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Seasonal Incidence of Major Insect Pests of Tomato (*Lycopersicon esculentum* Mill.) in Relation to Weather Parameters

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A B S T R A C T

The experiment was carried out in *rabi* season 2018-19 in the Insectary of Department of Entomology, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The first appearance of aphid, thrips and fruit borer was observed on tomato variety Azad Type-6 with its initial intensity of 4.8 aphids/plant, 7.6 thrips/plant and 1.2 larvae/m row length in the 51st SMW (third week of December), 52nd SMW (fourth week of December) and 2nd SMW (second week of January), respectively. Conducive Period of aphid, thrips and fruit borer infestation was found between mid January to mid February (3rd to 7th SMW), first week of February (6th SMW) and second week of February (6th SMW), respectively. Simple correlation coefficient (r) between the incidence of aphid & thrips and prevailing weather parameters revealed that maximum temperature, minimum relative humidity, average relative humidity and rainfall showed significant positive impact on aphid multiplication, while remaining environmental factors had their insignificant effect. Simple correlation coefficient (r) between the incidence of fruit borer larvae and prevailing weather parameters revealed that minimum relative humidity, average relative humidity and rainfall showed significant positive impact on fruit borer larvae multiplication, while remaining environmental factors had their insignificant effect.

Introduction

Tomato (*Solanum lycopersicum* L.) is an important vegetable crop grown worldwide after potato. Tomato has its origin in the South American Andes. Tomatoes contribute to a healthy, well-balanced diet. They are rich in minerals, vitamins, essential amino acids, sugars and dietary fibres. Tomato contains much vitamin B and C, iron and phosphorus. In India, tomato occupies an area of 808.5 thousand hectare with production of 19696.9 thousand metric tonnes and productivity of 24.4 metric tonnes per hectare (Horticulture Statistics Division, Department of Agriculture, Co-operation & Farmer's Welfare, 2016-17). Major tomato growing states in India are Bihar, Karnataka, Orissa, Maharashtra and

Andhra Pradesh. In Uttar Pradesh, it occupies an area of 20.88 thousand hectare with production of 826.32 thousand metric tonnes and productivity of 39.57 metric tonnes per hectare (Horticulture Statistics Division, Department of Agriculture, Co-operation & Farmer's Welfare, 2016-17).

A number of insect pests *i.e.* about 100 insect pests and 25 non insect pests species are reported to ravage the tomato fields (Lange and Bronson, 1981). The tomato fruit borer, *Helicoverpera armigera* (Hubner) is a key pest and cause upto 40-50 per cent damage to the tomato crop (Pareek and Bhargava 2003). The larval stage of this pest infest fruits and makes it unfit for human consumption. The young larval stage feed on the foliage and later instars bore inside the fruits (Singh and Narang, 1990) Incidence of above pests is dependent on weather parameters, therefore the present study was carried out to see the effect of weather parameters on incidence of major pests infesting tomato. Like other vegetables, tomato is more prone to insect pests and diseases mainly due to their tenderness and softness compared to other crops (Sajjad *et al.*, 2011).

Among other various factors responsible for low yield of tomato, insect pests viz., the fruit borer, *Helicoverpa armigera* (Hubner) and sucking insect pests viz. whitefly *Bemesia tabaci* (Genn)., Jassids, *Amrasca biguttulla biguttula* (Ishida), thrips *Thrips tabaci* (Lin) and serpentine leaf miner, *Liriomyza trifolii* (Burgess) are highly destructive causing serious damage and are responsible for lowering the yield of tomato crop (Lal *et al.*, 2008). Tomato crops can be infected with a large number of insects.

Among the various pest of tomato crop, *Helicoverpa armigera* considered as the most serious pest causing 50-60% damage (Singh and Singh, 1975).

Materials and Methods

Field experiment entitled seasonal incidence of major insect-pests of tomato (*Lycopersicon esculentum* Mill.) in relation to weather parameters was conducted in rabi season during 2018-19 in the Insectary of Department of Entomology, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. The experiment was laid out in Randomized Complete Block Design (RCBD) having 12 treatments including control replicated thrice in 3×3 m plot size with 60×50 cm spacing. The transplanting date and methods were observed according to the plan of work. The seedlings of tomato variety Azad Type-6 will be obtained from Vegetable Research Farm, Kalyanpur of the University.

Observation

To record the observation on succession of different insect pests attacking/visiting tomato (Var. Azad Type 6) crop, 5 plants were randomly selected and tagged from each replication on 5 cm top shoot of the main shoot, six leaves (two upper, two middle and two lower) per plant were randomly selected to record the observations. Meteorological data was provided by Agronomy department which is given in Table 3 and Fig 2. The observation on the insect-pests population along with their natural enemies was recorded at weekly intervals from transplanting of the seedlings till its harvest for seasonal abundance. Weekly incidence of major insect pests of tomato crop were correlated with weather parameters prevailing during the crop season. Simple mean of weekly observations recorded in incidence of different insect-pests was calculated and general equilibrium position (GEP) was obtained for a particular pest. Weekly increase for each insect-pests was also calculated by subtracting the observations of previous week from the incidence recorded in current week. Simple

correlation coefficient (r) were also recorded between the insect-pests incidence and prevailing weather parameters for insect-pests management.

Results and Discussion

Present investigation on seasonal incidence of major insect-pests of tomato (*Lycopersicon esculentum* Mill.) in relation to weather parameters was carried out in the Insectary, Department of Entomology utilising tomato variety Azad Type-6. Weekly observations on different insect-pests infesting tomato crop revealed that aphid (*Aphis gossypii* Glover), thrips (*Scirtothrips dorsalis* Hood) and fruit borer (*Helicoverpa armigera* Hubner) were appeared as major insect-pests infesting tomato variety Azad Type-6 during 2018-19 (Table-1). Relationship between pest intensity and weather parameters have been depicted in Table-2.

Aphid (*Aphis gossypii* Glover)

Aphid appeared in 51st standard meteorological week (SMW) with its initial population of 4.8 aphids/plant on 33 days old crop, which increased till the 1st week of February (6th SMW) touching to highest intensity of 117.6 aphids/plant. During this period, the crop was in vegetative phase with succulency, which provide better feeding condition for aphids. During February, higher population of aphids *viz.*, 109.2, 117.6, 102.2 and 91.8/plant were recorded in 5th, 6th, 7th and 8th SMW, respectively. During March, this pest was observed at the declining trend and completely vanished during 1st week of April (14th SMW). General equilibrium position (GEP) of aphid was calculated to be 52.4/plant exhibiting the average population during this season. Weekly increase of aphid intensity was calculated to know the suitable period for best multiplication of aphids, which was observed in 3rd week of January (3rd SMW) with a weekly increase of 36 aphids/plant. Simple correlation coefficient (r) between the incidence of aphid and prevailing weather parameters revealed that maximum temperature (r = 0.5131), minimum relative humidity (r = 0.7533), average relative humidity (r = 0.7040) and rainfall (r = 0.5153) showed significant positive impact on aphid multiplication, while remaining environmental factors had their insignificant effect. Minimum temperature (r = -0.5337), wind velocity (r = -0.4854), evaporation rate (r = - 0.6308) and bright sunshine (r = -0.6018) showed significant negative impact on weekly increase of aphid population.

The pest multiplied at a faster rate during January as the weekly increase was recorded from 10.8 aphids/plant to 36 aphids/plant. The maximum intensity was noticed in the 1st week of February (6th SMW), but the weekly increase was observed in a decreasing trend from mid of January. However, the pest intensity reduced gradually from mid February to maturity of the crop, which exhibited negative weekly increase. Period between mid January to mid February was found suitable for the best multiplication of aphid. Average ranging 14.5 ^{o}C to 16.0 ^{o}C (maximum 19.5 ^{o}C to 23.1 ^{o}C, minimum 6.0 to 10.6 ^{o}C) and average relative humidity between 61.0 to 72.5% (morning 83% to 90% & evening 39% to 61%) proved suitable for best multiplication of this pest during cropping season. Increasing in average temperature (above 60%) along with hardening of the plant parts. This favoured the pest incidence.

Thrips (*Scirtothrips dorsalis* Hood)

Thrips appeared in 52nd standard meteorological week (SMW) with its initial population of 7.6 thrips/plant on 38 days old crop, which increased till the 1st week of February (6th SMW) touching to highest intensity of 62.3 thrips/plant. During this

period, the crop was in vegetative phase with succulency, which provide better feeding condition for thrips. During January and February, higher population of thrips *viz.*, 47.8, 51.2, 59.7 and 62.3 thrips/plant were recorded in 3rd, 4th, 5th and 6th SMW, respectively. During March, this pest was observed at the declining trend and completely vanished during 3rd week of March (12th SMW). General equilibrium position (GEP) of thrips was calculated to be 23.4/plant exhibiting the average population during this season. Weekly increase of thrips intensity was calculated to know the suitable period for best multiplication of thrips, which was observed in 3rd week of January (3rd SMW) with a weekly increase 22.5 thrips/plant. Simple correlation coefficient (r) between the incidence of thrips and prevailing weather parameters revealed that, minimum relative humidity (r = 0.7194), average relative humidity (r = 0.6902) and rainfall (r = 0.5326) showed significant positive impact on thrips multiplication, while remaining environmental factors had their insignificant effect.

Maximum temperature (r = -0.5608) showed significant negative impact on thrips multiplication.

Appearance of thrips (*Scirtothrips dorsalis* Hood) was noticed in the last week of December (52nd SMW) with initial population (7.6 thrips/plant), which increased upto 1st week of February (6th SMW) showing 62.3 thrips/plant. A sizable weekly enhancement in thrips intensity was recorded to be 11.5 and 22.5 thrips/plant during 2nd & 3rd week of January (1st and 2nd SMW), respectively.

However the pest multiplied beyond this period also at a slower rate upto 1st week of February (5th SMW). The reduction in pest intensity was noticed from 2nd week of February (7th SMW), which completely vanished in the 2nd week of March (10th SMW). Based on the higher weekly increase in thrips intensity, average temperature (14 to 15^{o}C), relative humidity (61 to 72.5%) were seemed most conducive for this pest.

Fruit borer (*Helicoverpa armigera* Hubner)

Fruit borer appeared in 2nd standard meteorological week (SMW) with its initial population of 1.2/m row length on 54 days old crop, which increased till the 1th week of February (6th SMW) touching to highest intensity of 7.6/m row length. During this period, the crop was in vegetative phase with succulency which provide better feeding condition for fruit borer larvae.

During January and February, higher population of fruit borer larvae *viz.*, 5.8, 6.4, 7.6 and 6.9 fruit borer larvae were recorded in 4th, 5th, 6th and 7th SMW, respectively. During March, this pest was observed at the declining trend and completely vanished during 1st week of April (14th SMW).

General equilibrium position (GEP) of fruit borer larvae was calculated to be 3.0 fruit borer larvae/m row length exhibiting the average population during this season. Weekly increase of fruit borer larvae intensity was calculated to know the suitable period for best multiplication of fruit borer larvae, which was observed 3rd week of January (3rd SMW) with a weekly increase 3.1 fruit borer larvae.

Simple correlation coefficient (r) between the incidence of fruit borer larvae and prevailing weather parameters revealed that minimum relative humidity (r = 0.7553), average relative humidity (r = 0.6430) and rainfall (r = 0.5482) showed significant positive impact on fruit borer larvae multiplication, while remaining environmental factors had their insignificant effect. Evaporation rate (r = -0.5991) showed significant negative impact on weekly increase of fruit borer population.

Table.1 Seasonal incidence of major insect- pests on tomato crop during rabi 2018-19

SMW	Duration of observation	Aphids (No./plant)		Thrips (No./plant)		Fruit borer larvae (No./ m row length)	
		Actual Population	Weekly increase	Actual Population	Weekly increase	Actual Population	Weekly increase
50	Dec 10-16,2018	0	0	0	0	0	0
51	Dec 17-23	4.8	4.8	0	0	0	0
52	Dec 24-30	15.6	10.8	7.6	7.6	0	0
1	Jan 1-7,2019	33.7	18.1	13.8	6.2	0	0
2	Jan 8-14	52.3	18.6	25.3	11.5	1.2	1.2
3	Jan 15-21	88.3	36.0	47.8	22.5	4.3	3.1
4	Jan 22-28	94.7	6.4	51.2	3.4	5.8	1.5
5	Jan 29-Feb 4	109.2	14.5	59.7	7.5	6.4	0.6
6	Feb 5-11	117.6	8.4	62.3	2.6	7.6	1.2
7	Feb 12-18	102.2	-15.4	41.4	-20.9	6.9	-0.7
8	Feb 19-25	91.8	-10.4	36.7	-4.7	6.2	-0.7
9	Feb 26-Mar 4	73.9	-17.9	27.2	-9.5	4.8	-1.4
10	Mar 5-11	51.3	-22.6	19.1	-8.1	3.1	-1.7
11	Mar 12-18	35.3	-16.0	6.3	-12.8	2.7	-0.4
12	Mar 19-25	13.8	-21.5	0	-6.3	1.3	-1.4
13	Mar 26-Apr 1	7.6	-6.2	0	0	0.7	-0.6
14	Apr 2-8,2019	0	-7.6	0	0	0	-0.7
GEP		52.4		23.4		3.0	

Table.2 Simple correlation coefficient (r) between incidence of major insect- pests of tomato and prevailing weather parameters during 2018-19

Weather parameters		Aphids		Thrips		Fruit borer	
		Actual population	Weekly increase	Actual population	Weekly increase	Actual population	Weekly increase
Temperature (^{o}C)	Max.	-0.5131*	-0.4119	-0.5608*	-0.2319	-0.3535	-0.3712
	Min.	-0.1783	-0.5357*	-0.2529	-0.3704	0.0102	-0.4506
	Ave.	-0.3694	-0.4810	-0.4308	-0.3033	-0.1913	-0.4188
Relative Humidity (%)	Max.	0.4317	0.2119	0.4478	0.0402	0.3161	0.1726
	Min.	0.7533***	-0.1488	0.7194**	-0.2372	0.7553**	-0.0773
	Ave.	0.7040**	0.0217	0.6902**	-0.1255	0.6430*	0.0443
Rainfall (mm/day)		0.5153*	-0.1354	0.5326*	-0.2805	0.5482*	-0.1894
Wind velocity (km/hr)		0.3254	-0.4854*	0.2703	-0.4099	0.4719	-0.4904
Evaporation rate (mm/day)		-0.4387	-0.6308**	-0.5185	-0.4371	-0.2104	-0.5991*
Bright sunshine (hours)		0.3485	-0.6018*	0.3041	-0.5419*	0.4816	-0.2953

NB: *, ** & *** Significant at 5%, 1% and 0.1% level of significance.

Table.3 Meteorological observations prevailing during the experimental period 2018-19

SMW	Duration of observation	Temperature (^{0}C)			Relative Humidity (%)			Rainfall (mm /day)	Wind velocity (kmph)	Evapora-tion rate (mm/day)	Bright sunshine (hours)
		Maximum	Minimum	Average	Morning	Evening	Average				
50	Dec 10-16,2018	22.8	8.3	15.5	90	46	68.0	0	3.3	2.7	3.8
51	Dec 17-23	22.5	5.3	13.9	87	35	61.0	0	2.8	1.8	2.5
52	Dec 24-30	21.1	3.4	12.2	87	34	60.5	0	4.2	1.6	2.1
1	Jan 1-7,2019	22.4	7.3	14.8	87	48	67.5	0	2.7	1.1	1.7
2	Jan 8-14	21.4	7.6	14.5	87	43	65.0	0	2.3	1.4	5.3
3	Jan 15-21	23.1	6.0	14.5	83	39	61.0	0	3.7	1.7	7.8
4	Jan 22-28	19.6	10.6	15.1	84	61	72.5	13.5	4.5	1.7	6.9
5	Jan 29-Feb 4	21.3	8.3	14.8	85	50	67.5	0	6.0	1.8	8.3
6	Feb 5-11	22.1	10	16.0	90	55	72.5	10.5	4.3	1.9	8.6
7	Feb 12-18	23.3	11.6	17.4	89	57	73.5	1.7	5.7	2.1	6.1
8	Feb 19-25	26.1	12.8	19.7	85	50	67.5	0	6.5	2.3	5.7
9	Feb 26-Mar 4	22.6	10.5	16.5	87	52	69.5	9.1	5.8	3.0	8.1
10	Mar 5-11	27.4	12.0	19.7	79	41	60.0	0	2.8	3.1	8.7
11	Mar 12-18	29.2	13.2	21.2	80	38	59.0	0	4.1	3.4	8.9
12	Mar 19-25	32.2	15.8	24.0	63	39	51.0	0	3.7	3.7	8.3
13	Mar 26-Apr 1	34.5	17.3	25.9	75	41	58.0	0.4	5.6	3.7	8.2
14	Apr 2-8,2019	36.7	19.6	28.5	70.4	34.7	52.5	0	6.2	3.9	8.3

NB: SMW- Standard meteorological weeks

Fig.1 Incidence of major insect pests on tomato crop during rabi 2018 -19

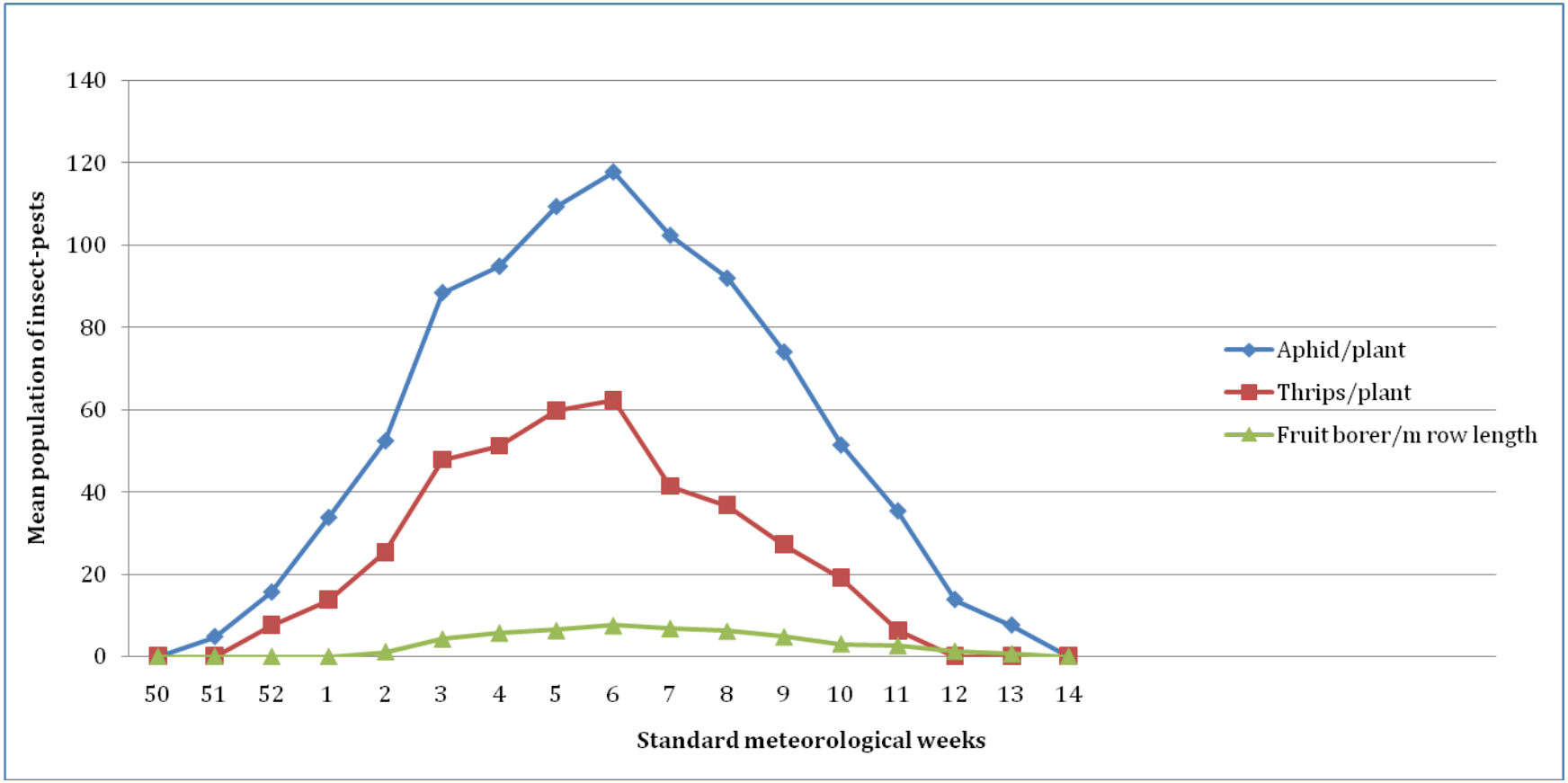
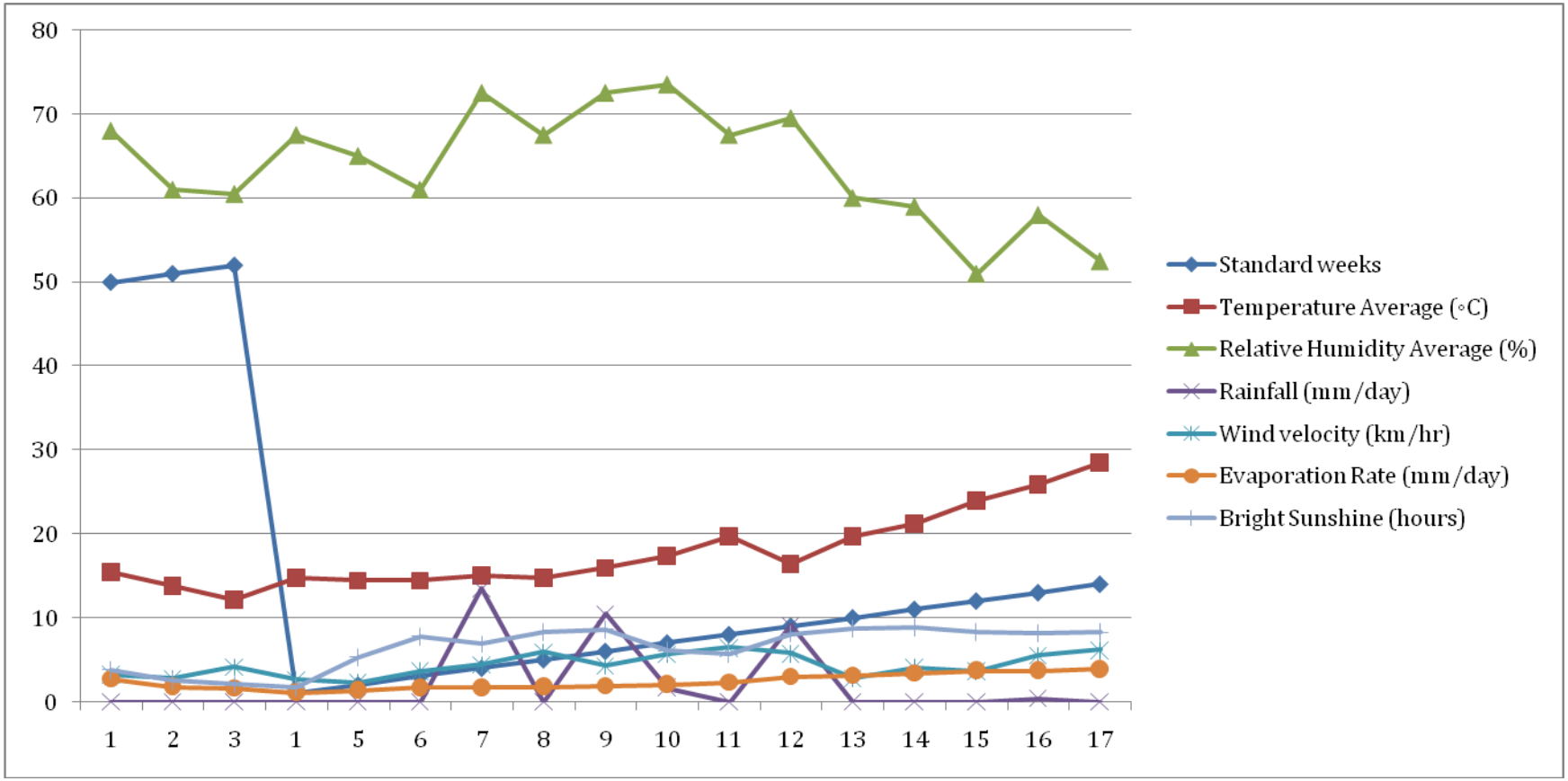


Fig.2 Meteorological observations prevailing during the experimental period 2018-19



Infestation of fruit borer (*Helicoverpa armigera* Hubner) was initially observed on the vegetative growth of the plants on 52 days old crop with its initial population of 1.2 larvae/m row length during 2nd week of January (2nd SMW). The pest showed and increasing trend till the 2nd week of February (6th SMW) with the highest intensity of 7.6 larvae/m row length. Fruiting in crop started during the 3rd week of January (3rd SMW) and the pest was noticed on vegetative growth as well as young plants during the next 2 weeks (upto 5th SMW). After this period the pest intensity was recorded solely on tomato fruits with the highest intensity of 7.6 larvae/m row length. The pest remained above 5 larvae/m row length during 4th week of January (4th SMW) to 3rd week of February (8th SMW). After mid February (6th SMW), the pest was observed in a declining trend due to reducing number of tomato fruits and unfavourable weather parameters. Weekly increased 0.6 to 3.1 larvae/m row length was noticed during the vegetative and early reproductive stage of crop up to mid of February (6th SMW). Non-significant impact of different weather parameters except evaporation rate (r = -5991) was calculated with intensity of larvae of fruit borer/m row length on tomato.

On the basis of seasonal incidence of major insect-pests on tomato cultivar Azad Type-6 during *rabi* 2018-19, it can be summarized that the intensity of aphid, thrips and fruit borer varied between 4.8 to 117.6 aphids/plant, 7.6 to 62.3 thrips/plant and 1.2 to 7.6 larvae /m row length during the cropping season. However, the peak intensity of these insect-pests is 117.6 aphids/plant, 62.3 thrips/plant and 7.6 larvae /m row was noticed during 2nd week of February i.e.(6th SMW), respectively. After 2nd week of February (6th SMW), the intensity of respective insect-pests was recorded in a declining trend. This exhibited that aphid and thrips being the sucking insect-pests damaged the crop voraciously during vegetative stage, while the fruit borer attacked the crop primarily in vegetative and thereafter shifted on tomato fruits. General equilibrium position (GEP) of aphid, thrips and fruit borer was calculated to be 52.4 aphids/plant, 23.4 thrips/plant and 3.0 larvae/m row length, respectively. The quantitative increase in the intensity of any insect-pest is depended on the crop stage with its susceptible stages and moreover on the ecological conditions of the area. Maximum temperature (r = -0.5131and -0.5608), minimum relative humidity (r = 0.7533 and 0.7194), average relative humidity (r = 0.7040 and 0.6902) and rainfall (r = 05153 and 0.5326) played significant role on the multiplication of aphid (*Aphis gossypii* Glover) and thrips (*Scirtothrips dorsalis* Hood). Significant positive role of minimum relative humidity (r = 0.7553), average relative humidity (r = 0.6430) and rainfall (r = 0.5482) could be observed on the intensity of fruit borer (*Helicoverpa armigera* Hubner). All these insect-pests were found to multiplied at a faster rate during 2nd week of January (2nd SMW) to 2nd week of February (7th SMW). Average temperature and relative humidity ranging between 14.5 ^{o}C to 17.4 ^{o}C and 61% to 73.5% were found more conducive for best multiplication of these insect-pests respectively, which played a major role among the abiotic factors. However, the significance of other weather factors were rainfall, wind velocity, evaporation rate and sunshine can not be negated at all.

Above cited results on the seasonal incidence of major insect-pests on tomato are in accordance with the work done by different researchers. Work of Chaudhuri *et al.*, (2001), who reported that the aphid (*Aphis gossypii*), whitefly (*Bemisia tabaci*), leaf miner (*Liriomyza trifolii*), tingid bug (*Urentius hystricellus*) and fruit borer (*Helicoverpa armigera*) as insect-pests on tomato crop, confirms these findings. View of Umeh and

Onukwu (2005) also support present work, who reported that the populations of major insect pests and yield of tomato. *Bemisia tabaci, Aphis gossypii* and *Helicoverpa armigera* contributed significantly to yield losses. There was a negative correlation between the percentage of plants attacked by the insect pests and yield. Kakati *et al.,* (2005) also support these findings, who reported that the population build up of the tomato fruit borer pest had significant negative correlation with minimum temperature and non-significant correlation with maximum temperature. Present piece of work gets full support of Nagamandla *et al.,* (2017) regarding thrips infestation on tomato. They observed that peak population of thrips (*Scirtothrips dorsalis* Hood), under open condition was observed in 7th SWM (1.20 thrips/leaf). Highest pest attack has been found to take place from 4th SMW to 7th SMW under open conditions. Maximum, Minimum and average relative humidity was significant negatively correlated with thrips population under open condition and all weather parameters were statistically non-significant under poly house condition. Work done by Sapkal *et al.,* (2018), support fully this work on fruit borer, *Helicoverpa armigera* (Hubner) regarding seasonal incidence of *Helicoverpa armigera* (Hubner) on tomato. The population of *H. armigera* started during 35th SMW (0.5 larvae/plant) and there after the population reaches 2.8 larvae plant in the 47th SMW and the highest population recorded during fruiting stage of the crop in the range of 4.2 larvae per plant.

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