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# DEVELOPMENT AND REPRODUCTIVE PERFORMANCE OF *SPODOPTERA FRUGIPERDA* (J E SMITH) ON DIFFERENT HOST PLANTS

**Burjikindi Madhuri[1]*, Kolli Bharghavi[1], Satwika Maharaj[2] and Chava Asritha[1]**

[1]University of Agricultural Sciences, Dharwad 580005, Karnataka, India
[2]Acharya N G Ranga Agricultural University, Lam, Guntur, Andhra Pradesh, India
*Email: madhuriburjikindi2016@gmail.com (corresponding author): ORCID ID 0009-0008-9513-9158

**ABSTRACT**

**The development, reproductive performance, and population dynamics of fall army worm *Spodoptera frugiperda* (J E Smith) on different host plants were evaluated under laboratory conditions. The egg masses were collected from maize fields and kept in laboratory for incubation. The first instar larvae were shifted on to maize, soybean, cotton leaves, and artificial diet. The duration of larval period, pupal period, adult longevity and the total life cycle was recorded. The results revealed that larvae reared on artificial diet exhibited shorter larval and pupal periods with less adult longevity compared to those reared on maize, soybean, and cotton. Additionally, fecundity was highest among individuals reared on artificial diet, followed by maize, soybean, and cotton.**

**Key words:** *Spodoptera frugiperda,* cotton, soyabean, maize, development, fecundity, larval period, life cycle, pupal period, instars, longevity, artificial diet

The fall army worm *Spodoptera frugiperda* (J E Smith) (Lepidoptera: Noctuidae), is a highly adaptable pest originating from the American continent. It consumes about 353 plant species under 76 families, with a preference for crops including sugarcane, millet, sorghum, maize, and rice (Praveen and Mallapur, 2019). Its rapid spread beyond the Americas since 2016 poses significant threats to global agriculture (Chormule et al., 2019). Its population dynamics are influenced by host plant characteristics, impacting its growth, reproduction, and survival (Dumas et al., 2015). Furthermore, the planting seasons for various crops frequently overlap or run concurrently in several parts of India, which may offer enough food supplies for *S. frugiperda* to occur and migrate (Ganiger et al., 2018). Understanding how hosts affect *S. frugiperda* biology is essential for effective IPM. Recent studies highlight preferences for certain hosts, with maize (Nandhini et al., 2024) and sorghum being favoured. Host preference studies important for addressing the effects of the nutritional composition of different crops on this pest. Therefore, further research into its developmental biology and feeding preferences on various host plants is crucial for devising effective management strategies. The purpose of the current study was to examine how various host plants and artificial diets affected the growth of various *S. frugiperda* stages in the laboratory.

## MATERIALS AND METHODS

The study was conducted in 2021 at the Department of Entomology, College of Agriculture, Dharwad. Three natural host plants, maize (BML 6) , soybean (JS 335), and cotton (Non Bt Suraj ) as well as an artificial diet (Jaba et al., 2020) were used to study biology (25± 2°C and 70± 5% RH). Larval feeding test was done, the top leaves of the host plants viz., maize, soybean and cotton plants (first completely expanded leaf) was extracted from each plant of all three selected host plants and leaf discs (2 cm dia) of the center of maize, cotton and soyabean leaves were used (Silva et al., 2017; Botton et al., 1998). To prevent the leaf discs from drying out, these leaf discs were set in tiny, 9 cm-dia petri dishes with moist filter paper that had been cut into circles (Silva et al., 2017). Excreta and leftover food were removed every day. Larvae were given fresh leaves respective host plant every 24 hours. The procedure was repeated until they reached their last instar. The last instar larvae were gathered and placed in different jar with sand to pupate. After emergence, the adults were released in 1:1 ratio into a plastic jar for mating (Nandhini et al., 2023). The jars were lined with yellow paper, which served as a substrate for the laying of eggs, and then covered with white muslin cloth, secured in place with a rubber band. The adults were given 10% honey solution, in a cotton swab and placed in a plastic

cup within a jar that was changed every day. Every day the eggs deposited by moths on the yellow paper and white muslin fabric were collected and counted using a hand lens and examined at regular intervals for recording the incubation period. Calculations were made to determine the average number of eggs laid by a female and the percentage of viable eggs from each treatment. Every 24 hr, observations on the pre-, oviposition-, and post-oviposition periods, as well as the adult lifespans of males and females, the sex ratio, fecundity, and the incubation period in days, were recorded (Nandhini et al., 2023).

## RESULTS AND DISCUSSION

On various host plants, the incubation time of *S. frugiperda* eggs varied from 2.27± 0.04 to 2.50± 0.10 days (Table 1). The eggs laid by the females fed on artificial diet took a much shorter time to incubate than the eggs laid by the females fed maize. When compared to eggs laid by females fed on artificial diet (2.27± 0.04), the incubation period of eggs laid by females fed soybean (2.48± 0.09) and cotton (2.50± 0.10) were considerably longer, although it was still comparable. The incubation period of eggs is impacted not only by nutritional changes in different host plants, but also by variations in the quality of nutrition in different cultivars within a given host (Rosa et al., 2012). Azidah and Sofian-Azirun (2006), however, found that the length of time the eggs took to incubate was unaffected by differences in the quality of the host plants. The mean larval period was found to be much higher on cotton, followed by soybean and maize. The artificial diet is composed of a well-balanced mix of nutrients, such as proteins, lipids, carbohydrates, and important vitamins, which provide the larva with the necessary amount of energy to transform into a pupa. Hence, compared to larva fed on other plant materials, those provided on artificial diet must have swiftly acquired the required amount of food and energy (Table 1).

*S. frugiperda* has historically preferred maize as a host, most likely because of the grain's high nutritional content. The results of the current studies supported by the findings of Xue-Ming et al. (2010), who found that the length of larval growth is influenced by variations in the nutritional composition of host plants. The lowest larval length of 11.98 days on mustard, 12.53 days on goosefoot, 13.10 days on soybean, 14.91 days on maize, and 15.50 days on cotton by beet armyworm was also reported by Farahani et al. (2011). Their findings were similar. Guo et al. (2021) and Kranthi and Devi (2021) also observed that *S. frugiperda* raised on maize exhibited the highest performance with shorter larval developmental length compared to potato and tobacco. The development of pupae has shown the consequences of feeding on host plants. The hosts also had a major impact on the development of the pre- and pupal stages (Table 1). The pupae fed cotton had the longest mean duration, but the larvae fed soybean and maize leaves had a noticeably shorter length. On an artificial diet, the shortest duration was noted. A large energy quantum in the pupa will shorten the time it takes for it to mature into an adult. The above observations were compared to research presented by Silva et al., 2017 who reported that *S. frugiperda* fed on maize had a shorter pupal development period compared to cotton and soyabean.

Cotton was shown to have the longest male and female life duration, whereas maize and soybean were found to be comparable (Table 1). Shortly after emerging, the male and females mate, and the males give the females their sperm, which causes the males to die. A significant number of eggs are produced

Table 1. Biology of *S. frugiperda* on different host plants

| Host plant | Incubation period | Total larval period | Pupal period | Adult longevity | | Total life cycle | | fecundity |
|---|---|---|---|---|---|---|---|---|
| | | | | Male | Female | Male | Female | |
| Maize | 2.39± 0.05$^{b}$ | 16.20± 0.11$^{b}$ | 10.21± 0.059$^{b}$ | 7.52± 0.14$^{b}$ | 10.80± 0.19$^{b}$ | 35.43± 0.29$^{b}$ | 36.50± 0.28$^{b}$ | 1005.95± 12.53$^{b}$ |
| Soybean | 2.48± 0.09$^{c}$ | 20.7± 0.24$^{c}$ | 11.65± 0.041$^{c}$ | 8.70± 0.26$^{c}$ | 11.35± 0.38$^{c}$ | 36.24± 0.52$^{c}$ | 38.29± 0.65$^{c}$ | 967.20± 7.62$^{c}$ |
| Cotton | 2.50± 0.10$^{c}$ | 23.96± 0.29$^{d}$ | 11.85± 0.035$^{d}$ | 8.92± 0.31$^{d}$ | 11.95± 0.42$^{c}$ | 39.27± 0.67$^{d}$ | 40.29± 0.85$^{d}$ | 851.39± 6.04$^{d}$ |
| Artificial diet | 2.27± 0.04$^{a}$ | 12.19± 0.08$^{a}$ | 9.52± 0.067$^{a}$ | 6.59± 0.11$^{a}$ | 7.82± 0.12$^{a}$ | 30.83± 0.16$^{a}$ | 32.81± 0.19$^{a}$ | 1506.28± 13.05$^{a}$ |
| CD (5%) | 0.08 | 1.59 | 0.57 | 0.84 | 1.95 | 2.57 | 2.19 | 37.85 |
| S.E ± | 0.03 | 0.56 | 0.20 | 0.29 | 0.68 | 0.90 | 0.77 | 13.23 |

*means followed by the same letter in the column do not differ by Ttukey test ($p \leq 0.05$); Ggreene et al. (1976).

quickly by females with high protein levels, and these eggs are fertilized with donated male sperm. The females become fatigued and eventually expire after they quickly transform their energy into eggs. Males and females fed low-nutritional diet may live longer as adults because they have lower energy and slower physiological processes, which delay and reduce egg production. Praveen and Mallapur, (2019), noted highest fecundity/ female in maize followed by sorghum (680 + 91.52 and 650 + 88.53). Highest male longevity reported in wheat (4.50+ 1.05) and female in maize, sorghum and wheat. Rosa et al. (2012) showed similar variations in the adult longevity of *S. frugiperda* when raised on several cultivars of maize. Their findings ranged from 14 to 32 days. When *S. frugiperda* were fed cotton, millet, corn, and soybeans, likewise showed similar heterogeneity in adult longevity (Barros et al., 2010).

Males and females raised on various host plants experienced a much longer overall developmental time than those raised on artificial food. *S. frugiperda* raised on cotton, however, exhibited a noticeably longer overall developmental period than other host plants, with maize and soybean coming in second (Table 1). The length of the egg incubation time, the larval period, the pupal period, and the adult phase all contribute to the overall developmental period. According to Kranthi and Devi's (2021) findings, there can be differences in the total developmental period depending on the host plant. For example, *S. frugiperda* raised on sugarcane had a significantly longer total developmental period of 36.81± 0.16 days, compared to 34.35± 0.22 days for sorghum and 33.35 u± 0.20 days for maize. According to Sharma (1994), *S. litura* takes 32.67 days to fully mature in soybean seeds and 43.72 days to fully develop in linseed. Guo et al. (2021) discovered that larvae fed maize had a much greater survival rate than those fed tobacco and potatoes.

When larvae were fed on artificial diet instead of their native host plants— cotton, soybean and maize fertility was higher. The artificial diet resulted in the maximum number of eggs oviposited, followed by maize and soybean, while cotton supported fewer eggs. The availability of proteins determines a female's fecundity. Given that the artificial diet is high in protein, it is likely the cause of the adults' increased egg production in relation to the larvae they raised on it. In a similar vein, Barros et al. (2010) observed that the *S. frugiperda* fecundity on cotton, millet, corn, and soybean was 1144.7± 132.7, 1574.1± 177.6, 1604.2± 353.8, and 1590.8± 381.7 eggs, respectively. According to Kranthi and Devi's (2021) research, the maximum number of eggs oviposited were on artificial diet (1846.36± 16.00 eggs), followed by sorghum (686.68± 4.00 eggs), maize (1009.24± 13.35 eggs), and sugarcane (544.18± 5.00 eggs) with the lowest number of eggs laid. Praveen and Mallapur, (2019) recorded, highest fecundity per female in maize followed by sorghum (680 + 91.52 and 650 + 88.53). Six cash crops were studied by Wang et al. (2020) for their effects on the development, survival, and fecundity of *S. frugiperda.* They found that the preadult stage, adult preoviposition period, and total preoviposition period were longest on tomato and longest on maize and wheat.

**Future line of work**

1) Conduct detailed analyses of the nutritional content and secondary metabolites of different host plants to understand their impact on S. frugiperda.
2) Examine how host plant characteristics influence feeding behavior, oviposition preferences, and survival strategies of S. frugiperda.

## CONCLUSION

The developmental stages of *S. frugiperda*, including larval growth, pupal duration, and adult emergence, are significantly influenced by the type of host plant. Nutritional quality, toxicity, and physical characteristics of the host plant affect larval survival and growth rates. Understanding the effects of different host plants on *S. frugiperda's* development and reproduction can inform better pest management practices. Host plants that are less conducive to optimal larval development and reproduction could be utilized in integrated pest management strategies to mitigate damage. According to our study, Cotton followed by soyabean are less preferred hosts of *S. frugiperda*. Hence, these crops can be used in IPM strategies against *S. frugiperda.*

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## AUTHOR CONTRIBUTION STATEMENT

BM conducted the experiment and wrote the manuscript. KB helped in statistical analysis of data and proof reading of the Article. SM and CA helped in the experiment and proof reading of the article. All the authors read and approved the manuscript.

## CONFLICT OF INTEREST

No conflict of interest.

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