Plant Archives Vol. 25, No. 2, 2025 pp. 2225-2230 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.2.318

POPULATION DYNAMICS OF ADULT FALL ARMYWORM (*SPODOPTERA FRUGIPERDA*) THROUGH HEROMONE TRAPS ON MAIZE

Monika Singh*, Amit Singh and Uma Shankar

Division of Entomology, SKUAST-Jammu, Chatha - 180 009 (J&K), India.

*Corresponding author E-mail : monikasbaloria@gmail.com

(Date of Receiving-05-07-2025; Date of Acceptance-20-09-2025)

ABSTRACT

A field experiments were carried out at Entomology farm, Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST-J) for two consecutive years (2021 and 2022) to examine the population dynamics of fall armyworm, The experiment was laid out in randomized block design and replicated thrice. Maize hybrid seeds were sown in the plot size of 10 x10 m^2 spaced at 60 x 20 cm between rows and plants. To analyze the adult populations, pheromone traps were installed in the field at a height higher than maize crop and replacement interval was 15 days. The weekly trap catches of fall armyworm adults were recorded to find out the adult mean population. The required weekly data on different weather parameters viz. maximum and minimum temperature, morning and evening relative humidity, rainfall, rainy days, and sunshine hours for both years of experimentation (2021 and 2022) were obtained from the section of Agro-Meteorology, SKUAST-Jammu and then weekly mean data of FAW population was correlated with weather parameters accordingly for simple correlation and linear regression studies. The results of study revealed that the population dynamics analysis indicated the emergence of adult fall armyworm starting from the 18th standard meteorological week (SMW), with first peak trap catches occurring in the 24th SMW during both years, followed by a second peak in 28th and 27th SMW during 2021 and 2022, respectively after which the population declined till 31st SMW. Weather parameters played an important role in population build-up of fall armyworm in maize crop which warrants timely and effective pest management strategies to mitigate the losses caused by FAW in maize. The meteorological conditions had 61.6% influence on the fall armyworm adult population build-up on maize.

Key words : *Spodoptera frugiperda*, Host range, Population dynamics, Meteorological weeks, Regression and Fall Armyworm.

Introduction

Maize (*Zea mays* L.) is the second major cereal crop, cultivated in approximately 165 countries on an average area of about 190 million hectares (Badhai *et a*l., 2020). Owing to its highest genetic yield potential, maize is considered as the 'Queen of Cereals'. It serves as a staple food for humans and is a crucial source of animal and poultry feed.

India ranks as the fifth leading producer of maize globally, contributing approximately 2.59 per cent to the global food grain production (FAO, 2020). During 2022-23, India exported 3,453,680.58 metric tons (MT) of maize globally, generating revenue of 8,987.13 crores (equivalent to 1,116.17 million USD) (APEDA, 2024). In India, maize cultivation is followed throughout the year, however, the *Kharif* crop predominantly covers 85 per cent of the total cultivated area. Its cultivation is widespread in Jammu and Kashmir, and is being grown in various regions including Kandi, Karewa, and Plain areas (Baba *et al*., 2019).

The maize crop suffers from both biotic and abiotic stresses. Insect pests are among the main factors leading to lower maize yield. Over 40 species of insect pest have been identified in maize Fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) has emerged as the most destructive pest of the maize ecosystem. Fall armyworm (FAW) is an invasive, polyphagous and highly destructive pest of cereals and

other cultivated plants. Being polyphagous, it feeds on 353 host-plants under 76 plant families (Montezano *et al*., 2018). Fall armyworm infestation caused a loss of around 8-21 million tons of maize per year (6.1 million USD) in twelve African countries, affecting over 300 million African people (Midega *et al*., 2018). In India, FAW was first recorded in Shivamogga, Karnataka in 2018 on maize (Sharanabasappa *et al*., 2018) which rapidly spread to almost all the neighboring states within no span of time. The maize yield in India fell to 27.8 million metric tonnes due to fall armyworm infestation back in 2018. The life cycle is completed within 30 days in summer; 60 days in spring and autumn seasons and 80-90 days in winter months. The voltinism of fall armyworm moths depends on the climatic conditions; however, about 1000-1500 eggs are laid by a typical female moth in her lifespan. (Pitre *et al*., 1983; Prasanna *et al*., 2018). The fall armyworm larvae feed voraciously on the stem, leaves and reproductive parts of more than 350 crop species, inflicting significant damage in maize and considerable damage to other crops like rice, sorghum, wheat, sugarcane, vegetables, and cotton (Abraham *et al*., 2017; Ganiger *et al*., 2018). Fall armyworm is a strong flier and migrates over longer distances of approximately 100 km per night (Liu *et al*., 2019) wherein weather factors play a major role in depicting the behavior of this pest (Anandhi *et al*., 2020). The population size and damage severity of fall armyworm is greatly decided by the environmental factors (Becker, 1974). Temperature and rainfall are the major environmental factors that govern the occurrence, survival and development of insect pests. The relationship between pests and weather factors has been documented by many authors on various crops (Saminathan *et al*., 2001; Priyanka *et al*., 2018). Insect populations do not remain constant all-round the year and vary with topography and weather parameters like temperature, rainfall and humidity (Wallner, 1987). Henceforth, it is quite important to study the population dynamics of fall armyworm with respect to fluctuations in weather parameters to provide necessary cues to devise timely management strategies of this destructive pest (Aasman, 2001).

Materials and Methods

A field experiment was conducted carried out at SKUAST-Jammu which is located in the Union Territory of Jammu and Kashmir. The Jammu district is located in the subtropical zone having an area of 3097 sq Km and having the altitude of 32.73°N and 74.87°E longitude, the Jammu District is located in the subtropical zone. To examine the population dynamics of fall armyworm, field experiments were carried out at Entomology farm, Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST-J) for two consecutive years (2021 and 2022). The experiment was laid out in randomized block design and replicated thrice Maize hybrid seeds were sown in the plot size of 10 x10 m^2 spaced at 60 x 20 cm between rows and plants. To analyze the adult populations, pheromone traps were installed in the field at a height higher than maize crop and replacement interval was 15 days. The weekly trap catches of fall armyworm adults were recorded to find out the adult mean population. The required weekly data on different weather parameters *viz*.; maximum and minimum temperature, morning and evening relative humidity, rainfall, rainy days, and sunshine hours for both years of experimentation (2021 and 2022) were obtained from the section of Agro-Meteorology, SKUAST-Jammu, and then weekly mean data of FAW population was correlated with weather parameters accordingly for simple correlation and linear regression studies. For statistical analysis, Data obtained from field experiment was statistically analyzed for analysis of variance by SPSS 16.0 software and means was compared with Tukey's HSD test at $P<0.05$

Results and Discussion

Population dynamics of fall armyworm (adults) in maize during 2021 and 2022

The data presented in Tables 1, 2 and Figs. 1, 2 related to population dynamics of fall armyworm (adults) through pheromone traps in maize recorded during 2021 and 2022 revealed that the population dynamics of fall armyworm (adults) using pheromone trap catches has resulted in noteworthy findings. It was observed that the adult fall armyworm population emerged during the 18th standard week in both years studied. As time progressed, the adult trap catches displayed a gradual upward trend, culminating in their peak abundance during the 24th standard week. After this peak, a conspicuous decline in the population was observed in the weeks leading up to the 26th standard week. Intriguingly, during the year 2021, the second peak was recorded during 28th standard week, while in 2022, it manifested slightly earlier, specifically during the 27th standard week. Following the second peak, the adult trap catches commenced a decline once more, ultimately leading to the lower trap catches during the 31st standard week. This fluctuation in the population dynamics of fall armyworm adults strongly suggests a cyclical pattern, which could be influenced by a variety of factors such as environmental conditions, seasonal variations, or other ecological elements.

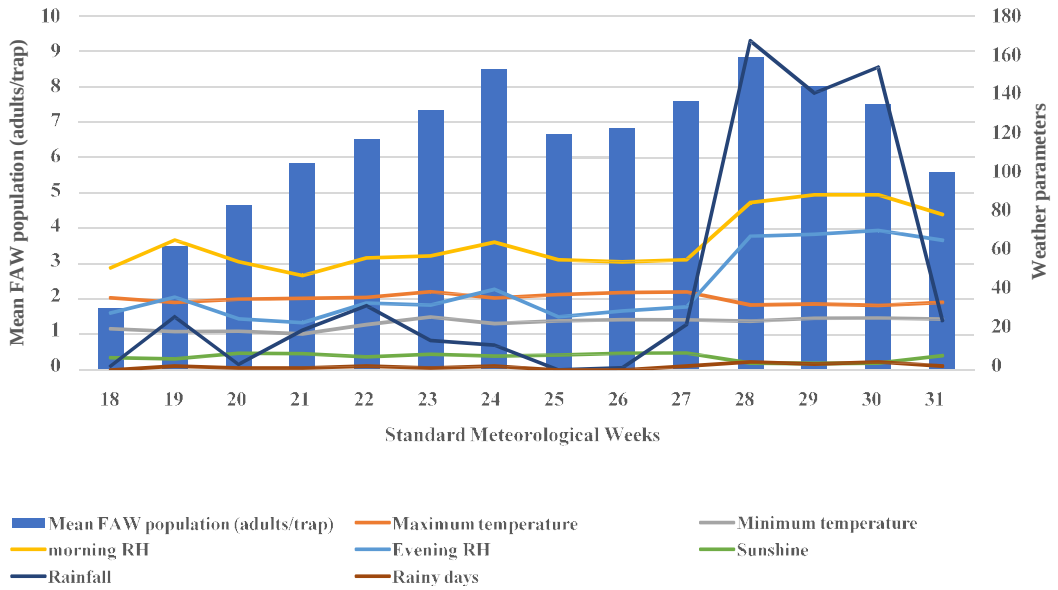

Fig. 1 : Population dynamics of fall armyworm adults through pheromone traps in maize during 2021.

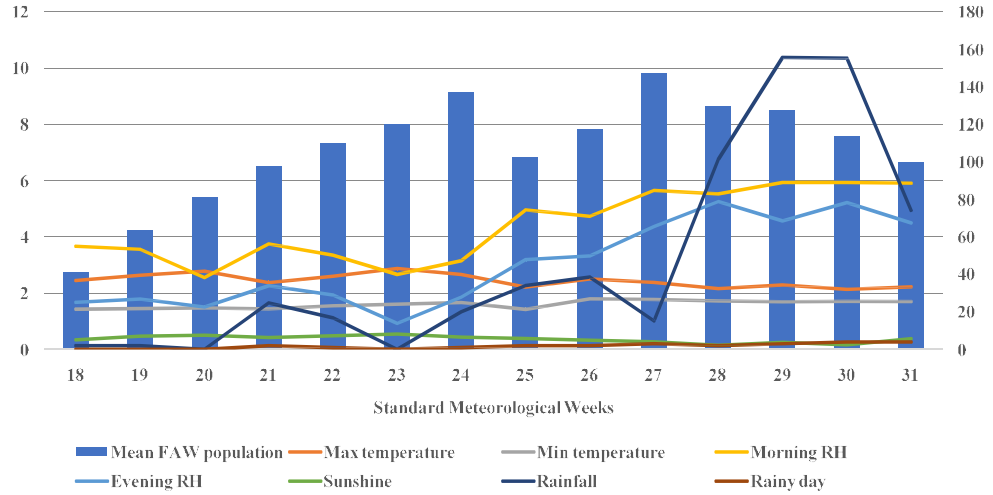

Fig. 2 : Population dynamics of fall armyworm adults through pheromone traps in maize during 2022.

Similar results were reported by Pradeep *et al.* (2022), who recorded a peak population of adult fall armyworm per trap in July, Ahissou *et al.* (2022), who recorded maximum trap catches of fall armyworm adults in the month of August when the crop was in the 6- 12 leaf stage. The slight variation in the results might have occurred due to different sowing times, and climatic and geographical conditions. Deshmukh *et al.* (2022) documented similar results that high fall armyworm trap catches in maize fields in the mid of year (June-July).

Correlation and regression studies of adult trap catches with weather parameters in maize during 2021 and 2022

The correlation and regression studies between abiotic factors (maximum and minimum temperatures, morning and evening relative humidity, sunshine hours, rainfall 62 and rainy days) and adult trap catches of fall armyworm in maize during 2021 and 2022 indicated that a highly significant positive correlation existed between the fall armyworm adult population and minimum temperature (0.689**) and rainy days (0.499**). Morning relative humidity (0.401*), evening relative humidity (0.457*), and rainfall (0.429*) had a significant positive correlation with adult trap catches of fall armyworm. However, there was a non-significant negative correlation of weekly mean maximum temperature (-0.083ns) and sunshine hours (-0.309ns) with pheromone trap catches of fall armyworm.

The linear regression equation for population dynamics of adult fall armyworm (Y= -0.889+0.747nsX1+1.413nsX2-0.835nsX3+0.560nsX4-0.115nsX5+0.115nsX6+2.186nsX7) showed the increasing trend of fall armyworm populations due to a gradual increase in temperature with 61.6 per cent overall impact of weather factors on population build-up of fall

Table 1 : Population dynamics of fall armyworm male adults/plant through pheromone traps in maize during 2021.

Standard Meteorological Weeks (SMW)	Mean FAW adults/trap	Temperature (^{0}C)		Relative humidity		Sunshine (hrs/day)	Rainfall (mm)	Rainy day
		Maximum	Minimum	Morning (%)	Evening (%)			
18	1.75	36.7	20.9	52	29	6.2	2.0	0
19	3.50	34.3	19.5	66	37	5.6	27.0	2
20	4.66	35.9	19.7	55	26	8.5	2.8	1
21	5.83	36.4	18.3	48	24	8.3	20.2	1
22	6.50	36.9	23.0	57	34	6.6	32.6	2
23	7.33	39.8	26.9	58	33	8.0	15.0	1
24	8.50	36.6	23.5	65	41	7.0	12.6	2
25	6.66	38.3	24.9	56	27	7.6	0.0	0
26	6.83	39.4	25.5	55	30	8.5	1.0	0
27	7.58	39.7	25.4	56	32	8.6	23.0	2
28	8.83	33.0	24.8	85	68	3.5	167.4	4
29	8.00	33.5	26.3	89	69	3.2	140.8	3
30	7.50	32.8	26.4	89	71	3.5	154.0	4
31	5.58	34.4	25.9	79	66	7.2	25.2	2

Table 2 : Population dynamics of armyworm male adults/plants through pheromone traps in maize during 2022.

Standard Meteorological Weeks (SMW)	Mean FAW adults/trap	Temperature (^{0}C)		Relative humidity		Sunshine (hrs/day)	Rainfall (mm)	Rainy day
		Maximum	Minimum	Morning (%)	Evening (%)			
18	2.75	36.8	21.5	55.0	25.1	5.1	2.0	0
19	4.25	39.6	21.9	53.4	26.9	7.1	2.0	0
20	5.41	41.8	22.1	38.3	22.7	7.6	0.0	0
21	6.50	35.6	21.6	56.3	34.0	6.3	24.8	2
22	7.33	39.1	23.3	50.3	29.1	7.3	16.8	1
23	8.00	43.2	24.0	40.0	14.0	8.2	0.0	0
24	9.16	40.0	25.0	47.3	27.9	6.5	20.0	1
25	6.83	33.2	21.4	74.4	47.9	5.8	34.0	2
26	7.83	37.6	27.0	71.0	49.9	4.9	38.6	2
27	9.83	35.7	26.7	84.9	65.6	4.1	15.2	3
28	8.66	32.4	25.9	83.0	78.9	2.2	101.4	2
29	8.50	34.4	25.4	89.1	68.6	3.8	155.8	3
30	7.58	32.0	25.7	89.1	78.4	2.4	155.4	4
31	6.66	33.3	25.5	88.7	67.6	5.7	74.2	4

Table 3 : Pooled correlation of pheromone trap catches in relation to abiotic factors in maize crop during both years (2021 and 2022).

Pheromone taps (lure)	Insect pest	Temperature (°C)		Relative humidity (%)		Sunshine (hrs/day)	Rainfall (mm)	Rainy day
		Maximum	Minimum	Morning	Evening			
Spodoptera frugiperda lure	*Spodoptera frugiperda* (FAW) adult male	-0.083^{ns}	0.689**	0.401*	0.457*	-0.309^{ns}	0.429*	0.499**

** Significant at the 0.01 level

* Significant at the 0.05 level

Table 4 : Pooled regression equations and co-efficient of multiple determination (R^2) of trap catches in relation to abiotic factors in maize crop during both years (2021 and 2022).

Pheromone trap (lure)	Insect pest	Regression linear equations	Multiple correlation (R)	Co-efficient of determination (R^2)	Co-efficient of Variation(%)
Spodoptera frugiperda Lure	*Spodoptera frugiperda* (FAW) adult male	$Y=0.889+0.747^{ns}X_1+1.413^{n}X_2-0.835^{ns}X_3+0.560^{ns}X_4-0.115^{ns}X_5+0.115^{ns}X_6+2.186^{ns}X_7$	0.785	0.616	61.6%

Where, Y= Mean no. of FAW adults/trap; X_1 =Maximum temperature; X_2 = Minimum temperature; X_3 = R.H morning; X_4 = R.H evening; X_5 = Sunshine hours; X_6 = Rainfall (mm); X_7 = Rainy day

armyworm on maize. Similar results were reported by Parameshwari *et al*. (2021), who recorded a negative correlation between adult fall armyworm and maximum temperature and a positive correlation between fall armyworm trap catches and minimum temperature and rainfall. Kumar *et al*. (2020), Geethalakshmi *et al*. (2004) and Mahalingam *et al*. (2003) also reported similar results.

Conclusion

On the basis of two-year study, the population dynamics analysis indicated the emergence of adult fall armyworm starting from the 18th standard meteorological week (SMW), with first peak trap catches occurring in the 24th SMW during both years, followed by a second peak in 28th and 27th SMW during 2021 and 2022, respectively after which the population declined till 31st SMW. Weather parameters played an important role in population build-up of fall armyworm in maize crop which warrants timely and effective pest management strategies to mitigate the losses caused by FAW in maize. The results of the study showed that meteorological conditions had 61.6% influence on the fall armyworm adult population build-up on maize crop.

References

Aasman, K. (2001). Effect of temperature on development and activity of maize stem borer *Chilo partellus*. *Bull. Environ. Entomol.*, **22**, 125–127.

Abraham, P., Beale T., Cock M., Corniani N., Day R., Godwin J., Murphy S., Richards G. and Vos J. (2017). Fall armyworm status, impacts and control options in Africa. *Preliminary Evidence Note*, Pp 14.

Ahissou, B.R., Sawadogo W.M., Bonzi S., Baimey H., Somda I., Bokonon-Ganta A. and Verheggen F. (2021). Natural enemies of the fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) in Burkina Faso. *Tropicultura*, **39(3)**, 145-149.

Alam, T., Shivakumara M.N., Prasad R. and Narayan A. (2022). Studies on the population dynamics of fall armyworm, *Spodoptera frugiperda* (J.E. Smith) on maize in relation to weather parameters. *The Pharma Innov. J.*, **SP11(10)**, 971-975.

Anandhi, S., Saminathan V.R., Yasotha P., Sharavanan P.T. and Rajanbabu V. (2020). Seasonal dynamics and spatial distribution of fall armyworm, *Spodoptera frugiperda* (J.E. Smith) on maize (*Zea mays* L.) in Cauvery delta zone. *J. Pharmacog. Photochem.*, **9(4)**, 978-982.

Baba, S.H., Zargar B.A., Husain N., Malik I. and Bhat I.F. (2019). Trends of maize production in Jammu and Kashmir. *J. Pharmacog. Phytochem.*, **8(3)**, 4558-4561.

Badhai, S., Gupta A.K. and Koiri B. (2020). Integrated management of fall armyworm (*Spodoptera frugiperda*) in maize crop. *Rev. Food Agricult.*, **1(1)**, 27-29.

Becker, P.C. (1974). *Pest of ornamental plants*. Ministry of Agriculture Fisheries and Food, London, pp. 25-29.

Deshmukh, P., Sannathimmappa S.S., Kalleshwaraswamy H.G. and Firake D.M. (2022). Seasonal activity of *Spodoptera frugiperda* (J. E. Smith) in maize agroecosystem of South India. *Curr. Sci.*, **123**, 81-86.

Ganiger, P.C., Yeshwanth H.M., Muralimohan K., Vinay N., Kumar A.R.V. and Chandrashekara K. (2018). Occurrence of the new invasive pest, fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera, Noctuidae), in the maize fields of Karnataka, India. *Curr. Sci.*, **115(4)**, 621–23.

Geethalakshmi, V., Selvaraju R., Balasubramanian T.N. and Vasanthi C. (2004). Influence of weather on population dynamics of Spodoptera- a polyphagous pest. *J. Ecobiol.*, **16(4)**, 267-274.

Ghoderao, T.N., Suradkar A.L. and Tupe A.P. (2023). Seasonal incidence of fall armyworm, *Spodoptera frugiperda* (J.E. Smith) and their natural enemies in relation to weather parameters. *The Pharma Innov. J.*, **12(3)**, 4389-4393.

Kalyan, D., Mahla M.K., Ramesh Babu S., Swaminathan S., Meena A.K. and Kalyan R.K. (2019). Population dynamics of fall armyworm, *Spodoptera frugiperda* (J.E. Smith) on maize. *Indian J. Appl. Entomol.*, **33(2)**, 110-114.

Kumar, V.N., Yasodha P. and Justin C.G.L. (2020). Seasonal incidence of maize fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Noctuidae; Lepidoptera) in Perambalur district of Tamil Nadu, India. *J. Entomol. Zool. Stud.*, **8(3)**, 1-4.

Liu, H., Lan T. and Fang D. (2019). Chromosome level draft genomes of the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae), an alien invasive pest in China. *bioRxiv*, 671560. 1218

Mahalingam, C.A., Saminathan V.R. and Venkatesan S. (2003).

Impact of weather parameters on the pheromone trap catches of *Spodoptera litura* (Fab.). *Indian J. Agricult. Sci*., **73(8)**, 438-440.

Midega, C.A.O., Pittchar J.O., Pickett J.A., Hailu G.W. and Khan Z.R. (2018). A climate adapted push-pull system effectively controls fall armyworm, *Spodoptera frugiperda* (J. E. Smith), in maize in east Africa. *J. Crop Protection*, **105**, 10-15.

Montezano, D.G., Specht A., Sosa-Gómez D.R., Roque-Specht V.F., Sousa-Silva J.C., Paula-Moraes S.V.D., Peterson J.A. and Hunt T. (2018). Host plants of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in the Americas. *Afr. Entomol*., **26(3)**, 286-300.

Murua, G., Molina-Ochoa J. and Coviella C. (2006). Population dynamics of the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae) and its parasitoids in northwestern Argentina. *Florida Entomologist*, **89(2)**, 175-183.

Parameshwari, D., Pazhanisamy M. and Muralikrishnan L. (2021). Influence of weather parameters on population dynamics of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) on maize. *Int. J. Entomological Res.*, **6(6)**, 87-90.

Pitre, H.N., Mulrooney J.E. and Hogg D.B. (1983). Fall armyworm (Lepidoptera: Noctuidae) oviposition: Crop preferences and egg distribution on plants. *J. Economical Entomol*., **76(5)**, 463-466.

Pradeep, P., Deshmukh S.S., Sannathimmappa H.G., Kalleshwaraswamy C.M and Firake D.M. (2022). Seasonal activity of *Spodoptera frugiperda* (J. E. Smith) in maize agroecosystem of south India. *Curr. Sci.*, **123(1)**, 81-86.

Prasanna, B.M., Huesing J.E., Eddy R. and Peschke V.M. (2018). Fall armyworm in Africa: A guide for integrated pest management. 1st ed.; CIMMYT: CDMX, Mexico.

Priyanka, S.L., Saminathan V.R., Sithanantham S., Ambethgar V. and Manivannan N. (2018). Studies on influence of weather parameters on *Helicoverpa armigera* (Hubner) in red gram (*Cajanus cajan* L.). *Ecosystem Research explorer*, **6(17)**, 60-66.

Reddy, K.J.M., Kumari K., Saha T. and Singh S.N. (2020). First record, seasonal incidence and life cycle of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) in maize at Sabour, Bhagalpur, Bihar. *J. Entomol. Zool. Stud*., **8(5)**, 1631-1635.

Ren, Q., Haseeb M., Fan J., Wu P., Tian T. and Zhang R. (2020). Functional response and intraspecific competition in the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae). *Insects*, **11**, 806.

Saminathan,V.R., Jayaraj S. and Regupathy A. (2001). Studies on the influence of major weather factors on the incidence of gram caterpillar *Helicoverpa armigera* (Hubner) and *Amrasca devastans* (Distant) on cotton. Proceedings of the national symposium on pest management strategies: Current trends and future prospects. Entomological Research Institute, Loyala College, Chennai.

Sharanabasappa, D., Kallerhwaraswamy C.M., Asokan R., Swamy Mahadeva H.M., Maruthi M.S., Pavithra H.B., Shivaraynavp K., Prabhu S.T. and Goergen G. (2018). First report of the fall armyworm, *Spodoptera frugiperda* (J. E. Simth) (Lepidoptera: Noctuidae), an alien invasive pest on maize in India. *Pest Manage. Horticult. Ecosyst.*, **24(1)**, 23-29.

Sharanabasappa, D., Kalleshwaraswamy C.M., Poorani J., Maruthi M.S. and Pavithra H.B. (2019). Natural enemies of *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae), a recent invasive pest on maize in South India. *Florida Entomologist*, **102**, 619-623.

Sunitha, S.V.L., Swathi M., Madhumathi T., Anil Kumar P. and Chiranjeevi C.H. (2021). Population dynamics of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) on sorghum. *J. Entomol.*, **5(2)**, 23-34.

Wallner, W.E. (1987). Factors affecting insect population dynamics: differences between outbreak and non-outbreak species. *Annu. Rev. Entomol. J.*, **32(1)**, 317-340.

Yang, X.M., Song Y.F., Sun X.X., Shen X.J., Wu Q.L. and Zhang H.W. (2021). Population occurrence of the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae), in the winter season of China. *J. Integ. Agricult.*, **20(3)**, 772-782.