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POPULATION DYNAMICS OF FALL ARMYWORM, *SPODOPTERA FRUGIPERDA* (J.E. SMITH) ON MAIZE

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SUMMARY

Population dynamics of *Spodoptera frugiperda* (J.E. Smith) were studied at CCS Haryana Agricultural University, Regional Research Station, Uchani, Karnal on maize hybrid HQPM 1. The meteorological parameters observed during the investigation have been correlated with population of the pest. The infestation by *S. frugiperda* during 2020 varied from 9.3 to 79.1 per cent from 28th to 40th SMW (2nd week of July to 1st week of October). In the present investigations, larval population had a significant positive correlation with evening relative humidity (r = 0.652) and significant negative correlation with sun shine hours (r = -0.634). Average plant infestation had a non-significant positive correlation with morning relative humidity (r = 0.48).

Key words: Population, *Spodoptera frugiperda*, weather parameters, correlation, maize

Maize is known as the "Queen of Cereals" because of its significance in human and animal diet as well as high yield potential. It is one of the most adaptable crop and can thrive in almost all agro-climatic conditions (Jeyaraman, 2017). Maize plant is a C_4, cross-pollinated and day-neutral with economically significant growth in tropical and sub-tropical regions of the world.

Maize is a staple food crop in many areas of the world and also used as a fodder crop particularly for dairy animals. Its kernels are widely used as a source of starch. It has a starch content of 72 per cent, protein content of 10 per cent and fat content of 4 per cent (Ranum *et al.,* 2014). Globally, maize is cultivated in an area of 197.20 million hectares with a production of 1148.48 million tonnes and a productivity of 5.82 tonnes ha^{-1} (Anonymous, 2019a). In Haryana, area under maize is 30000 hectares with production of 70000 tonnes with average productivity of 2.50 t/ha (Anonymous, 2020). Productivity of India is 3.07 t/ha against the world average of 5.82 t/ha (Anonymous, 2019a). A number of factors are responsible for this low productivity, includes insect pests as major constraint. In India about 13.2% economic yield losses have been reported due to insect-pests attack and disease incidence (Anonymous, 2019) While there are approximately 139 insect pests that cause varying degrees of damage to the maize crop but only a dozen of them are of national importance and need control measures. In recent years, fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae) has appeared as a serious pest worldwide. It is a polyphagous, gregarious and disruptive pest that targets 353 plant species from 76 families. It is one of the most severe maize pest but also targets number of other crops namely, sorghum, sugarcane, cabbage, sunflower, beet, peanut, soybean, alfalfa, onion, cotton, pasture, grasses, millets, squash, tomato etc. (Montezano *et al.,* 2018). *S. frugiperda* infestations resulted in the yield losses of 15 to 73 per cent when 55 to 100 per cent of the plants were infested at various stages of development (Hruska and Gould, 1997). It infests maize plants from seedling to tasseling by destroying young plants, causing defoliation, grain deterioration and reducing yield quantity and quality (Peairs and Sanders, 1979). In India, *S. frugiperda* was reported for the first time in the maize research fields at the University of Agricultural and Horticultural Sciences in Shivmoga, Karnataka (Kalleshwaraswamy *et al.,* 2018). By August 2018, the pest had spread across the whole Southern India's maize growing regions. In Haryana, *S. frugiperda* was reported first time during the September, 2019 causing damage to maize and sorghum. Management of *S. frugiperda* is indispensable for successful cultivation of maize. Our ecosystem is a dynamic structure comprising biotic habitats in a complex relationship with the abiotic components interacting as an accomplished system. Ecological relevancies of such interactions should have been acknowledged and the

roles of abiotic drivers impacting herbivore abundance, population dynamics, biology and their adaptation to the environment should have been demonstrated. Recently, great emphasis is given to ecology-based pest management strategies, although an efficient management strategy needs to study the initial and peak infestation periods in the field. Also, in devising any control strategy, the knowledge of population dynamics of the pest is considered as a pre-requisite.

MATERIALS AND METHODS

Field study on population dynamics of *S. frugiperda* was conducted at CCS Haryana Agricultural University Regional Research Station, Uchani, Karnal. The experiment was laid in the plot size of 75 m^2 consisting of 25 rows of 4m each. The maize hybrid HQPM 1 was planted at 75cm × 20 cm spacing in June, 2020. Recommended agronomic practices except insecticidal sprays were followed as per the package of practices (CCS HAU) to raise the crop. Data on weather parameters were obtained from meteorological observatory of Central Soil Salinity Research Institute, Karnal. Weekly weather entities from June 2020 to October 2020 were recorded. During the crop period, the maximum temperature (31.46ºC to 36.33ºC), minimum temperature (18.74ºC to 27.66ºC), morning relative humidity (86.71 to 97.71 per cent), evening relative humidity (49.71 to 87.43 per cent) and the bright sunshine hours (5.11 to 8.77 hours per day) were recorded. Pest infestation and pest abundance was observed on predetermined and tagged 50 plants per replication at each observation by visual count. Larval count was recorded in morning hours between 6.30 am to 8.30 am and evening hours between 5.00 pm to 7.00 pm. The observation were recorded at weekly interval starting from 5 days after germination till harvest of the crop.

RESULTS AND DISCUSSION

The results of the investigation on population dynamics of *S. frugiperda* on maize HQPM 1 revealed that the infestation of *S. frugiperda* was initiated in the 2nd week of July at 16 DAG (28th SMW) with an average population of 0.15 larvae per plant. The population increased gradually and reached to its peak in the 2th week of August (33th SMW) with a mean population of 4.93 larvae per plant. The per cent infestation was ranged from 9.3 to 79.1 per cent during 28th to 40th SMW (second week of July to first week of October, 2020) (Table 1, Fig. 1 & 2). The present investigations were consistent with those of Visalakshi *et al*., (2019) observed the peak infestation of *S. frugiperda* in the 2nd week of August. Chormule *et al*., (2019) indicated that the insect infestation started in the 3rd week of August. However, Venkateswarlu *et al.,* (2018) noticed population build up from 1st week of October (40th SMW) which reached to its maximum in last week of October. Kuate *et al*., (2019) also reported that the mean occurrence of *S. frugiperda* was maximum in October-November (60.7%), followed by February-March (58.4%) and May-June (40.6%) whereas Kumar *et al*., (2020) observed that the lowest incidence of *S. frugiperda* in the 2nd fortnight of October 2019 (10%) and the highest incidence in

TABLE 1
Population dynamics and infestation of *S. frugiperda* on maize

SMW	Duration	Average no. of larva of fall armyworm/ plant	Infestation (%)	Max. Temp. (°C)	Min. Temp. (°C)	RH (%) M	RH (%) E	Sun Shine hours
27	02 July-08 July	0.00	0.0	35.43	26.13	90.00	69.00	8.77
28	09 July-15 July	0.15	9.3	33.37	25.81	93.71	71.29	8.49
29	16 July-22 July	1.21	12.7	32.19	26.40	96.43	87.43	5.11
30	23 July-29 July	2.63	35.7	33.31	26.77	94.43	75.71	7.74
31	30 July-05 Aug.	4.15	53.3	33.31	26.81	93.86	80.43	6.01
32	06 Aug.-12 Aug.	4.60	62.0	34.33	27.57	94.71	81.86	6.57
33	13 Aug.-19 Aug.	4.93	75.6	32.07	26.60	97.71	86.00	5.16
34	20 Aug.-26 Aug.	3.15	76.7	31.46	25.31	95.71	79.00	5.71
35	27 Aug.-02 Sep.	2.91	77.2	32.70	25.47	93.71	80.00	8.13
36	03 Sep.-09 Sep.	2.62	77.8	34.06	25.81	96.00	74.57	7.16
37	10 Sep.-16 Sep.	2.38	78.1	34.65	26.10	97.57	69.14	8.11
38	17 Sep.-23 Sep.	2.30	78.4	34.97	25.76	92.86	74.57	7.94
39	24 Sep.-30 Sep.	0.90	78.6	34.29	22.61	94.14	61.86	7.77
40	01 Oct.-07 Oct.	0.41	79.1	34.49	18.74	97.14	49.71	8.60

SMW=Standard Meteorological Week, RH (M): Relative Humidity Morning, RH (E): Relative Humidity Evening.

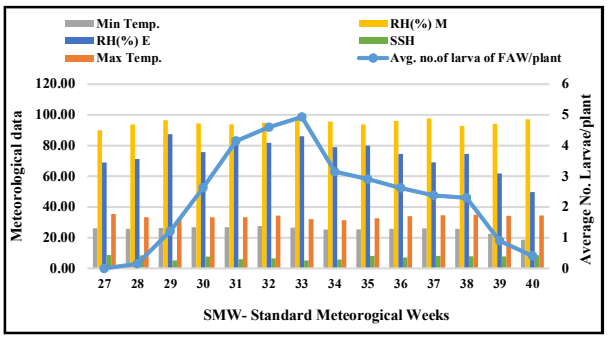

Fig. 1. Population of *S. frugiperda* larvae in relation to environmental factors during different standard meteorological weeks.

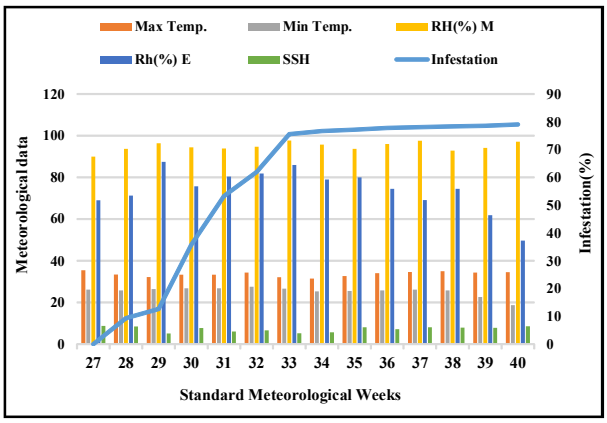

Fig. 2. Plant infestation by *S. frugiperda* in relation to environmental factors during different standard meteorological weeks.

the 1st fortnight of November (72%). Padhee and Prasanna, (2019) observed that prevalence of *S. frugiperda* was more than 70 per cent in a corn field. Dhar *et al.,* (2019) noticed first appearance of *S. frugiperda* in 20-22 days old crop. However, Bhavani *et al.,* (2019) observed the incidence in 20 to 60 days old crop. In the present investigations, larval population had a significant positive correlation with evening relative humidity (r = 0.652) and significant negative correlation with sun shine hours (r = -0.634) whereas non-significant positive correlation with minimum temperature (r= 0.519), morning relative humidity (r = 0.329) and non-significant negative correlation with maximum temperature (r = -0.401). Per cent plant infestation indicated a non-significant negative correlation with maximum temperature (r = -0.29), minimum temperature (r = -0.33), evening relative humidity (r = -0.166) and sun shine hours (r = -0.080) and non-significant positive correlation with morning relative humidity (r = 0.48) (Table 2). Similar results were reported by Fonseca-Medrano *et al.,* (2019) who observed that the pest showed a significant and positive correlation with relative humidity and minimum

TABLE 2
Correlation of larval population and infestation of *S. frugiperda* with environmental factors on maize

Weather parameter	Avg. no. of larva of fall armyworm/plant	Infestation (%)
Temperature (max.)	-0.401	-0.029
Temperature (min.)	0.519	-0.33
Relative humidity (%) Mor.	0.329	0.48
Relative humidity (%) Eve.	0.652*	-0.166
Sun shine hours	-0.634*	-0.080

*Significant at 5% level.

temperature, but a negative correlation with maximum temperature. Deole and Paul, (2018) reported that *S. frugiperda* population had a non-significant negative correlation with total rainfall (r= -0.32), evening relative humidity (r=- 0.233) and wind velocity (r=-0.341), while significant positive correlation with maximum temperature (r=0.586). Murua *et al.,* (2008) noticed that *S. frugiperda* population had a significant and positive correlation with rainfall. However, Kumar *et al.,* (2020) found positive correlation of *S. frugiperda* population with maximum temperature, and negative correlation with minimum temperature, relative humidity and rainfall. The natural enemies of fall armyworm as coccinellids, tiger beetle, ground beetle, pentatomid bug, praying mantis and spiders along with three hymenopteran larval parasitoids (*Chelonus* sp., *Cotesia* sp., *Campoletis* sp.,) were noticed during the investigation.

CONCLUSION

Plate 1. Experimental field for population dynamics and per cent infestation of *S. frugiperda* on maize.

The field population of *S. frugiperda* during different standard meteorological weeks (28th to 40th) prevailed from July to October during 2020 with 9.3 to 79.1 per cent infestation. Environmental factors affect *S. frugiperda* population in different ways as larval population had a significant positive correlation with evening relative humidity and significant negative correlation with sun shine hours. Whereas non-

significant positive correlation with minimum temperature, morning relative humidity and non-significant negative correlation with maximum temperature. Per cent plant infestation indicated a non-significant negative correlation with maximum temperature, minimum temperature, evening relative humidity as well as sun shine hours and non-significant positive correlation with morning relative humidity. Natural enemies were noticed as *Chelonus* sp., *Cotesia* sp., *Campoletis* sp., praying mantis and spiders.

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