Res. Jr. of Agril. Sci. **11**(6): 1426-1429, Nov-Dec 2020

ISSN: 0976-1675

www.rjas.org

Research Journal of Agricultural Sciences

© Centre for Advanced Research in Agricultural Sciences

Short Communication

DI: 6277-2707-283

Comparative Analysis of the Life Cycle of Fall Armyworm *Spodoptera frugiperda* Smith, 1797 (Lepidoptera, Noctuidae) on Natural and Artificial Maize Diet under Laboratory Conditions

Harshita Sharma and Dolly Kumar*

Division of Entomology, Department of Zoology,
Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara - 390 002, Gujarat, India

Received: 27 July 2020; Revised accepted: 08 September 2020

Key words: *Spodoptera frugiperda*, Control, Fall armyworm, Larvae, Maize diet, Pest

Spodoptera frugiperda is a serious pest of American origin present throughout the world. It is a polyphagous pest preferring maize, causes white elongated patches and windows on leaves and fecal pellets deposited in the whorls. The adult male has brown forewing with a white spot and triangular white patch while the female has plain greyish wings (Sharanabasappa *et al*. 2018). In India, the first report of the FAW came from Karnataka (Deshmukh *et al*. 2019). Other Indian states reported its presence like that of Maharashtra, Gujarat, Rajasthan, Tamil Nadu (Deshmukh *et al*. 2019) (Sisodiya *et al*. 2018, Babu *et al*. 2019, Srikanth *et al*. 2018). A genetic study from Africa and India revealed the possibility of a common source of invasion between the countries (Nagoshi *et al*. 2019). Regions where the worm is most damaging, yields increase by an insecticide application (Andrews 2014). There are two main types of FAW strain designated as corn and rice strain which are morphologically identical, so molecular techniques are used for identity (Nagoshi and Meagher 2004). It is important to know the biology of FAW to identify the life stages to control (Sharanabasappa *et al*. 2018). In Lepidopteran pest, *Plutella xylostella* a threat to crucifers, knowledge of the biology influences the host plant quality and helps in its management (Gowri and Manimegalai 2016). In Florida, field FAW strain was resistant to classes of insecticides including synthetic pyrethroids, organophosphate, and carbamates (Yu 1991). Alternative methods in the form of chemical insecticides, biologicals, botanicals for the control of FAW is a must. Such a study requires knowledge of its stages and its rearing to conduct experiments. The present study was undertaken to study the biology of *Spodoptera frugiperda* on two diets.

***Corresponding author:** Prof. Dolly Kumar, Head, Department of Zoology, Faculty of Science, The Maharaja Sayajirao University of Baroda, Vadodara - 390 002, Gujarat

e-mail: dollymsu@gmail.com

Collection: A detailed survey of various agricultural fields in and around Vadodara was done. It was amongst the initial observation for the occurrence of fall armyworm from few agricultural fields of Vadodara in June 2019. The insects were collected from the agricultural fields where the attack of FAW was observed. Survey and collection revealed high infestation of FAW in maize fields of Vadodara (Fig 1-2). The stage selected for the collection was the larval stage (in caterpillar form). The identifying feature of the FAW caterpillar being the Y shaped white line on the front and the four dots which form a square at the posterior end. The colour is shades of brown with black lines on its body. The caterpillars were allowed to feed on the natural leaves after the collection was done.

Fig 1 Maize field in Channi region of Vadodara

Fig 2 Collection of fall Armyworm

Rearing: The insects were reared on a natural diet for a complete life cycle. The larvae were reared in insect culture trays containing the maize-based artificial diet and natural diet in separate trays closed with a lid and maintained at

25±4°C, 70±10% RH (Fig 4-5). Each insect was kept in separate cells to avoid cannibalism. The adults were allowed to mate in separate cages. The first rearing started from the 2nd/3rd instar stage brought from fields, fed on a natural diet i.e. maize leaves to the last instar, pupa, and adult. The adults were allowed to mate. The hatching of the eggs resulted in neonates that were fed with a maize-based artificial diet in one set and a natural diet (maize leaves) in another set until it entered the pre-pupation phase. Pupae formed were kept in different plastic boxes. The pupae were washed with 1% sodium hypochlorite to avoid infections. Adults emerged from these were fed on honey-sucrose based diet with the help of cotton for diet soaking. Different life stages were studied (Fig 5). Biology of fall armyworm was studied to elicit information on the eggs, all the six instars, pupal and adult emergence.

Fig 3 Larvae reared on artificial diet

Fig 4 Larvae reared on natural diet

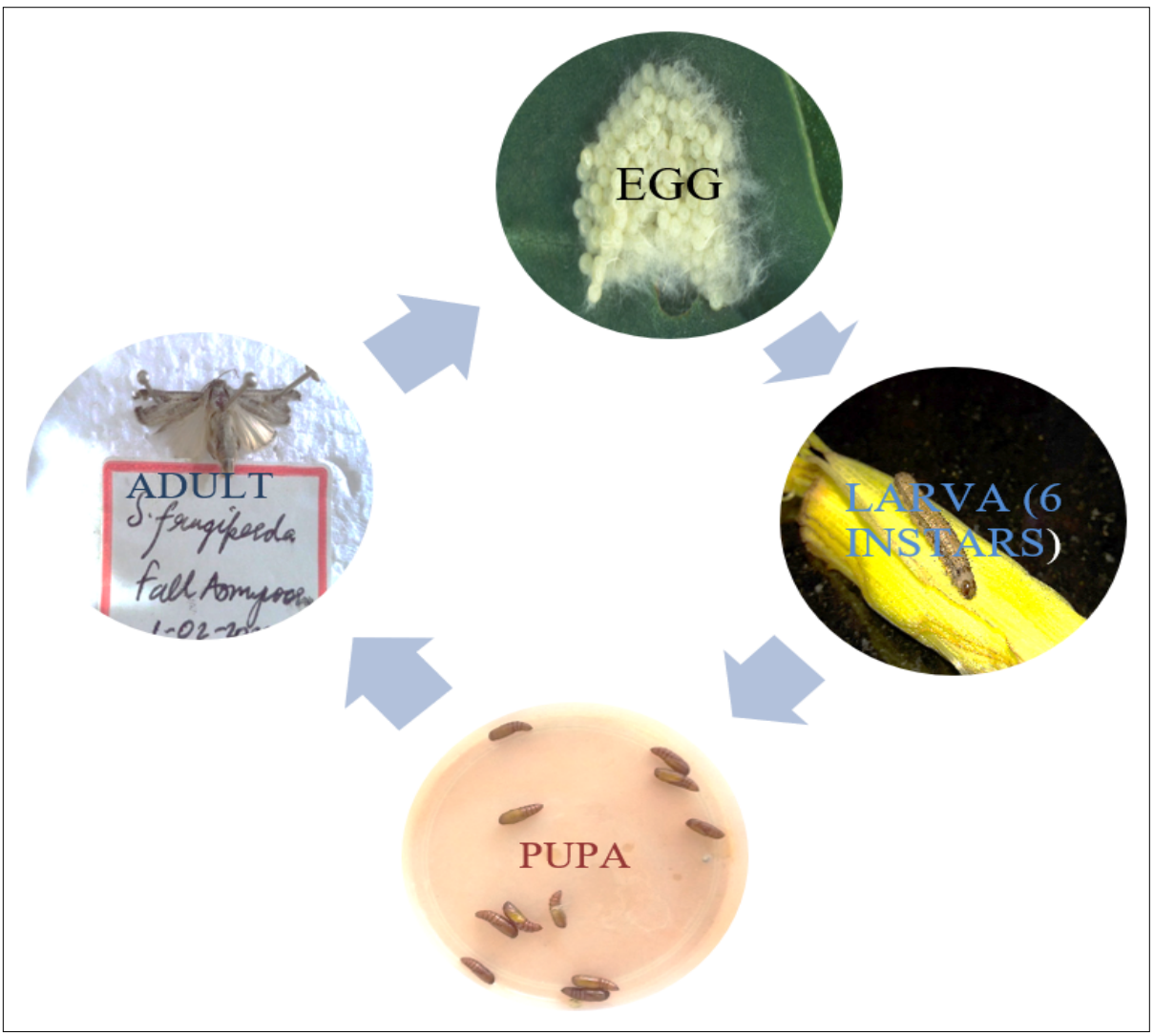

Fig 5 Life cycle of fall Armyworm (*Spodoptera frugiperda*)

Table 1 Artificial maize flour based diet

Ingredients	Amount
Agar agar powder	16 g
Ascorbic acid	5 g
Becosule	6 g
Formaldehyde (10%)	12 ml
Maize powder	120 g
Methyl-paraben	3 g
Propionic acid	2 ml
Sorbic acid	2 g
Yeast powder	50 g
Water	1000 ml

Table 2 Artificial diet for adults

Ingredients	Amount
Honey	100 g
Sucrose	100 g
Becosule	4 g
Methyl paraben	4 g
Ascorbic acid	40 g
Water	1000 ml

Artificial diets: A larval diet was prepared with as minimum ingredients as possible to make it economic is shown in (Table 1). The pupae formed were sterilized with 1% sodium hypochlorite and released in adult cages. An adult diet was prepared with ingredients shown in (Table 2).

Statistics: Percent pupation was checked. Larval growth was compared for both the diets using the formula of larval growth index. The statistics used for comparing days in different life-stages was using the statistical software Minitab19.

Percent pupation on the two diets is shown in (Table 3). Larval Growth Index is shown in (Table 4). Statistics result in (Table 5) shows descriptive statistics for diets which reveals the average days the insect retains its different life stages. (ND=Natural Diet, AD=Artificial Diet, 1 and 2 showing the replicates). The maize-based artificial diet was found to be successful and economical for an easy laboratory rearing of the pest inside the lab. The results of the study were justifying the biology study of the fall armyworm studied before. The larval growth index for natural v/s artificial diet was found to be a little better for the artificial diet where factors like percent pupation and larval period were taken into consideration. The statistic software results revealed mean days value to be lesser in the larval stage and more in adult stage for artificial diet compared to a natural diet which is proof of artificial diet being better than the natural diet for lab rearing.

Table 3 Percent pupation in two different diets

Diet	Larvae/tray	No. of trays	Total Larvae released	No. of Pupa formed	% Pupation
Diet 1 (Natural)	10	2	20	17	85%
Diet 2 (Artificial)	10	2	20	19	95%

Table 4 Larval Growth Index of two different diets

Diet	Percent Pupation	Larval period	Larval Growth Index
1 (Natural)	85%	19.6	4.34
2 (Artificial)	95%	17.85	5.32

Larval Growth Index (LGI) = Percent pupation/ Larval period (days)

The study would help to understand the biology of the invasive pest in laboratory conditions and to check for similarities and differences with the previous studies. Such a study incorporating maize flour in the artificial diet for the pest would help us understand and standardize diet preference for fall armyworm. Challenges and problems in rearing would enable us with the opportunity to look for solutions to standardize diet. The reason for the better larval growth index in the artificial diet as compared to the natural diet could be because of the reason that natural diet had left of maize brought directly from the fields which could have been subjected to pesticides, further natural diet pertains more chances of getting foul due to its natural property which is not the case with an artificial diet which could retain its state for 2 or 3 days. Also, the artificial diet consisted of many of the necessary ingredients for the proper growth and survival of the larva. Natural diet tends to get more infected by microbial infection as compared to an artificial diet.

Optimizing rearing methods for pests is helpful to conduct various experiments on the pest without the hindrance of a shortage of test insects to carry out a successful IPM program.

SUMMARY

Spodoptera frugiperda (J. E. Smith), commonly called fall armyworm (FAW) is one of the major insect pests of the world. Its boundary was limited to the American continent until the year 2016 where the first report outside America came. From affecting Africa in 2016 and became invasive in India in 2018, the pest is continuing to infest various crops, majorly maize fields of India. Some Indian states including Karnataka, Maharashtra, Gujarat, Rajasthan, Tamil Nadu, Mizoram, etc. have reported the serious outbreaks of this pest. Fall armyworm although being polyphagous prefers maize the most along with sorghum, sugarcane, paddy, millets. Maize is an important cereal in the country after wheat and rice. Efforts are being made to control the pest in the country. Knowledge of the biology of the pest would help identify and understand the pest better. Such a knowledge is prerequisite for various control programs of the pest. A study of the biology of the pest fall armyworm

on a maize-based artificial diet in India is new and has been discussed here. It is also compared with the natural diet in the form of maize leaves to check for its application.

Acknowledgment

To CSIR for the financial assistance provided to me in the form of CSIR-NET-JRF fellowship.

Table 5 Descriptive statistics for diets

Variable	Stage	N	N*	Mean	StDev
ND (A) Days	Adult	9	1	5.667	0.500
	Egg	10	0	3.800	0.632
	Larva	10	0	19.200	0.789
	Pupa	10	0	8.400	2.989
ND (B) Days	Adult	8	2	5.875	0.354
	Egg	10	0	3.900	0.568
	Larva	10	0	19.300	0.675
	Pupa	10	0	7.60	4.06
AD (A) Days	Adult	10	0	6.600	0.516
	Egg	10	0	2.900	0.568
	Larva	10	0	17.900	0.568
	Pupa	10	0	7.800	0.422
AD (B) Days	Adult	9	1	6.667	0.866
	Egg	10	0	3.700	0.483
	Larva	10	0	17.800	0.632
	Pupa	10	0	6.800	2.486

LITERATURE CITED

Andrews K L. 2014. Latin American Research on Spodoptera frugiperda (Lepidoptera: Noctuidae) Author (s): Keith L. Andrews Published by Florida Entomological Society. *JSTOR* **71**(4): 630-653.

Babu R S, Kalyan R, Joshi S, Balai C, Mahla M and Smith J E. 2019. Report of an exotic invasive pest the fall armyworm, Spodoptera frugiperda. *On Maize in Southern Rajasthan Article in Journal of Entomology and Zoology Studies* **7**(3): 1296-1300.

Deshmukh S, Chormule A, Shejawal N, Kalleshwaraswamy C, Asokan R and Mahadeva S H. 2019. First report of the fall Armyworm, Spodoptera frugiperda (J. E. Smith) (Lepidoptera, Noctuidae) on sugarcane and other crops from Maharashtra, India. *Journal of Entomology and Zoology Studies* **7**(1): 114-117.

Gowri G and Manimegalai K. 2016. Biology of diamondback moth, *Plutella xylostella* (Lepidoptera: Plutellidae) of cauliflower under laboratory condition. *International Journal of Fauna and Biological Studies* **3**(5): 29-31.

Nagoshi Rod N and Meagher R L. 2004. Behavior and distribution of the two-fall armyworm host strain in Florida behavior and distribution of the two. *Florida Entomologist* **87**(4): 440-449.

Nagoshi, Rodney N, Dhanani I, Asokan R, Mahadevaswamy H M, Kalleshwaraswamy C M, Sharanabasappa and Meagher R L. 2019. Genetic characterization of fall armyworm infesting South Africa and India indicate a recent introduction from a common source population. *PLoS ONE* **14**(5): 1-16.

Sharanabasappa, Kalleshwaraswamy C M, Maruthi M S and Pavithra H B. 2018. Biology of invasive fall armyworm *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) on maize. *Indian Journal of Entomology* 80(3): 540.

Sisodiya D, Raghunandan B, Bhatt N, Verma H, Shewale C, Timbadiya B and Borad P. 2018. The fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae); the first report of new invasive pest in maize fields of Gujarat, India. *Journal of Entomology and Zoology Studies* **6**(5): 2089-2091.

Srikanth J, Geetha N, Singaravelu B, Ramasubramanian T, Mahesh P, Saravanan L and Muthukumar M. 2018. First report of the occurrence of fall armyworm *Spodoptera frugiperda* in sugarcane from Tamil Nadu, India. **8**: 195-202.

Yu S J. 1991. Insecticide resistance in the fall armyworm, Spodoptera frugiperda (J. E. Smith). *Pesticide Biochemistry and Physiology* **39**(1): 84-91.