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Studies on the cannibalistic behaviour of fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) under laboratory conditions

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Abstract

Fall armyworm, *Spodoptera frugiperda*, is a highly polyphagous invasive pest known to display intraspecific predation, or cannibalism, among its larval instars. The present laboratory investigation examined the cannibalistic tendency of larvae belonging to different instar stages when confined together on a diet of maize leaves, with survival recorded after 24 and 48 hours. The results showed that cannibalism was absent in the first and second instar larvae, while it progressively increased from the third instar (16%) to a peak in the fifth instar (22%), before declining in the sixth instar (15%). The fourth instar recorded an intermediate value of 20%. These findings indicate that cannibalistic behaviour in *S. frugiperda* intensifies as larvae mature, reaching its highest expression in the penultimate stage, and tapers off as larvae approach pupation.

Keywords: Fall armyworm; *Spodoptera frugiperda*; cannibalism; larval instar; intraspecific predation; laboratory bioassay

1. Introduction

The fall armyworm, *Spodoptera frugiperda* (J. E. Smith), is a transboundary invasive lepidopteran pest native to the tropical and subtropical Americas that has, in recent years, spread rapidly across Africa and Asia, including India, causing extensive damage to maize and several other crops. Its rapid establishment is attributed to a wide host range, high fecundity, strong dispersal ability, and behavioural traits such as cannibalism that influence population regulation within a habitat. Cannibalism, the killing and consumption of conspecifics, is a well-documented phenomenon among noctuid larvae and is believed to serve as a density-dependent mechanism that reduces intraspecific competition for food and space, while simultaneously supplementing the nutritional requirements of the cannibalizing larvae. Understanding the pattern of cannibalistic behaviour across larval instars is important not only from a behavioural-ecology perspective but also for refining mass-rearing protocols and predicting field population dynamics of this pest. The present study was therefore undertaken to quantify and compare the intensity of cannibalism among the six larval instar stages of fall armyworm under controlled laboratory conditions.

2. Objective

To study the cannibalistic behaviour of fall armyworm across its larval instar stages under laboratory conditions.

3. Materials and Methods

3.1 Experimental Site

The laboratory component of the study was carried out at the Entomology Laboratory, Department of Entomology, while the source larvae were obtained from the Research-cum-Instructional Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, during kharif 2022. Raipur lies in the tropical central plains of Chhattisgarh, India.

3.2 Collection and Rearing

Larvae of *S. frugiperda* were collected from heavily infested maize fields on the IGKV campus and brought to the laboratory, where they were sorted into six instar categories based on body length and distinguishing morphological characters, as summarised in Table 1.

Table 1: Morphological characteristics of the six larval instars of *Spodoptera frugiperda*

Instar	Body Length (mm)	Distinguishing Features
I	0.9 - 1.8	Light-green body; large black head; black setae-bearing spots on thoracic/abdominal segments
II	2.0 - 4.3	Green body; faint body spots; dark band on first thoracic segment
III	5.1 - 7.8	Brownish-green dorsum with longitudinal white lines
IV	9.0 - 15.7	Brown body; reddish-brown head mottled with white
V	17.1 - 24.0	Brownish-green body; inverted "Y" mark on head; well-developed mouthparts
VI	23.5 - 36.0	Largest instar; three white pronotal stripes; four black dorsal spots in a square

3.3 Cannibalism Bioassay

Cannibalistic behaviour was assessed separately for larvae of each instar stage. Five larvae belonging to the same instar were placed together in a Petri plate and provided a continuous supply of fresh maize leaves as diet. Survivors were counted after 24 and 48 hours, and any larva that could

not be accounted for was presumed to have been cannibalized. The bioassay was replicated a variable number of times depending on the instar stage, with a greater number of trials assigned to stages known to exhibit pronounced cannibalism: three trials each for the first and second instars, five trials each for the third and sixth instars, and ten trials each for the fourth and fifth instars. The percentage of cannibalism for each instar was calculated by dividing the number of larvae cannibalized by the number of larvae initially introduced, expressed as a percentage.

4. Results and Discussion

Cannibalism was completely absent among first and second instar larvae under the tested conditions, suggesting that early instars either lack the aggressive predatory tendency or are less capable of overpowering conspecifics of similar size. From the third instar onward, cannibalism became evident and increased progressively, reaching a maximum of 22% in the fifth instar, followed by 20% in the fourth instar and 16% in the third instar. The sixth, and final, larval instar recorded a comparatively lower cannibalism rate of 15% (Table 2, Fig. 1).

Table 2: Cannibalism percentage recorded across larval instar stages (III-VI)

Instar Stage	III	IV	V	VI
No. of Trials	5	10	10	5
Cannibalism (%)	16	20	22	15

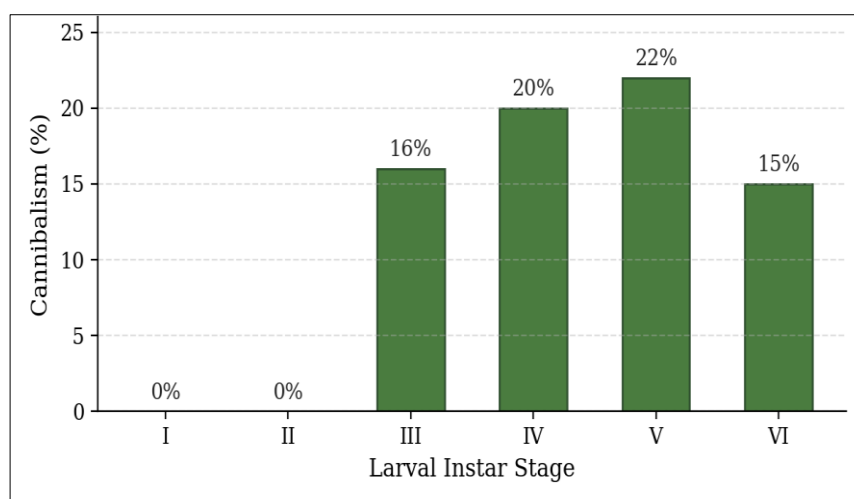


Fig 1: Cannibalism percentage across the six larval instar stages of *Spodoptera frugiperda*

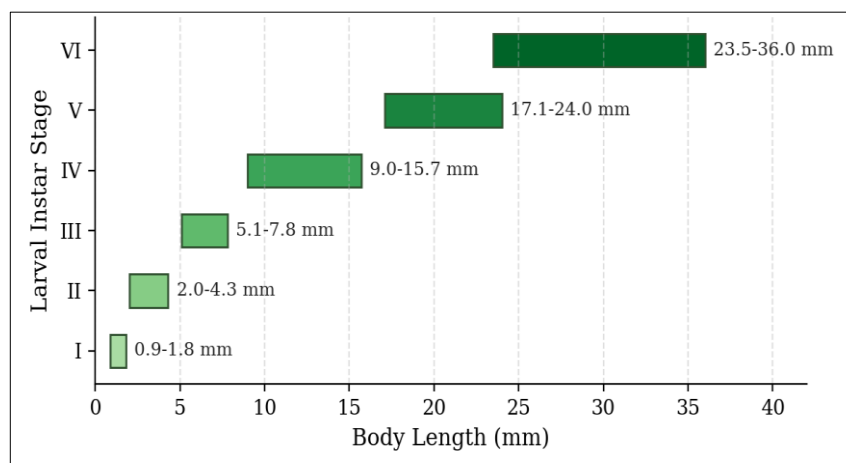


Fig 2: Body length range of fall armyworm larvae across the six instar stages

The rising trend of cannibalism between the third and fifth instars corroborates earlier reports that mature larval stages of many lepidopteran insects cannibalize more frequently than immature stages, since older larvae are physically better equipped to overpower and consume smaller or weaker conspecifics. The decline observed in the sixth instar coincides with the onset of the pre-pupal phase, during which larvae become progressively less mobile and reduce feeding activity in preparation for pupation, thereby lowering the opportunity and motivation for cannibalistic encounters. Several earlier workers have similarly reported that cannibalism in fall armyworm is frequent irrespective of the availability of alternative food and is not influenced by the sex of the cannibalizing larva, with nearly all larvae preying upon at least one younger conspecific when given the opportunity. While some studies place peak cannibalistic intensity in the fourth instar or towards the end of the second instar, others report that same-aged larvae show the highest incidence during the fifth and sixth instars, a pattern broadly consistent with the trend recorded in the present study, although a contrasting view holds that cannibalism among equal-aged larvae is concentrated in the first and second instars. This variation across studies likely reflects differences in rearing density, diet quality, and experimental duration. It is also well established that asymmetry in larval size and age strongly favours cannibalism, with older and larger individuals acting as the more voracious cannibals, and that natural diets such as host-plant foliage tend to promote higher cannibalism rates than artificial diets, possibly owing to differences in feeding stimulation and larval crowding on leaf tissue.

5. Conclusion

The present study confirms that cannibalistic behaviour is an intrinsic feature of fall armyworm larval biology, being absent in the earliest instars, increasing steadily from the third to the fifth instar, and declining in the sixth instar as larvae approach pupation. The fifth instar emerged as the stage most prone to cannibalism (22%), making it an important consideration in mass-rearing and population studies of this invasive pest. These findings reinforce the role of cannibalism as a density- and stage-dependent behavioural trait that may naturally moderate fall armyworm populations under crowded field conditions.

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