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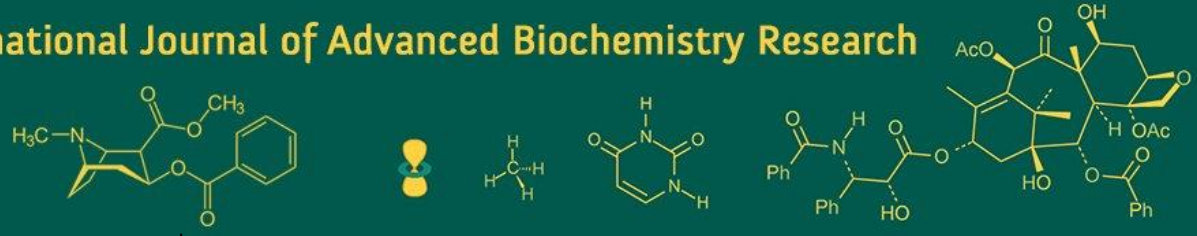

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Biology and management of fall army worm, *Spodoptera frugiperda* in maize crop at Karbi Anglong district of Assam

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Abstract
The present investigation was carried out at AAU-Zonal Research Station, Diphu, Assam to study the biology of fall army worm and to evaluate various newer class of insecticides against Fall army worm, *Spodoptera frugiperda* in maize crop. The study revealed that the average mean of incubation period was found to be 4.3±0.03. Total developmental period from egg to adult was found to be 30-45 days with an average mean of 36.4±1.34.The egg laying capacity of the female moth varied 100-450 eggs with an average of 280.9±1.34. The efficacy study of newer class of insecticides revealed that all the treatments were effective in controlling the pest population with the highest reduction percentage in the treatment with Chlorantraniliprole 18.5 SC (82.47) and Pyridalyl 10% EC (82.05) 10 DAT. The lowest was found in Azadirachtin 1500ppm (55.37) 10 DAT. However, a non chemical intervention during the initial stage of the pest occurance has been found to bring down the pest population in substiantial amount.

Keywords: Biology, fall armyworm, maize, newer insecticide

Introduction
Fall armyworm (FAW), *Spodoptera frugiperda* belongs to the order Lepidoptera and family Noctuidae. They are native to the tropical and subtropical region of America. It has invaded many African and Asian countries and has caused huge economic losses. Due to its deleterious and invasiveness, it was rated as one of the top ten out of 1187 arthropod pests by the Centre for Agriculture and Biosciences International (CABI) in the report "State of the World's Plants" in 2017 (Wild 2017) [19]. It occurred in several countries such as Brazil, Argentina, and the USA (Prowell *et al*., 2004; Clark *et al*., 2007) [14, 3], causing economic losses in a variety of crops such as maize, soybean, cotton and beans (Pogue, 2002; Nagoshi, 2007; Bueno *et al*., 2010) [13, 11, 2], number of weeds, such as *Ipomoea* sp., and crops such as rice, maize, and other grasses (Nabity *et al*., 2011) [10] The occurrence of this new invasive pest was reported for the first time from India by Sharanabasappa and Kalleshwaraswamy (2018) [15-16]. Subsequently in 2019 it spread to various north-eastern states of India including Assam. In Assam, it was first observed on the north bank of Brahmaputra near Kokrajhar district during kharif 2018; whereas, in the south bank of Brahmaputra it was first reported from Karbi-Anglong district in May, 2019. *Spodoptera frugiperda* is observed to be occurring only during Summer season in this particular region during the occur of the study. FAW is a notorious pestiferous insect with high dispersal ability, wide host range and high fecundity that make it one of the most severe economic pests. The purchase and distribution of pesticides (several of which are highly toxic/hazardous) without proper knowledge has become a part of the emergency response to FAW, which is not only unsustainable in the long run, but is bound to be highly damaging to human health, biodiversity and the environment that result in an unsustainable "pesticide treadmill". Thus, the present investigation was taken up to prime out the newer class of chemicals which claims to be less toxic to minimize the misuse of various toxic chemicals by the farmers. The fall armyworm larva feeds by remaining most of its life in the whorl of maize, thus reducing its contact with insecticides (FAO 2018) [5]. Multiple sprays of insecticides thus may lead to the quick development of resistance as has occurred in other areas (Gutierrez-Moreno *et al*. 2019) [6].

Therefore, it is necessary to determine the field efficacy of newer class of insecticides on fall armyworm to integrate with Integrated Pest Management practices.

Need of the study

Spodoptera frugiperda is a polyphagous pest that feeds on more than 80 crops that includes maize, wheat, sorghum, millet, sugarcane, vegetable crops and cotton. It has become a global threat to food security affecting food production and millions of rural livelihoods. The adult FAW moth being a strong flyer and with the help of high speed wind it has been reported to travel at least 100 km per night. Due to its high reproductive rate the pest can potentially established and spread naturally over the large area in a new territory, FAW is impossible to eradicate and reducing its spread has now become a global challenge. Lu *et al*. (2023) [8] reported that the insect preferred maize and sorghum over the other plants, and performance was overall best on maize, but the insect was also able to complete its life cycle on the other plants. Mbande *et al*. (2023) [9] studied the effects of simulated extreme weather conditions on low and high temperature tolerance and reproduction of fall army-worm adults, and reported that heat shock increased heat tolerance and decreased fecundity and egg hatching success. These results show that climate change may have unexpected effects on the spread of fall armyworm and its status as a pest.

The purchase and distribution of pesticides (several of which are highly toxic/hazardous) has become a part of the emergency response to FAW, which is not only unsustainable in the long run, but is bound to be highly damaging to human health, biodiversity and the environment that result in an unsustainable "pesticide treadmill". Therefore, it is extremely important to discourage the use of highly hazardous pesticides against FAW, and instead to urgently promote and deploy proven, FAW identification, biology and ecology, damage symptoms and signs of FAW in relation to other similar caterpillars, monitoring and scouting techniques for FAW, IPM options for FAW and farmers' role in community based monitoring, surveillance and management is in urgent need.

Materials and Methods

The study of biology of FAW was carried out in the laboratory of AAU-ZRS, Diphu by maintaining FAW larvae collected from maize fields. The larvae were reared on maize leaves using insect cage containing the maize cut leaf bits and closed with mesh lid and maintained at 24±2º C, 75 to 80% RH. A pair of male and female adults was released in the rearing cage in fresh maize leaves which were replaced every 12hrs. Filter papers were kept wet timely to kept the leaves fresh for longer period. The laid eggs were then examined at an interval of 12 hrs for hatching. The eggs were allowed to hatch, then the neonates were carefully collected using a soft camel hair brush and were individually transferred in 20 Petri-dishes for further examination. Male and female longevity were observed with their release in a rearing cage (30 x 30 x 45 cm). The larval and pupal period, incubation period and fecundity were recorded.

The field experiment was conducted at AAU-Zonal Research Station, Diphu to assess the efficacy of newer insecticide Chlorantraniliprole 18.5 SC, Spinetoram 11.7 SC, Pyridal 10% EC, Thiamethoxam 25WG, Emamectin benzoate 5 SG,Azadirachtin 5% and control against fall army worm, *Spodoptera frugiperda*.

Table 1: Details of the treatments

Treatments	Dose g ai/ha	Dosage (ml/l or g/l)
Chlorantraniliprole 18.5 SC	27.75	0.3
Spinetoram 11.7 SC	30	0.5
Pyridalyl 10% EC	50	1.0
Thiamethoxam 25WG	100	2.0
Emamectin benzoate 5 SG	12.5	4/10L
Azadirachtin 5%		2.0
Control(water)		

Application of treatments

Spraying was done when sufficient infestation of the pest were noticed and data were recorded at 3, 7 and 10th after spraying of insecticides. Spraying were applied specifically at the whorl region of the plants. The data collected was subjected to statistical analysis as Randomized Complete Block Design after suitable transformations.

Results and Discussion

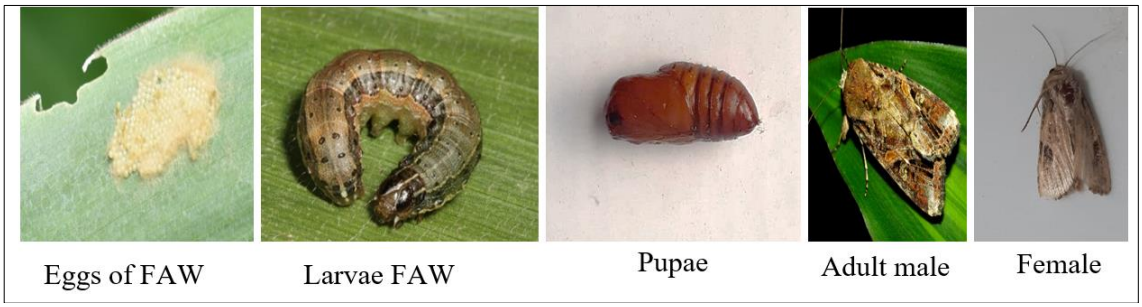
Table 2: Duration of different developmental stages of FAW, *Spodoptera frugiperda* under laboratory condition

Stage		Duration		
		Ranges		Mean ± SD
		2022	2023	
Incubation period(days)		3-4	3-5	4.3±0.03
Larval period (1-3 stages) days		4-7	5-8	6.1±0.07
Larval period (4-6 stages)		6-14	6-13	9.8±0.14
Pupal period (days)		7-8	8-9	7.4±0.03
Adult longevity (days)	Male	8-10	9-10	8.8±0.14
	Female	10-12	10-13	9.75±0.44
Total developmental period (days) (egg to adult)		32-45	30-45	36.4±1.34
Total eggs/female		100-400	100-450	280.9±1.34

From table 2. It can be concluded that total number of eggs laid by the female fall armyworm ranged between 100-450 an average mean of 280.9±1.34 which are laid in mass inside the whorls or on undersurface of leaf or on stem. Eggs were found to be laid on single or multiple layers. Eggs were observed to be creamy, grey or whitish colored covered with anal tuft of hairs

The average mean of incubation period was found to be 4.3±0.03 and the larval period of 1-3 stages ranged between 4-8 days for an average mean of 6.1±0.07 and for 4-6 stage larvae the average mean was found to be 9.8±0.14, respectively. FAW caterpillars were found to have characteristic marks and spots. The FAW caterpillar has a dark head, with an upside-down Y-shaped marking on the front. Each of the body segments of the caterpillar has a pattern of four raised spots. It has four dark spots forming a square on the second-to-last body segment. Total developmental period from egg to adult was found to be 30-45 days with an average mean of 36.4±1.34. Sneha Tiwari *et.al*., 2021 [18] reported similar finding that an average life cycle of *Spodoptera frugiperda* took 34.5 ± 0.72 days in laboratory condition, when the host was sweet corn. Nandita Paul and Sonali Deole (2020) [12] reported that the gravid female was observed laying eggs with the fecundity 160-200

eggs in batches. Incubation, total larval and pupal period were observed to be from 2-4, 14-16 and 8- 10 days, respectively. The total life cycle of male and female was observed to be 29-35, respectively. Their report is almost similar in range with our findings in the report presented in table 3.



Diagnostic damage symptoms

Initial stage 1st & 2nd instar: Papery windows & defoliation

3rd,4 th & 5th instar caterpillar Feed solitarily inside the whorls and cause large holes accompanied by larval droppings

The pest affects the crop at different growth stages from early vegetative to physiological maturity. After hatching, young larvae migrate from plant to plant for feeding on the leaves that causes extensive damage that looks like "window pane or Papery windows" 'Window-paning' is the most common damage symptom at early whorl; however, this is sometimes indistinguishable from damage that is due to other stem borers. Later larval instars chew larger holes, causing ragged whorl leaves, and produce sawdust-like larval droppings, while fresh feeding produces big lumps. Caterpillars hide deep in the whorls. They feed inside whorls and can destroy silks and developing tassels, thereby limiting fertilization of the ear and effect the crop yield.

Table 3: Efficacy of newer class of insecticide against *Spodoptera frugiferda* in maize

Treatments	Dose g a.i/ha	Dosage ml/l or g/l	No. of larvae/plants				% reduction of FAW after treatment		
			Pre-treatment	3 DAT	7DAT	10 DAT	3 DAT	7DAT	10 DAT
Chlorantraniliprole 18.5 SC	27.75	0.3	2.26	0.60 (1.04)	0.10 (0.77)	0.33 (1.19)	68.76	94.80	82.47
Spinetoram 11.7 SC	30	0.5	1.93	0.68 (1.08)	0.17 (0.82)	0.36 (1.19)	68.14	92.59	80.22
Pyridalyl 10% EC	50	1.0	3.17	1.00 (1.18)	0.21 (0.84)	0.67 (1.22)	67.31	93.01	82.05
Thiometaxam 25WG	100	2.0	3.23	1.03 (1.23)	0.51 (1.00)	0.50 (1.20)	66.49	83.71	79.17
Emamectin benzoate 5 SG	12.5	0.4	2.43	0.65 (1.08)	0.23 (0.85)	0.33 (1.17)	68.01	90.15	80.33
Azadirachtin 1500ppm		2.0	2.03	0.93 (1.18)	0.72 (1.10)	0.86 (1.29)	50.87	64.15	55.37
Control		-	2.76	3.0 (1.86)	3.17 (1.91)	3.43 (1.57)	-	-	-
S.Ed±				0.15	0.12	0.03	-	-	-
CD(0.05)			NS	1.92	0.26	0.07	-	-	-

From the field study of efficacy of newer class of insecticides the data revealed that all the insecticides significantly reduced the fall army worm population and the pre-treatment count before the application of treatments ranged from 1.93 to 3.23/plant. Chlorantraniliprole 18.5 SC was found to be the most effective in controlling the pest population with 68.76,94.80 and 82.47% reduction at 3,7 and 10 DAT followed by Pyridalyl 10% EC with 67.31,93.0 and 82.05% reduction of the FAW which were statistically found at par with each other. However, Azadirachtin 1500ppm was found to be the lowest effective against the pest with 50.87,64.15 and 55.37% reduction of FAW, respectively. Whereas in the control the pest population was found to be increasing. The finding is similar with the findings of (*Sharanabasappa Deshmukh et al*., 2020) [17] who reported that chlorantraniliprole18.5 SC, showed the highest acute toxicity. The Central Insecticide Board and Registration Committee recommends the use of Chlorantraniliprole 18.5 SC, thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC, and spinetoram 11.7 SC (DPPQS 2019) for fall armyworm management.

Interventions

On incidence of FAW during the early stage of the crop and early larval stage spraying of water regularly helps to control the pest infestation. Early sowing of maize during Rabi season was observed with less pest infestation

Conclusions

From the present investigations, it may be concluded that early sowing of the Rabi maize could avoid *Spodoptera frugiperda* infestation, while for management of the Kharif maize. The average life cycle of *Spodoptera frugiperda* took 36.4±1.34 days in maize under laboratory condition. To control FAW Chlorantraniliprole 18.5 SC can be an important component of integrated pest management.

Competing Interests

Authors have declared that no competing interests exist.

References

1. Abbas A, Farman U, Muhammad H, Xiao H, Muhammad ZN D, Hina G, *et al*. Biological Control of Fall Armyworm, Spodoptera frugiperda. Agronomy. 2022;12(11):2704.
2. Bueno RCOF, Carneiro TR, Bueno AF, Pratissoli D, Fernandes OA, Vieira SS. Parasitism capacity of *Telenomus remus* Nixon (Hymenoptera: Scelionidae) on Spodoptera frugiperda (Smith) (Lepidoptera: Noctuidae) eggs. Braz Arch Biol Technol. 2010;53:133-9.
3. Clark PL, Molina-Ochoa J, Martinelli S, Skoda SR, Isenhour DJ, Lee DJ, *et al*. Population variation of Spodoptera frugiperda (J. E. Smith) in the Western Hemisphere. J Insect Sci. 2007;7:1-10.
4. DPPQS – Directorate of Plant Protection, Quarantine & Storage. Advisory on exotic pest fall armyworm (FAW) Spodoptera frugiperda on maize in Karnataka State, India. 2019. Available from: http://ppqs.gov.in/advisories-section
5. FAO. Integrated management of the fall armyworm on maize: a guide for farmer field schools in Africa. Rome: Food and Agriculture Organization; c2018.
6. Gutiérrez-Moreno R, Mota-Sanchez D, Blanco CA, Whalon M, Terán-Santofimio H, Rodriguez-Maciel JC, *et al*. Field-evolved resistance of the fall armyworm (Lepidoptera: Noctuidae) to synthetic insecticides in Puerto Rico and Mexico. J Econ Entomol. 2019;112:792–80.
7. Jing Wan, Huang C, LI Chang-you, Zhou Hong-xu, Ren Yong-lin, LI Zai-yuan, *et al*. Biology, invasion and management of the agricultural invader: Fall armyworm, Spodoptera frugiperda (Lepidoptera: Noctuidae). J Integr Agric. 2021;20(3):646-663.
8. Lu J, Zhang B, Zhuang M, Ren M, Li D, *et al*. Preference and performance of the fall armyworm, Spodoptera frugiperda, on six cereal crop species. Entomol Exp Appl. 2023;171.
9. Mbande A, Mutamiswa R, Nyamukondiwa C, Chidawanyika F. Contrasting effects of acute heat shock on physiological and ecological performance of the fall armyworm. Entomol. Exp. Appl. 2023;171.
10. Nabity PD, Zangerl AR, Berenbaum MR, Delucia EH. Bioenergy crops Miscanthus giganteus and Panicum virgatum reduce growth and survivorship of Spodoptera frugiperda (Lepidoptera: Noctuidae). J Econ Entomol. 2011;104:459-64.
11. Nagoshi RN, Adamczyk JJ, Meagher J, Gore RL, Jackson R. Using stable isotope analysis to examine fall armyworm (Lepidoptera: Noctuidae) host strains in a cotton habitat. J Econ Entomol. 2007;100:1569-76.
12. Nandita Paul, Sonali. Biology of Fall Army Worm, Spodoptera frugiperda (J. E. Smith) (Lepidoptera: Noctuidae) on Maize Crop at Raipur (Chhattisgarh). Int. J Curr Microbiol. Appl. Sci. 2020;9(9):2319-7706.
13. Pogue GM. A world revision of the genus Spodoptera Guenée (Lepidoptera: Noctuidae). Mem Am Entomol Soc. 2002;43:1-202.
14. Prowell DP, McMichael M, Silvain JF. Multilocus genetic analysis of host use, introgression, and speciation in host strains of fall armyworm (Lepidoptera: Noctuidae). Ann Entomol. Soc. Am. 2004;97:1034-44.
15. Sharanabasappa, Kalleshwaraswamy CM. Fall armyworm has reached Indian subcontinent. 2018. Available from: http://www.iita.org/newsitem/fall-armyworm-has-reached-the-indian-subcontinent
16. Sharanabasappa D, Kalleshwaraswamy CM, Maruthi MS, Pavithra HB. Biology of invasive fall armyworm Spodoptera frugiperda (J.E. Smith) (Lepidoptera: Noctuidae) on maize. Indian J Entomol. 2018;80:540–543.
17. Sharanabasappa Deshmukh, Pavithra HB, Kalleshwaraswamy CM, Shivanna BK, Maruthi MS, David Mota-Sanchez. Field Efficacy of Insecticides for Management of Invasive Fall Armyworm, Spodoptera frugiperda (J. E. Smith) (Lepidoptera: Noctuidae) on Maize in India. Florida Entomol. 2020;103(2):221-227.
18. Tiwari S, Deole S. Studies on life cycle of fall armyworm, Spodoptera frugiperda (J.E. Smith) on maize at Raipur, Chhattisgarh. Pharma Innovation J. 2021;10(2):643-646.
19. Wild S. African countries mobilize to battle invasive caterpillar. Nature. 2017;543:13-14.