Journal of Agrometeorology 21 (2) : 193-196 (June 2019)

Influence of prevailing weather parameters on population dynamics of fruit borer, *Helicoverpa armigera* (Hübner) on tomato in Haryana

SHIVANI KHOKHAR[1], KRISHNA ROLANIA[1], GAURAV SINGH[1] and ANIL KUMAR[2]

[1]Department of Entomology, [2]Department of Agricultural Meteorology,
CCS Haryana Agricultural University, Hisar-125004, Haryana, India
Corresponding author e-mail: shivanikhokhar08@yahoo.in

ABSTRACT

A field experiment was conducted for two years (2016-17 and 2017-18) at Entomological Research Area, Department of Entomology, CCS Haryana Agricultural University, Hisar to ascertain the influence of various meteorological parameters on population fluctuations of *Helicoverpa armigera* on tomato. The maximum oviposition (4.60 eggs/ plant) was recorded during 15th standard meteorological week (SMW) whereas larval population was at peak (4.91 larvae/ plant) during 16th SMW. The larval population showed significant positive correlation with maximum temperature (r=0.617*) and highly significant negative correlation with morning (r=-0.784**) as well as evening relative humidity (r=-0.814**). Maximum eggs parasitization (12.85 %) by *Trichogramma* sp. was recorded during 16th SMW. These trichogrammatid parasitoids exhibited non-significant correlation with weather parameters and highly significant positive correlation (r=0.976**) with egg counts of *H. armigera*. Multiple linear regression analysis showed that 77 per cent (R^2=0.77) variability in larval population was accounted by weather parameters particularly maximum temperature, morning and evening relative humidity.

Keywords: Helicoverpa armigera, population, weather, parasitization, correlation

Tomato (*Solanum lycopersicum*), being the second most important vegetable crop, is cultivated throughout the world either outdoor or indoor for its edible fruits and fresh market consumption. The production and productivity of tomato crop is hampered by various biotic and abiotic factors among which, tomato fruit borer, *Helicoverpa armigera* Hübner is the major biotic stress (Consenza and Green, 1979). Being highly polyphagous in nature, it is reported to attack nearly 181 host plants and severally damage most of the economically important agricultural crops like cotton (Mukherjee and Bhowmik, 2009), tomato (Nebapure *et al.* 2018), pigeonpea (Deb and Bharpoda, 2017), chickpea (Sagar *et al.* 2017), oil seeds, cereals and vegetable crops (Dabhi *et al.* 2013). Studies on seasonal incidence in relation to abiotic factors are important for better understanding of pest scenario in different agro-climatic conditions. Before developing any management programme against insect-pests for particular agro ecosystem, it is necessary to have basic information on seasonal abundance of pest as well as their natural enemies in relation to meteorological parameters, as it helps to determine weak link in insect life cycle. Keeping this in view, we studied population dynamics of *H. armigera* and its relation with prevailing weather parameters.

MATERIALS AND METHODS

The experiment was conducted for two years (2016-17 and 2017-18) at Research Farm, Department of Entomology, CCS Haryana Agricultural University, Hisar to study the effect of weather parameters on the population dynamics of *H. armigera* and its potential parasitoids *(Trichogramma* spp.*)* in tomato. Crop was raised by following the recommended package of practices excluding the plant protection measures. Nursery of tomato *cv*. Selection-7 was procured from Department of Vegetable Science, CCS Haryana Agricultural University, Hisar and each year seedlings were transplanted in a flat bed of 100 m^2 by adopting 60 cm × 45 cm spacing in the second week of February. The whole bed was divided into 4 quadrates of 5 m × 5 m each and pest population (eggs and larvae) was recorded at weekly interval starting from 15 days after transplanting. Eggs and larvae were counted during morning hours (6.00 to 8.00 AM) from randomly selected five plants per quadrate. Growing shoots and buds were carefully examined with hand lens for the presence of eggs and young larvae which were counted by "direct visual counting method". Leaves and flower buds were thoroughly examined for the presence of early instar larvae. To record egg parasitization by *Trichogramma* spp., 50 eggs of *H. armigera*

Table 1: Population dynamics of *H. armigera* in relation to different weather parameters in tomato (pooled data of 2016-17 & 2017-18)

SMW	*H. armigera*		Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Sunshine (hours)	Wind Velocity (km h^{-1})
	Eggs/ plant	Larvae/ plant	Maximum	Minimum	Morning	Evening			
9	0.9	0.0	27.5	10.2	91	42	0.0	7.4	2.8
10	1.1	0.5	27.2	10.1	87	40	0.5	7.4	3.6
11	1.4	1.1	28.7	10.0	85	35	0.0	7.8	2.6
12	2.2	1.2	30.9	13.0	86	38	0.0	7.9	2.9
13	2.8	2.4	35.5	15.2	79	29	0.0	8.7	3.2
14	3.8	2.8	35.7	18.6	64	30	0.0	6.3	6.5
15	4.6	3.0	35.4	16.0	65	27	1.0	8.6	4.6
16	4.4	4.9	40.3	21.1	50	25	0.0	9.1	4.7
17	3.9	4.7	38.9	20.7	52	25	0.0	8.2	5.1
18	2.6	4.2	39.1	23.1	57	26	0.0	7.5	7.0
19	1.3	3.2	40.9	23.6	56	23	0.1	7.8	5.9
20	0.4	2. 8	40.5	24.7	56	31	0.0	6.8	6.1
21	0.2	1.3	41.7	24.3	52	25	0.0	8.4	4.6
22	0.0	0.9	41.0	25.6	70	41	2.2	7.7	8.4

Table 2: Correlation co-efficient between *H. armigera* population, egg parasitization and different weather parameters (pooled values of 2017 and 2018)

Weather parameter	Eggs/plant	Larvae/plant	Egg parasitization by *Trichogramma* spp.
Maximum temperature (Tmax)	0.054	0.617*	0.077
Minimum temperature ((Tmin)	-0.101	0.513	-0.078
Morning relative humidity (RH I)	-0.266	-0.784**	-0.257
Evening relative humidity (RH II)	-0.487	-0.814**	-0.449
Sunshine duration (BSS)	-0.207	-0.267	-0.166
Rainfall	0.313	0.256	0.260
Wind velocity	-0.061	0.375	-0.028

* Correlation is significant at the 0.05 level of significance (Two-tailed)
; ** Highly significant

were collected per week and kept at room temperature for incubation. After that, eggs were examined under the stereo zoom binocular microscope in Biocontrol laboratory, Department of Entomology for the presence of parasitization, if any. The weekly meteorological data on different weather parameters was procured from Agrometeorological observatory (Lat.: $29^0$10' N, Long.: $75^0$46' E & Alt. 215 m), Department of Agrometeorology, CCS Haryana Agricultural University, Hisar. Data on pest population counts and all weather parameters were pooled for 2017 and 2018. Correlation co-efficient and multiple linear regressions of fruit borer population with different weather parameters was estimated using OPSTAT software (http://192.168.2.174/opstat/default.asp) *i.e.* online platform for on-campus user.

RESULTS AND DISCUSSION

Egg counts of H. armigera in relation to weather parameters

Continuous monitoring of pest population revealed that oviposition by *H. armigera* was first noticed during 9th SMW (1st week of March) with 0.90 eggs per plant which increased afterwards and attained the peak (4.60 eggs/

Table 3: Fruit infestation by *H. armigera* in tomato at different pickings (pooled data of 2017 & 2018)

Fruit picking period	Fruit infestation (%) (Number basis)	Fruit infestation (%) (Weight basis)
18 SMW - First picking	24.2	27.0
19 SMW - Second picking	28.4	32.7
20 SMW - Third picking	35.4	38.6
21 SMW - Fourth picking	36.6	38.7
22 SMW - Fifth picking	25.1	27.8
Mean fruit infestation	29.9	33.0

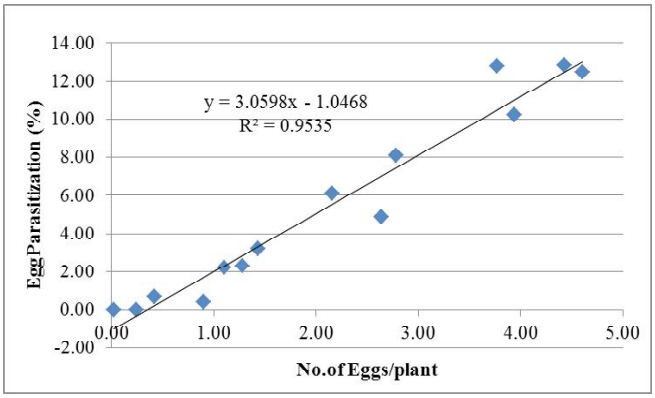

Fig. 1: Egg parasitization of *H. armigera* eggs by trichogramma spp. in relation to number of eggs of *H. armigera*

plant) during 15th SMW (Table 1). Thereafter, a declining trend was recorded in egg laying which continued up to 22nd SMW. Eggs of *H. armigera* were majorly parasitized by egg parasitoid, *Trichogramma* spp. under prevailing weather conditions. *Trichogrammatids* exhibited non- significant correlation with all meteorological parameters (Table 2). However, egg parasitizing behaviour of parasitoid was significantly positively correlated (r=0.976*) with eggs counts of *H. armigera* indicating a proportional increase in eggs parasitization with increase in number of eggs laid (Fig. 1). Present findings were supported by Ballal and Singh (2003) who reported that per cent egg parasitization of *H. armigera* by *Trichogramma* spp. were positively correlated with number of eggs.

***Larval population in relation to weather factors*:**

Commencement of larval population of *H. armigera* was first noticed during 9th SMW (1st week of March) which followed an increasing trend up to 16th SMW and then experienced a declining trend which continued up to 22nd SMW (Table 1). Selvaraj and Bisht (2014) also reported that incidence of *H. armigera* started during February and March which attained peak infestation level during March and April (15th and 16th SMW). The larval population was significantly and positively correlated with prevailing maximum temperature and non-significantly positively correlated with minimum temperature as revealed by the correlation analysis (Table 2). Antithetical to this, a highly significant negative relationship was observed between larval population and relative humidity (morning as well as evening) whereas the influence of all other weather factors was non-significant. Jat *et al.* (2017) reported significant positive association (r = 0.518*) between weather parameters and larval population of *H. armigera* on pigeonpea. The larvae of tomato fruit borer was observed feeding on leaves, buds, flower and fruits throughout the crop period (9th SMW to 22nd SMW) but the infestation was more pronounced on fruits which resulted into direct loss in yield as recorded at each picking interval. Maximum fruit infestation was recorded during 3rd picking (20 SMW *i.e.,* 3rd week of May) on both number and weight basis (Table 3). Similar fruit infestation by *H. armigera* was reported by Singh and Singh (1977).

Regression analysis

The multiple linear regression analysis of *H. armigera* larval population indicated that three important weather parameters *viz.,* maximum temperature, morning relative humidity and evening relative humidity accounted 77 per cent variability in larval population Prasannakumar *et al.* (2011) reported that tomato fruit borer were influenced to an extent of 97 per cent by the combination of weather parameters *viz.,* temperature (maximum and minimum), relative humidity (morning and evening) and rainfall.

$$\text{Larval (Y)} = 9.01 - 0.035 * \text{Tmax} - 0.0.39 * \text{RH I} - 0.095 * \text{RH II}$$

$$R^2 = 0.77^{**}$$

CONCLUSIONS

It is evident from the two year study that peak egg and larval population occurred during 15th and 16th SMW coinciding with vegetative and fruit development stage of the crop, respectively. The larval population had significant positive correlation with maximum temperature and negative

correlation with relative humidity. The maximum temperature, morning and relative humidity altogether explained 77 per cent variability in pest population.

ACKNOWLEDGEMENT

We are thankful to Head, Department of Entomology, COA, CCS Haryana Agricultural University, Hisar for providing required support during these studies. We are also thankful to Department of Agrometeorology for providing the required weather data and technical support during course of work.

REFERENCES

Ballal, C.R. and Singh, S.P. (2003). The effectiveness of *Trichogramma chilonis* and *T. brasiliense* as parasitoids of *Helicoverpa armigera* on sunflower and redgram. *Biocontrol Sci. Techn.,* 13:231-240.

Consenza, G.W. and Green, H.B. (1979). Behaviour of the tomato fruitworm, *Heliothis zea* on susceptible and resistant lines of processing tomatoes. *Hortscience*, 14:171-173.

Dabhi, M.V., Koshiya, D.J. and Korat, D.M. (2013). Effect of abiotic factors on population of aphid and damage by shoot and fruit borer in okra during summer and kharif season at Anand in Gujarat. *J. Agrometeorol.*, 15(1):71-74.

Deb, S. and Bharpoda, T.M. (2017). Impact of meteorological factors on population of major insect pests in tomato, *Lycopersicon esculentum* Mill. under middle Gujarat condition. *J. Agrometeorol.*, 19(3):251-254.

Jat, B.L., Dahiya, K.K., Lal, R and Niwas, R. (2017). Effect of weather parameters on seasonal incidence of pod borer complex in pigeonpea. *J. Agrometeorol.*, 19(3): 255-258.

Mukherjee, A. and Bhowmik, P. (2009). Incidence of cotton bollworm *(Helicoverpa armigera Hibner)* in relation to meterological parameters in the saline zone of West Bengal. *J. Agrometeorol.*, 11(2):169-171.

Nebapure, S.M., Sagar, D. and Chander, S. (2018). Population dynamics of insect pests on short duration pigeon pea in relation to weather parameters. *J. Agrometeorol.*, 20(3):234-237.

Prasannakumar, N. R., Chakravarthy, A. K., Naveen, A.H. and Narasimhamurthy, T.N. (2011). Influence of weather parameters on pheromone traps catches of selected lepidopterous insects pests on vegetable crops. *Curr. Biotic.,* 4(4):442-452.

Sagar, D., Nebapure, S.M. and Chander, S. (2017). Development and validation of weather based prediction model for *Helicoverpa armigera* in chickpea. *J. Agrometeorol.*, 19(4):328-333.

Selvaraj and Bisht, R.S. (2014). Seasonal incidence of *Helicoverpa armigera* (Hübner) on tomato at Pantnagar, Uttarakhand. *Int. J. App. Basic. Med. Res.*, 12(3):351-355.

Singh, H. and Singh, G. (1977). Biology studies on *Heliothis armigera* (Hub.) in Punjab, India. *J. Entomol. Sci.,* 27:154-164.

Received : January 2019 ; Accepted : March 2019