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Host preference and biology of *Spodoptera frugiperda* (J.E. Smith) on different host plants under laboratory conditions

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ABSTRACT

Effects of different host plants (castor, maize, bajara, mung bean, groundnut and cotton) on developmental period, pupal weight, sex ratio, longevity and oviposition of *S. frugiperda* (Lepidoptera: Noctuidae), were studied under laboratory conditions. All of the biological parameters included in the study were affected by the host plants. *S. Frugiperda* larvae developed differently on the different host plants, from shortest to longest in the following order: maize, castor, groundnut, mungbean, bajara and cotton. Pupal development was shorter on maize and castor than on the other host plants, and males generally developed longer than the females. A pupal weight of females was recorded highest on maize and castor. Female pupae were generally heavier than their male counterpart. More females than males were found among emerged adults. In a choice test, *S. Frugiperda* females oviposited most on maize and castor, least on cotton, and intermediate on groundnut, mungbean and bajara. It can be inferred from the above parameters that maize and castor are suitable hosts for *S. frugiperda* and it may also be used as a trap crop to prevent the attack of economically important crops.

Key words: *Developmental period, Host plants, Host preference, Oviposition, Spodoptera frugiperda*

Introduction

Maize (*Zea mays* L.) is the third most important grain crop of the world, which is widely cultivated all over the world in different agro-climatic zones. The fall armyworm, *S. frugiperda* (Lepidoptera: Noctuidae) is native to the America and it is a key pest of maize and many other crops throughout the America. *S. frugiperda* has been reported for the first time in 2016 in Africa, in Nigeria, Sao Tome in Benin and Togo causing significant damages to maize. This pest has been detected for the first time on the Indian subcontinent in mid-May, 2018 in maize fields at the College of Agriculture, (UAHS), Shivamogga. Fall armyworm is of serious concern due to its notorious and polyphagous behaviour. The main reason for its fast spread might be its strong capacity to fly and disperse long distances. The invasion of this pest could also be due to advances in agriculture, global trade and transport and human activities despite strict quarantine norms.

The fall armyworm, *S. frugiperda*, is a multivoltine pest of several agricultural, pasture, and turf crops including corn (*Zea mays* L.), cotton (*Gossypium* Spp.

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L.), sorghum (*Sorghum bicolor* L.) and several grasses (Luginbill, 1928; Young, 1979). Larvae are highly polyphagous, and have been documented on over 80 host plant species spanning 23 families (Pashley, 1988). Therefore, there is need to identify the various host of the pest and based on that crop rotation should be adopted.

Materials and Method

Experimental details

The experiment was conducted at Biocontrol Research Laboratory, Department of Entomology, Junagadh Agricultural University, Junagadh during 2019-20. Experimental design used for this experiment was CRD (Completely Randomized Design) with six treatment and 4 repetitions. Different host plants *viz.,* castor (*Ricinus communis* L.), maize (*Zea mays* L.), bajara (*Pennisetum glaucum* L.), mung bean (*Vigna radiate* L.), groundnut (*Arachis hypogea* L.) and cotton (*Gossypium hirsutum* L.) were used for this study. For this purpose, all these plants were sown in small pot in air conditioned room at Biocontrol Research Laboratory. The materials used and methodology adopted during this study is given below.

Methodology

Larvae were collected from maize field of Instructional Farm, College of Agriculture, JAU, Junagadh and reared on artificial diet prescribed by (Nagarkatti and Sathyaprakash, 1974) in small containers (3.5 cm × 1.3 cm) for two generations. Newly exuviated fifth instars were individually reared in petri dishes (9.0 cm × 1.5 cm) to avoid cannibalism. Before pupation, a few pieces of paper tissue were placed on the dish bottom for larval pupation. Newly emerged adults were placed in a container (6.5 cm × 12 cm) and were fed with 10% sugar-water solution.

Larval development and adult reproduction

Each host plant treatment had 100 larvae and these were divided into 10 sets for further rearing. The larvae were monitored for development and mortality at 24 hours interval. In the meantime, the dishes were cleaned and new leaf pieces were replaced as needed. Before pupation, a few pieces of paper tissue were placed on the dish bottom for larval pupation. Two day old pupae were sexed and separately weighed. Newly emerged adults were placed in a container (6.5 cm x 12 cm) and fed with 10% sugar-water solution. The adults were monitored daily for mortality and oviposition.

Observations recorded on larval development and adult reproduction

The observations were recorded on larval and pupal developmental period and pupal weight. The adults were monitored daily for mortality, sex ratio, adult longevity; oviposition and numbers of egg masses oviposit on the leaf by each female were collected and counted daily until the female died.

Host preference for oviposition

This experiment was conducted in an air conditioned room at 26 ± 1 °C, 12:12 L: D, and 70% RH. Adults of *S. frugiperda* were developed from the larvae that had been fed with the semi-synthetic diet prescribed by Nagarkatti and Sathyaprakash (1974) for two generations. Newly emerged 10 pairs of adults (Sex ratio of 1:1) were collected and released in each net containing six host plants randomly placed at one of the different corners. The plants were adjusted to the same height. The adults were fed with 10% sugar-water solution through a cotton ball in a small plastic container. The adults were allowed to mate in the cage for three days.

Observations recorded on host preference for oviposition

The females were allowed to oviposit for 2 days, and the number of egg masses and eggs in each egg masses were recorded for each plant.

Results and Discussion

Developmental period of *S. frugiperda*

Perusal of data (Table 1) revealed that the developmental period for all the instars differed significantly in all host plants. Overall larval development was significantly affected by host plants, and was longest on cotton (41.00 days), followed by bajara (40.70 days) mung bean (38.00 days), groundnut (37.50 days), castor (36.25 days), and shortest on maize (35.00 days). Of the six instars, first, second, third, fourth, fifth and sixth instars development took longer on cotton. In contract, shortest development periods of 2.00, 2.00, 2.00, 2.00, 2.00 and 5.25 days, respectively were observed on maize and 2.25,

2.25, 2.00, 2.25, 2.25 and 5.50 days, respectively on castor, followed by 2.25, 2.50, 2.00, 2.50, 2.00, 5.50 days, respectively on groundnut, 2.75, 2.75. 2.50, 2.75, 2.25, 5.50 days, respectively on mung bean and 3.00, 2.75, 2.75, 2.75, 3.00, 7.00 days, respectively on bajara, whereas, in case of cotton, these values were 3.00, 3.00, 2.75, 3.00 3.00 and 6.75 days, respectively. The shortest (8.75 days) pupal period was observed on maize and it was at par with castor (9.00 days). Longest pupal period of 11.00, 10.75, 10.50, and 10.50 was observed on cotton, bajara, mung bean and groundnut, respectively. Adult development times were longest on maize (11.00 days) and it was at par with castor (10.75 days) and groundnut (10.25 days), while it was found shortest on cotton (8.50 days) followed by bajara (8.75 days) and mung bean (9.00). Overall adult development was significantly affected by host plants, and was longest on maize, followed by castor, groundnut, mung bean, bajara and shortest on cotton (**Fig. 1**).

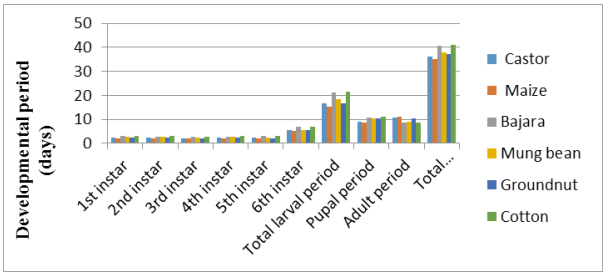

Fig. 1. Effects of different host plants on developmental period of *S. frugiperda*

The total developmental time (egg to adult) 37.50±5.00 days in male and 40.50±4.88 days in female of *S. frugiperda* larvae on maize leaf (Sharanabasappa *et al.*, 2018) this was more or less similar to developmental period of maize in this study.

Pupal weight (g/pupa)

The data revealed that the pupal weights differed significantly depending on the host plants on which the larvae were fed and differed significantly between females and males when they fed on the same host plants and when larvae fed on different host plants (Table 2). The female pupae on maize were heaviest (0.210 g), followed by those on castor (0.202 g). Moderate pupal weight was observed on groundnut (0.187 g) and mung bean (0.184 g) and lightest on cotton (0.164 g) and bajara (0.179 g) and the male pupae on maize were heaviest (0.189 g)

Table 1. Effects of different host plants on developmental period of *S. frugiperda*

Host	Age specific survival of *S. frugiperda* (days)									
	1st instar	2nd instar	3rd instar	4th Instar	5th instar	6th instar	Total larval Period	Pupal Period	Adult (Healthy adult) Period	Total developmental period
Castor	1.49 (2.25)	1.49 (2.25)	1.41(2.00)	1.49 (2.25)	1.49 (2.25)	2.34 (5.50)	4.06(16.50)	3.00 (9.00)	3.28(10.75)	6.02(36.25)
Maize	1.41 (2.00)	1.41 (2.00)	1.41 (2.00)	1.41 (2.00)	1.41 (2.00)	2.29 (5.25)	3.91(15.25)	2.96 (8.75)	3.31(11.00)	5.91(35.00)
Bajara	1.73 (3.00)	1.65 (2.75)	1.65 (2.75)	1.65 (2.75)	1.73 (3.00)	2.65 (7.00)	4.61(21.25)	3.28 (10.75)	2.96(8.75)	6.38(40.70)
Mung bean	1.65 (2.75)	1.65 (2.75)	1.57 (2.50)	1.65 (2.75)	1.49 (2.25)	2.35 (5.50)	4.30(18.50)	3.24 (10.50)	3.00(9.00)	6.16(38.00)
Groundnut	1.49 (2.25)	1.57 (2.50)	1.41 (2.00)	1.57 (2.50)	1.41 (2.00)	2.35 (5.50)	4.09(16.75)	3.24 (10.50)	3.20(10.25)	6.12(37.50)
Cotton	1.72 (3.00)	1.73 (3.00)	1.65 (2.75)	1.73 (3.00)	1.73(3.00)	2.60 (6.75)	4.59(21.50)	3.31 (11.00)	2.91(8.50)	6.40(41.00)
S.Em.±	0.08	0.06	0.06	0.06	0.05	0.09	0.17	0.08	0.09	0.08
C.D. at 5 %	0.22	0.19	0.18	0.17	0.14	0.25	0.49	0.25	0.28	0.24
C.V. %	9.49	7.94	7.86	7.14	5.99	7.06	7.77	5.22	6.10	2.63

Figures in parenthesis are original values, while outside values are square root transformed.

followed by those on castor (0.183 g) and groundnut (0.178 g) moderate weight on mung bean (0.164 g) and lightest on cotton (0.137 g) followed by bajara (0.151 g). Female pupae were generally heavier than their male.

Similar results were also reported by (Savaliya, 2014) who recorded that the female and male pupae were heaviest 0.382 and 0.353 g/pupa, respectively on castor. Pengjun *et al.* (2019) who found that *S. frugiperda* feeding on maize kernel; pupal body weight was (0.187 ± 0.030 g/pupa) more or less similar range was also observed in present study.

Sex ratio

It is evident from the data (Table 2) of sex ratios were biased, and more female adults emerged than male adults when their larvae were fed with the different host plants. Female and male ratios were higher on maize (1:1.88) followed by castor (1:1.75), groundnut (1:1.71), mung bean (1:1.58) and lower on bajara (1:1.04) and cotton (1:0.69) than on the other host plants.

The present findings are in more or less conformation with (Marua and Virla, 2004), they observed that the sex ratio of *S. frugiperda* fed on corn resulted in a female biased sex ratio (1.16:1). Earlier (Savaliya, 2014), who recorded that the sex ratios were biased, and more female adults emerged than male adults when their larvae were fed with the four host plants. Female and male ratios were higher on castor (1:1.72) followed by lucerne (1:1.50) and lower on groundnut (1:1.30) and soybean (1:1.14) than on the other two host plants.

Longevity

Perusal of data (Table 2), the longevities of both female and male *S. frugiperda* adults were also significantly affected by the host plants on which their larvae fed. The highest female and male longevity were recorded on maize (11.75 and 9.00 days, respectively), followed by castor (11.25 and 8.75 days, respectively), groundnut (10.75 and 8.25 days, respectively) and mung bean (10.25 and 7.75 days, respectively) and the lowest female and male longevity were found on cotton (9.25 and 7.00 days, respectively) followed by bajara (9.50 and 8.00 days, respectively).

In the present study, female adults generally lived longer (9.25-11.75 days) than males (7.00-9.00 days), differing on different host plants. Similar results were reported by (Sharanabasappa *et al.*, 2018) that the female adult of *S. Frugiperda* survived for 10.80 days with a range of 9-12 days compared to male (8.20 days) with a range of 7-9 days, female adults generally lived longer than males.

Oviposition

Numbers of egg masses and total eggs oviposited by *S. frugiperda* females on the six host plants differed significantly (Table 1). *S. frugiperda* oviposited maxi-

Table 2. Effects of different host plants on pupal weight, sex ratio, longevity and oviposition of *S. frugiperda*

Host plant	Pupal weight (g/pupa)		Sex ratio Female : Male	Longevity (days)		Oviposition	
	Female	Male		Female	Male	Number of egg masses	Fecundity/ female
Castor	0.453 (0.202)	0.428 (0.183)	1:1.75	3.36 (11.25)	2.96 (8.75)	2.60 (6.75)	32.69 (1069.00)
Maize	0.460 (0.210)	0.430 (0.189)	1:1.88	3.43 (11.75)	3.00 (9.00)	2.79 (7.75)	32.78 (1075.00)
Bajara	0.423 (0.179)	0.388 (0.151)	1:1.04	3.08 (9.50)	2.83 (8.00)	2.29 (5.25)	26.92 (726.00)
Mung bean	0.430 (0.184)	0.403 (0.164)	1:1.58	3.2 (10.25)	2.79 (7.75)	2.40 (5.75)	29.31 (859.00)
Groundnut	0.433 (0.187)	0.420 (0.178)	1:1.71	3.28 (10.75)	2.87 (8.25)	2.45 (6.00)	29.74 (884.00)
Cotton	0.400 (0.164)	0.370 (0.137)	1:0.69	3.04 (9.25)	2.65 (7.00)	2.17 (4.75)	25.88 (676.00)
S.Em.±	0.01	0.01	–	0.04	0.04	0.09	0.61
C.D. at 5 %	0.02	0.02	–	0.12	0.13	0.26	1.82
C.V. %	2.45	3.29	–	2.45	2.97	7.27	4.15

Figures in parenthesis are original values, while outside values are square root transformed.

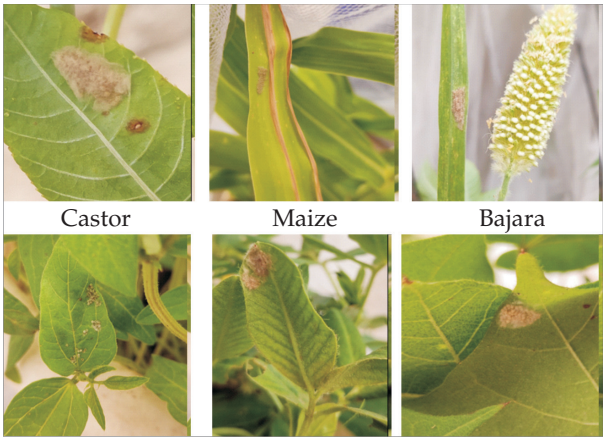

Fig. 2. Egg lying of *S. frugiperda* on different host plants

mum (7.75) of egg masses/female on maize followed by castor (6.75 egg masses/female), groundnut (6.00 egg masses/female) and mung bean (5.75 egg masses/female) and lowest egg masses/female on cotton (4.75 egg masses/female) it was at par with bajara (5.25 egg masses/female) more or less similar trends were also observed on fecundity as maximum number of eggs/female was deposited on maize (1075.00 eggs/female) followed by castor (1069.00 eggs/female), groundnut (884.00 eggs/female), mung bean (859.00 eggs/female), bajara (726.00 eggs/female) and cotton (676.00 eggs/female) (Fig. 2).

In present study, 676.00 to 1075.00 eggs per female were deposited on different hosts. Observations on fecundity were almost similar to the observations recorded by (Marua and Virla, 2004), who observed the fecundity of *S. frugiperda* 1316.67 on maize.

Conclusion

Comparing the effects of different host plantson *S. frugiperda* revealed that shorter larval and pupal period with the highest pupal weight, sex ratio and female and male longevity of *S. frugiperda* were recorded on maize and castor, afemales oviposited most on maize and castor with more number of egg masses. It can be inferred from the above parameters that maize and castor is a suitable host for *S. frugiperda* and it may also be used as trap crop to prevent the attack of economically important crops.

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