached its peak during last week of February 2016 and first fortnight of March 2017. Correlation coefficient between whitefly population with weather parameters indicated that, the nymphs and adults population showed a positive correlation with minimum temperature (r = 0.180 nymphs and 0.297 adults, respectively) and maximum temperature (r = 0.384 nymphs and r = 0.202 adults, respectively). Whereas, average temperature had a significant positive correlation with nymphs (r = 0.562) and whitefly adults (r = 0.475). With respect to relative humidity, the whitefly nymphs and adults population exhibited a positive correlation with maximum relative humidity (r = 0.203 nymphs and r = 0.005 adults, respectively) and a negative correlation with minimum relative humidity (r = -0.199 nymphs and r = -0.356 adults, respectively). Sharma *et al.* (2017) [10] reported that there was a positive correlation between adult whitefly population and weather factors like maximum and minimum temperature have reported similar findings.

3.2 Incidence of leaf miner (*Liriomyza trifolii* Burgess) and its correlation with weather parameters

Leaf miner, *L. trifolii* incidence occurred from 5th SMW (February) with initial population of 1.03 live mines/ leaf and with increasing trend was observed up to 16th SMW. Highest number of live mines per leaf were noticed on 16th SMW (April) *i.e.*, 4.70 live mines/ leaf. Whereas, the incidence of number of live mines was decreased from 17th SMW onwards and reached to 2.01 live mines/ leaf by the end of 18th SMW (May) (Fig.1). The present investigation is line with Chaudhuri and Senapati (2004) [3] who reported that higher level of leaf miner infestation was recorded from late March to May. With respect to correlation the number of live mines per leaf showed a significant positive correlation with maximum and average temperature (r = 0.729 & r = 0.735, respectively) and a negative correlation with minimum temperature (r = -0.034). Whereas, the number of live mines per leaf exhibited a positive correlation with minimum, maximum and average relative humidity (r = 0.120, r = 0.392 & r = 0.247, respectively). Wade *et al.* (2020) [12] have reported similar findings where the peak population of leaf miner were observed in 7th and 12th SMW, respectively. Whereas, the leaf miner showed a positive correlation with maximum temperature and evening relative humidity.

3.3 Incidence of tomato pin worm (*Tuta absoluta* Meyrick) and its correlation with weather parameters

Tomato pin worm, *T. absoluta* incidence occurred from 9th SMW (February) with initial incidence of 1.18 mines/ leaf. Further, increasing trend was noticed up to 18th SMW (May) (Fig.1). Whereas, peak incidence of mines per leaf was observed on 18th SMW *i.e.*, 5.39 mines/ leaf (Table 1 and 2). Present observations were more or less similar with the results of earlier workers Mahmoud *et al.* (2015) [7] who reported that *T. absoluta* population increased gradually and reached its maximum activity in April. With respect to correlation the number of mines per leaf showed a positive correlation with minimum, maximum and average temperature (r = 0.138, r = 0.237 & r = 0.372, respectively). Whereas, the number of mines per leaf exhibited a positive correlation with maximum relative humidity (r = 0.047) and negative correlation with minimum and average relative humidity (r = -0.349 & r = -0.233, respectively). Similarly, Devaraj *et al.* (2017) [4] reported that temperature had positive correlation on *T. absoluta* population that recorded the highest incidence level (February). Relative humidity and wind speed had negative influence on the infestation levels. The present investigation were also in line with Anitha *et al.* (2018) [1] who reported that leaf damage and fruit damage caused by tomato pin worm was positively correlated with maximum and minimum temperature and negatively correlation with minimum relative humidity.

Table 1: Population dynamics of insect pests on tomato (cv. Arka Samrat) during cropping season in relation to abiotic factors

SMW/ Date of observation	Whitefly nymphs/ 2cm^2	Whitefly adult/ leaf	No. of live mines/ leaf (leaf miner)	No. of mines/ leaf (tomato pin worm)	Temperature (^{O}C)			Relative humidity (%)		
					Max.	Min.	Avg.	Max.	Min.	Avg.
3 SMW/ 18/01/2020	0.11	0.20	0.00	0.00	31.85	21.71	26.78	81.71	62.57	72.14
4 SMW/ 25/01/2020	0.15	0.42	0.00	0.00	32.42	20.14	26.28	83.85	64.71	74.28
5 SMW/ 01/02/2020	0.20	0.86	1.03	0.00	32.28	21.71	26.99	82.28	62.71	72.49
6 SMW/ 8/02/2020	0.26	1.00	1.35	0.00	33.57	22.71	28.14	80.41	60.82	70.61
7 SMW/ 15/02/2020	0.38	1.15	1.90	0.00	32.57	21.71	27.14	80.14	63.71	71.92
8 SMW/ 22/02/2020	0.73	1.34	2.30	0.00	33.42	23.20	28.31	84.57	60.00	72.28
9 SMW/ 29/02/2020	1.08	1.58	3.80	1.18	33.71	21.85	27.78	85.15	67.71	76.43
10SMW/07/03/2020	1.10	1.80	3.85	1.40	34.71	20.57	27.64	84.00	68.72	76.36
11SMW/ 14/03/2020	1.12	1.95	3.92	2.22	35.85	20.00	27.92	86.05	67.71	76.88
12SMW/ 21/03/2020	1.20	2.00	4.00	2.99	35.57	20.28	27.92	83.42	65.57	74.49
13SMW/ 28/03/2020	1.34	2.20	4.20	3.60	36.00	19.08	27.54	84.57	62.28	73.42
14 SMW/ 4/04/2020	1.43	2.38	4.40	4.00	35.71	22.42	29.06	83.57	62.28	72.92
15SMW/ 11/04/2020	1.68	3.00	4.61	4.50	34.71	21.57	28.14	83.28	61.00	72.14
16SMW/ 18/04/2020	2.10	4.00	4.70	5.23	33.42	23.50	28.46	81.54	60.14	70.84
17SMW/ 25/04/2020	1.86	3.50	3.62	5.30	32.52	23.00	27.76	82.14	60.12	71.13
18SMW/ 02/05/2020	1.42	3.28	2.01	5.39	31.50	22.15	26.82	82.17	60.00	71.08

SMW: Standard Meteorological Weeks

Table 2: Correlation between key abiotic factors and major pests of tomato (cv. Arka Samrat) during cropping season

Insect pests	Temperature (°C)			Relative humidity (%)		
	Maximum	Minimum	Average	Maximum	Minimum	Average
Whitefly nymph	0.384	0.180	0.562*	0.203	-0.199	-0.060
Whitefly adult	0.202	0.297	0.475	0.005	-0.356	-0.255
Leaf miner	0.729**	-0.034	0.735**	0.392	0.120	0.247
Pin worm	0.237	0.138	0.372	0.047	-0.349	-0.233

*significant at 5 per cent level of significance n = 14 r = 0.497

**significant at 1 per cent level of significance n = 14 r = 0.622

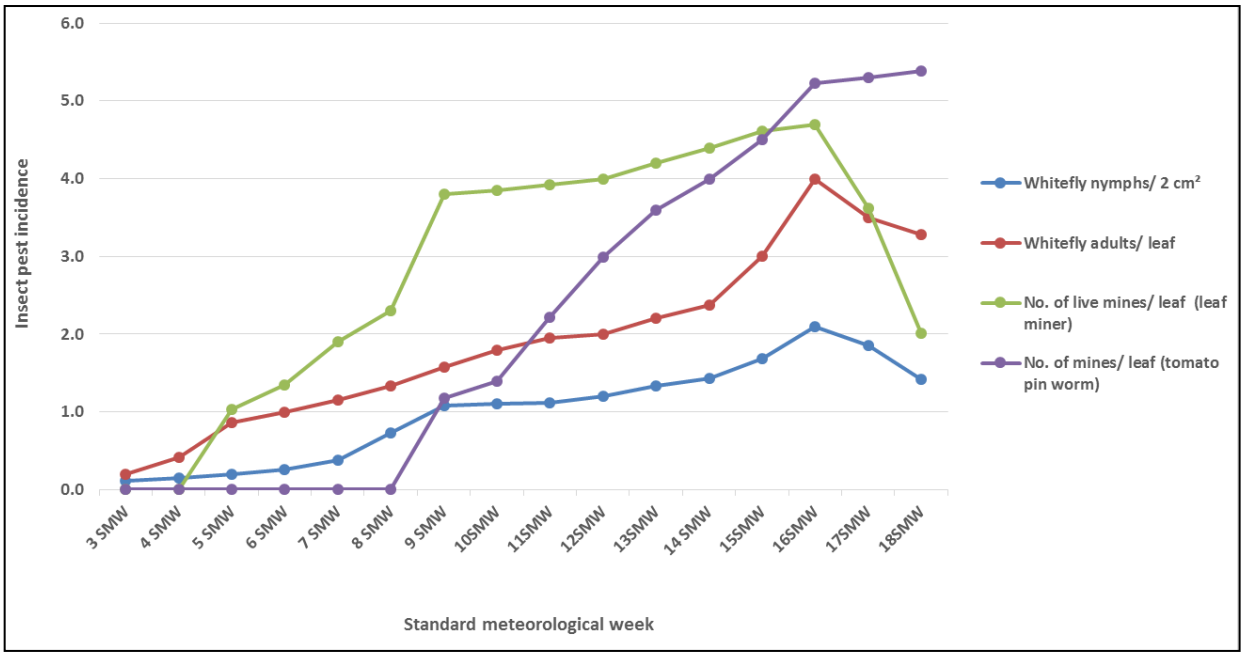

Fig 1: Population dynamics of whitefly, leaf miner and tomato pin worm during the tomato cropping season under polyhouse condition

4. Conclusion

From the present investigation, it can be concluded that peak incidence of whitefly nymphs and adults were noticed during 16th SMW, which showed a positive correlation with minimum and maximum temperature. Whereas, peak incidence of leaf miner was noticed during 16th SMW, which showed positive correlation with maximum temperature, maximum and minimum relative humidity. However, peak incidence of tomato pin worm was noticed during 18th SMW, which showed positive correlation with maximum, minimum temperature and negative correlation with minimum relative humidity.

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