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Effect of abiotic and biotic factors on population of tomato fruit borer (*Helicoverpa Armigera*) on tomato

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Abstract
5 species of insects were observed to be associated with various stages of the tomato crop. The first major group of insects to attack in the vegetative stage was Jassid, aphid, serpentine leaf miner and whitefly and was available till maturity of the crop. The second group of insect which included only one insect *i.e.* tomato fruit borer was the most important and pre dominant pest. Jassid was present on the crop during the entire cropping season and remained available up to the crop maturity stage. Aphid was present on the crop almost during the entire cropping season and remained available up to crop maturity stage. Leaf miner was present on the crop during the entire cropping season and remained available up to the crop maturity stage. Whitefly was present on the crop during the fruiting stage and remained available up to crop maturity stage. Lady bird beetle was present on the crop from the reproductive stage.
The fruit borer larva was first observed during the 2nd SW and reached at its peak (1.4 larvae / plant) during 4th SW. During this period the maximum and minimum temperature were 21.5 and 9^{0}C, respectively, whereas morning and evening relative humidity were 89 and 57 per cent, respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 6.8 hrs, 3.5 km / hr, 8.7 mm, 10.2 mm and 1.9 mm, respectively. After 10th SW, there was a gradual decline in the larval population and was available up to 16th SW.

Keywords: abiotic and biotic factors, tomato fruit borer, (Helicoverpa Armigera)

Introduction

Tomato (*Solenum esculentum*) is one of the most important vegetable crop in the world and is grown in all season. The origin of tomato is Peru in South America and Mexico in North America for exotic and cultivated type, respectively. Vasco-De- Gamma, a native of Portugal, made its transport in India. Razdan and Mattoo, (2007) [6] fresh fruits of tomatoes are used in salads, various culinary preparations, juices, or processed in the form of purees, concentrates, condiments sauces and vegetables an important source of vitamins A & C and minerals. Chowdhury, (1979) [1] 100g fresh edible portion of tomato contains water 94.1 g; protein 1.0 g; fat 0.3 g; carbohydrate 4.0 g; fiber 0.6 g; vitamins. The 1100 IU; citric acid 390 mg; oxalic acid 7.5 mg; potassium 268 mg; calcium 11 mg; magnesium 11 mg; iron 0.6 mg; phosphorous 27 mg; sulphur 11 mg; chlorine 51 mg. The tomato fruits are not only nutritive but have rich medicinal value. The pulp and juice of fruit is mild aperients, a promoter of gastric secretion and blood purifier. It stimulates torpid liver and cures chronic dyspepsia. It's also very useful for the patients of bronchitis and asthma. Its fruits are useful in sore mouth etc. Tiwari and Choudhury, (1990) [12] it has also been reported a good natural stimulate that helps to wash away the poisons, which cause disease and contaminate the human body system. Mutanen *et al*., (2011) [5] tomatoes are the richest source of lycopene, a phytochemical that protects cells from oxidants that have been linked to human cancer and other antioxidant compounds in tomato fruit include flavonoids and phenolic acids are regarded as potentially health benefitting compounds since they are implicated in the prevention of human inflammatory and cardiovascular diseases as well as cancer.
Tomato production faces many problems. Among the various factors that minimize its production and quality, insect-pest infestation is undoubtedly the most important one. The tomato crop is known to suffer heavy losses by varieties of pests appearing at different stages of its growth and development. These pests cause problem in the production of tomato fruits every year Dharumarajan *et al*., (2009) [2]. Swarup & Sharma, (1965) [11] had listed many insect pests, among them whitefly, tomato fruit borer, leaf miner, aphid and jassids from seedling to harvesting of fruits. These insects infest and hamper the growth & development of the plants and fruits. The sucking pests not only feed on foliage, stem and fruit but also act as the vector for disseminating tomato virus.

Besides other insect pests causing considerable damage, fruit borer *H. armigera* is the serious one which causes considerable losses in quantity as well as quality of tomato fruits Reddy and Zehrm (2004) [8]. The pest is active throughout the year at places having moderate climate but its activity is adversely affected by severe cold. Considerable economical losses due to *H. armigera* of about 50-60% fruits in tomato crop. In view of the above mentioned facts there was a need to find out the effect of abiotic and biotic factors on tomato fruit borer *H. armigera* under field conditions, so study was carry out.

Materials and Methods

The details of materials used and techniques adopted in the investigation are as Pusa Ruby varieties were transplanted in the field in the lines. The experiment was laid out in (RBD) replicated thrice. The tomato plants were transplanted in 4x5 m^2 plots and all the recommended agronomical practices were followed to raise the crop. The soil of nursery was inoculated with *Trichoderma* @ 1 kg/ acre of soil. Seeds were sown on December. As a precautionary measure two seedlings were transplanted at a single spot and one week after, the healthy plants were allowed only to grow and weaker ones were removed. A light irrigation was provided after planting the seedlings. The 25 days old seedlings were transplanted. Five pheromone traps/ ha were applied for the monitoring of moth population activity in the field during the crop season.

3. 5. Monitoring of major insect pests of tomato

Major insect pests associated with tomato crop was recorded right from transplanting till harvest of the crop at weakly interval. Population (total of nymphs and adults) of aphid, jassid, thrips, leaf miner and whitefly were taken on 6 leaves per plant *viz. (*two upper, two middle and two lower plant canopies).

Leaf miner: Five plants per plot were selected at random and six leaves (two upper, two middle and two lower) in every plant were observe for the phyto extract and to calculate the per cent infestation by leaf miner, 30 leaves of five selected plants, were observed.

$$\% \text{ Leaf infestation by leaf minor} = \frac{\text{No. of damage leaf observed}}{\text{Total No. of leaf observed}} \times 100$$

Jassid: Five plants per plot were selected at random and six leaves (two upper, two middle and two lower) in every plant was observe for the phyto extract.

Aphid: Five plants per plot were selected at random and six leaves (two upper, two middle and two lower) in every plant was observe for the phyto extract.

White fly: The observations were taken on one selected twig of 10cm in each plant of randomly selected plants in the plot. Each twig was covered carefully with transparent polythene bags. The numbers of nymph and adult flies were counted in each twig. Five plants were selected randomly for this purpose.

Tomato fruit borer

For the monitoring of *H. armigera*, pheromone traps were installed in field. The field was divided into 3 equal plots. Two pheromone traps were placed by erecting a long stick 4-6 feet and trap was tied tightly to it at 1 meter high from ground level. The height of traps was increased as the crop grows such that septa was 1 feet above from the crop level. Pheromone septa were replaced every 4 week. A minimum of 20 meters distance was maintained between the traps. Trapped moths were counted weekly. The catches were totaled and average percentage catches interpreted according to standard week. (The calendar year was divided in standard week; 1st Jan to 7th Jan was considered as first standard week).

Results and Discussion

(A) Biotic factors

Studies revealed that about 5 species of insects were observed to be associated with various stages of the tomato crop (after transplanting) (Table 1). The first major group of insects to attack in the vegetative stage was jassid, aphid, serpentine leaf miner and whitefly and was available till maturity of the crop. The second group of insect which included only one insect *i.e.* tomato fruit borer was the most important and pre dominant pest.

Table 1: List of insect complex on tomato (after transplantation)

Common name	Scientific name	Order	Family
Ladybird beetle	*Coccinella septempunctata* L.	Coleoptera	Coccinellidae
Leaf miner	*Liriomyza trifolii* (Burgess)	Diptera	Aphididae
Jassid	*Amrasca devastans* (Butler)	Hemiptera	Cicadellidae
Aphid	*Aphis gossypii* (Glover)	Hemiptera	Agromyzidae
Whitefly	*Bemisia tabaci* (Genn.)	Hemiptera	Aleyrodidae
Fruit borer	*Helicoverpa armigera* (Hub.)	Lepidoptera	Noctuidae

1. Jassid, *Amrasca devastans* (Butler) (Hemiptera: Cicadellidae)

In the study jassid was first observed when the crop age was about 17 days old (after transplantation) (Table 2 and Figure 1). From the figure it is evident that the pest was present on the crop during the entire cropping season and remained available up to the crop maturity stage *i.e*. last week of March. First appearance of the pest was recorded during the 50th standard week (SW). The number of jassid (nymph + adult) was worked out as weekly average per leaf. After 6th SW there was a decline in the jassid population and was available upto 12th SW (*i.e.*19th to 25th March)

2. Aphid, *Aphis gossypii* (Glover) (Hemiptera: Aphididae)

Aphid was first recorded when the crop age was about 17 days old (after transplantation). From the figure it is evident that the pest was present on the crop almost during the entire cropping season and remained available up to crop maturity stage *i.e.* third week of April. First appearance of the pest was recorded during the 50th SW. The number of aphid (nymph + adult) was worked out as weekly average per leaf. It is seen that the aphid population started increasing from 50th SW (10th to 16th Dec.) and reached at its peak (1.45 aphid /leaf) during 7th SW (12th to 18th Feb). After 7th SW, there was a gradual decline in the aphid population and was available up to 16th SW (16th to 22nd April)

3. Serpentine leaf miner, *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae)

First appearance of the serpentine leaf miner was observed when the crop age was about 25 days (Table 2 and Figure 1). From the figure it is evident that the pest was present on the crop during the entire cropping season and remained available up to the crop maturity stage *i.e.* third week of April. Symptom of leaf miner infestation on the foliage was first observed on 12th December *i.e.* 50th SW. The percentage leaves infested by serpentine leaf miner was worked out as weekly average. From the figure it is evident that serpentine leaf miner infestation started increasing gradually from 50th SW and reached at its peak (34.2 percent) during 9th SW (26th Feb to 4th March). After 9th SW, there was a sudden decline in the leaf miner infestation and it reached 31 percent in the 10th SW (5th to 11th March). After 10th SW, there was a gradual increase in the leaf miner infestation and it attained second peak (45.6 percent) in the 16th SW (16th to 22nd April). After 16th SW the crop was harvested.

4. Whitefly, *Bemisia tabaci* (Genn.) (Hemiptera: Aleyrodidae)

In the study incidence of whitefly was first observed when the crop age was about 39 days (after transplantation) (Table 2 and Figure). From the figure it is evident that the pest was present on the crop during the fruiting stage and remained available up to crop maturity stage *i.e.* third week of March. First appearance of the pest was recorded during the 1st SW. The numbers of whiteflies (nymph + adult) were worked out as weekly average per leaf. From the figure it is seen that whitefly population started increasing from 1st SW (1st to 7th January) and reached at its first peak (3.4 whitefly /leaf) during 4th SW (22nd to 28th January). After 4th SW there was a sudden decline in the whitefly population and reached 2.6 whiteflies /leaf during 4th SW (29th January to 4th February). From 6th SW (5th to 11th February) it started increasing and attained second peak (6.2 whiteflies /leaf) during 8th SW (19th to 25th February) After 8th SW there was a gradual decline in the whitefly population and was available up to 14th SW (2nd to 8th April)

5. Natural enemie

Ladybird beetle, *Coccinella septempunctata* L. (Coleoptera: Coccinellidae)

First incidence of lady bird beetle was observed when the crop age was about 38 days (Table 2 and Figure 1). From the figure it is evident that the predator was present on the crop from the reproductive stage and remained available up to the second week of Feb *i.e.* reproductive stage of the crop.

Fruit borer, *H. armigera* (Lepidoptera: Noctuidae)

First incidence of the fruit borer was observed when the crop age was about 38 days old (after transplantation) (Table 2 and Figure 1). From the figure it is evident that the pest was present on the crop during the fruiting stage and remained available up to the crop maturity stage *i.e.* third week of April.

(B) Abiotic factors

The fruit borer larva was first observed during the 2nd SW (8th to 14th January). The number of fruit borer larvae was worked out as weekly average per plant. From the figure it is evident that fruit borer larval population started increasing from 2nd SW and reached at its peak (1.4 larvae / plant) during 4th SW (22nd to 28th January). During this period the maximum and minimum temperature were 21.5 and 9 ^{0}C, respectively, whereas morning and evening relative humidity were 89 and 57 per cent, respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 6.8 hrs, 3.5 km / hr, 8.7 mm, 10.2 mm and 1.9 mm, respectively. There was 13.2 mm rainfall during this week, which occurred in 2 days. After 4th SW, there was a decline in the larval population and it reached 1.1 larvae/plant during 5th SW (29th Jan. to 4th Feb.). After 5th SW, there was a gradual increase in the larval population and it attained second peak (5.2 larvae/plant) in the 10th SW (5th to 11th March). During this period maximum and minimum temperature were 30.8 and 11.6 0C, respectively, whereas morning and evening relative humidity were 76 and 18 percent, respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 8.3 hrs, 4.9 km/hr, 8.9 mm, 6mm and 4.8 mm, respectively. No rains were observed during this period. After 10th SW, there was a gradual decline in the larval population and was available upto 16th SW (16th to 22nd April).

Present findings are in accordance with those of Umeh *et al*., (2002) [13], Reddy and Kumar (2004) [7], Kharpuse (2005) [3] and Kumar (2008) [4], respectively. They also reported that the fruit borer, *H. armigera (*Hub.*)* to be an important fruit borer pest of tomato and was present in the reproductive stage of the crop.

Compilation of the information on insect succession on tomato revealed that 6 species of insect complex appeared at different stages of crop growth which constituted 3 species of order Hemiptera, 1 each of Diptera, Coleoptera and Lepidoptera, respectively (Table 1 and Figure 1).

These investigations are confirmed by on the contrary, Reddy and Kumar (2004) [7] have reported fifty one insect species belonging to 21 families on tomato. The 5 major insects reported in the present findings are in conformity with the findings of Kumar (2008) [4] who also reported the above 5 major insects.

Table 2: Insect pest complex and natural enemies on tomato.

Date of observations	Insects				Crop age	Crop stage
	Name		Order	Family		
	Common	Scientific			(DAT)	
12$^{B'}$, 19^{ih} and 26* Dec	Jassid	*Amrasca devastans (Butler)*	Hemiptera	Cicadeilidae	17-31	VS
	Aphid	*Aphis gossypii (Glover)*	Hemiptera	Aphid idae		
	Leaf miner	*Uriomyza trifolii (Burgess)*	Diptera	Agromyzidae		
	Jassid	*A. devastans (Butler)*	Hemiptera	Cicadeilidae		
2nd Jan	Aphid	*A. gossypii Glover)*	Hemiptera	Aphididae		
	Leaf miner	*L trifolii (Burgess)*	Diptera	Agromyzidae	38	VS
	Ladybird beetle	*Coccinella septempunctata L*	Coleoptera	CoccineHidae		
	Jassid	*A. devastans (Butler)*	Hemiptera	Cicadeilidae		
	Aphid	*A. gossypii (Glover)*	Hemiptera	Aphididae		RS
9th, 16*, 23rd and 30^{s1} Jan	Whitefly	*Bemisia tabaci (Genn.)*	Hemiptera	Aleyrodidae	39-66	and 25% M

	Ladybird beetle	*G. septempunctata L.*	Coleoptera	CoccineHidae		
	Fruit borer	*Helicoverpa armigera (Hub.)*	Lepidoptera	Noctuidae		
	Jassid	*A. devastans (Butler)*	Hemiptera	Cicadeilidae		
	Aphid	*A. gossypii (Glover)*	Hemiptera	Aphididae		RS
6th,13th	Whitefly	*B tabaci (Genn.)*	Hemiptera	Aleyrodidae	66-87	
and	Leaf miner	*L trifolii (Burgess)*	Diptera	Agromyzidae		And
20th Feb	Lady bird beetle	*C. septempunctata L.*	Coleoptera	CoccineHidae		50% M
	Furit borer	*H. armigera (Hub.)*	Lepidoptera	Noctuidae		
27th Feb., and	Jassid	*A. devastans (Butler)*	Hemiptera	Cicadeilidae		
	Aphid	*A. gossypii (Glover)*	Hemiptera	Aphididae	88-101	50% M
5th Mar	Whitefly	*S. tabaci (Genn.)*	Hemiptera	Aleyrodidae		
	Leaf miner	*L. trifolii (Burgess)*	Diptera	Agromyzidae		
	Furit borer	*H. armigera (Hub.)*	Lepidoptera	Noctuidae		
12m,19m and 26th Mar	Jassid	*A. devastans (Butler)*	Hemiptera	Cicadeilidae		
	Aphid	*A. gossypii (Glover)*	Hemiptera	Aphididae		
	Whitefly	*8. tabaci (Genn.)*	Hemiptera	Aleyrodidae		
	Leaf miner	*L trifolii (Burgess)*	Diptera	Agromyzidae	102-129	M
	Furit borer	*H. armigera (Hub)*	Lepidoptera	Noctuidae		
2nd, 9th	Aphid	*A. gossypii (Glover)*	Hemiptera	Aphididae		
And	Leaf miner	*L trifolii (Burgess)*	Diptera	Agromyzidae		
16th April	Fruit borer	*H. armigera (Hub.)*	Lepidoptera	Noctuidae		

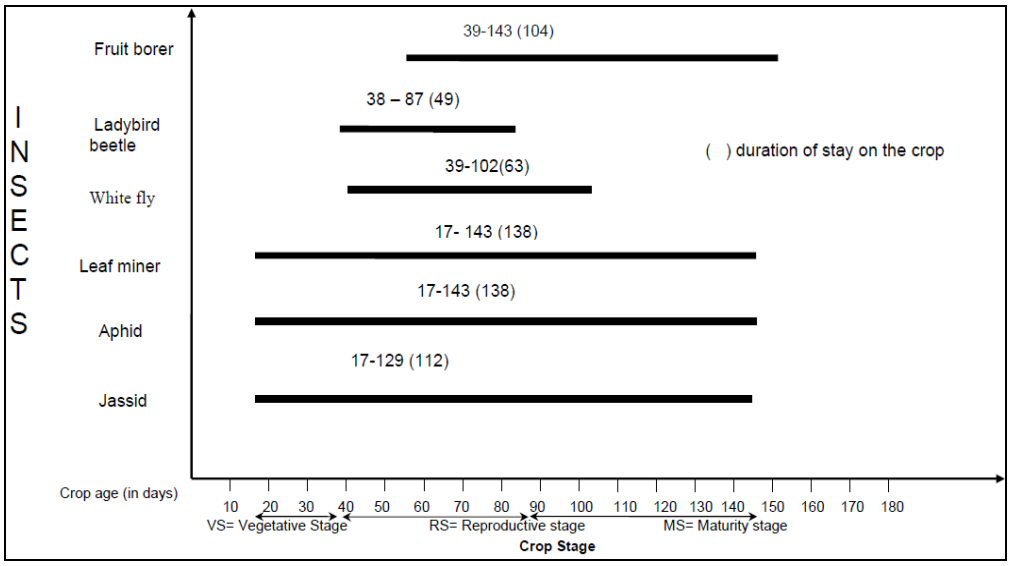

Fig 1: Presence of insect and natural enemy on tomato (after transplantation).

Conclusion

5 species of insects were observed to be associated with various stages of the tomato crop (after transplanting) (Table 1). The first major group of insects to attack in the vegetative stage was jassid, aphid, serpentine leaf miner and whitefly and was available till maturity of the crop. The second group of insect which included only one insect *i.e.* tomato fruit borer was the most important and pre dominant pest. Jassis was present on the crop during the entire cropping season and remained available up to the crop maturity stage *i.e.* last week of March. Aphid was present on the crop almost during the entire cropping season and remained available up to crop maturity stage *i.e.* third week of April. Leaf miner was present on the crop during the entire cropping season and remained available up to the crop maturity stage *i.e.* third week of April. Whitefly was present on the crop during the fruiting stage and remained available up to crop maturity stage *i.e.* third week of March. Lady bird beetle was present on the crop from the reproductive stage and remained available up to the second week of Feb *i.e.* reproductive stage of the crop.

The fruit borer larva was first observed during the 2nd SW (8th to 14th January) and reached at its peak (1.4 larvae / plant) during 4th SW (22nd to 28th January). During this period the maximum and minimum temperature were 21.5 and 9 ^{0}C, respectively, whereas morning and evening relative humidity were 89 and 57 per cent, respectively. Further sunshine, wind speed, morning and evening vapour pressure and evaporation were 6.8 hrs, 3.5 km / hr, 8.7 mm, 10.2 mm and 1.9 mm, respectively. After 10th SW, there was a gradual decline in the larval population and was available upto 16th SW (16th to 22nd April).

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