International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating: 5.29
IJABR 2025; 9(7): 619-623
www.biochemjournal.com
Received: 20-05-2025
Accepted: 26-06-2025

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Efficacy of entomopathogens, pesticidal plants and chemicals against fall armyworm, *Spodoptera frugiperda* (J. E. Smith) under laboratory condition

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DOI: https://www.doi.org/10.33545/26174693.2025.v9.i7h.4799

Abstract

The experimental research was conducted under laboratory conditions at the Division of Entomology, Dr. Sharadchandra Pawar College of Agriculture, Baramati. This study evaluates the efficacy of entomopathogens, pesticidal plants, and chemicals against fall armyworm. During the experiment second instar larvae were fed an artificial diet treated with eight different treatments: *Azadirachta indica* (15000 ppm), *Datura stramonium* (10%), *Lantana camara* (10%), *Bacillus thuringiensis var. kurstaki* (1% WG), *Metarhizium anisopliae* (1.15% WP), Emamectin benzoate (5% SG), Spinetoram (11.7 SC), and an untreated control. Larval mortality was recorded at 24, 48, and 72 hours after exposure. Among the treatments, *Lantana camara* showed the highest mortality (91.11-98.89%) across all doses and time intervals, followed by *Metarhizium anisopliae* (88.89-96.66%) and Emamectin benzoate (87.89-98.89%). The findings highlight the efficacy of plant extracts and microbial agents, particularly *Lantana camara* and *Metarhizium anisopliae*, as promising, eco-friendly alternatives to synthetic insecticides for fall armyworm management.

Keywords: Fall armyworm, artificial diet, plant extracts, microbial agent, chemicals

Introduction

Maize (*Zea mays* L.) is the world's widely grown cereal grain, originally developed in Central America. Maize is widely regarded as the "Queen of cereals" because to its great genetic yield potential. Globally, maize is consumed mostly for feed (61%), food (17%), and industry (22%), with 83% of its global production going towards the feed, starch, and biofuel industries, it has established itself as an industrial crop (Kumar *et al.*, 2012) [6]. Maize contains about 72% starch, 10% protein, and 4% fat (Ranum *et al.*, 2014) [15]. Due to biotic stressors including pests and diseases, maize, the most important cereal crop, poses serious risks to food security. It is native to the tropical and subtropical region of America, where it is a serious pest of corn but also known to attack more than 100 hosts. Fall armyworm is a lepidopteran pest that feeds in large numbers on leaves, stems and reproductive parts of more than 350 plant species, causing 70 percent yield loss in the overall economy (Montezano *et al.*, 2018) [11]. Fall armyworm acts as a cutworm and feeds extensively on maize foliage, most economic damage is caused by late instar larvae that bore into the maize cob (Prasanna *et al.*, 2018) [13]. Fall armyworm affects maize at all phases of growth, from seedling up to ear development. Fall armyworm larvae feed on opening leaves by scraping and skeletonizing the top epidermis, resulting in a silvery translucent membrane and papery patches. Pinhole symptoms appear on the leaves as a result of the injury. Late instar damage (3rd instar onwards) causes severe defoliation of leaves. A study estimates a 20 to 50% maize yield loss due to FAW infestation (Early *et al.*, 2018) [4]. Damage levels on the leaf, tassel, and silk were reported to range between 25% and 50% and there was a decrease in grain yield by 58% (Chimweta *et al.*, 2019) [2]. According to studies, fall armyworm can cause maize yield losses ranging from 8.3 to 20.6 million tonnes/year in absence of management practices (Day *et al.*, 2017) [3]. The current plant protection methods followed for managing insect pests depend heavily on the synthetic insecticides. Their uninterrupted and substantial use has created several serious problems such as resurgence, secondary pest outbreak, environmental pollution and serious animal and human health problems.

Therefore, in order to overcome these problems, there has been a steady effort towards searching for new methods and insect control which are economical, effective and environmentally safe.

2. Material and Methods

An experiment was conducted to evaluate the efficacy of different entomopathogens, pesticidal plants and chemicals against fall armyworm by using Completely Randomized Design (CRD) consisting of eight treatments *Azadirachta indica* (15000 ppm), *Datura stramonium* (10%), *Lantana camara* (10%), *Bacillus thuringiensis var*. *kurstaki* (1% WG), *Metarhizium anisopliae* (1.15% WP), Emamectin benzoate (5% SG), Spinetoram (11.7 SC), and an untreated control, each with three replications, in the laboratory at the Division of Entomology, Dr. Sharadchandra Pawar College of Agriculture, Baramati.

2.1 Mass rearing of fall armyworm

The *S. frugiperda* culture was initiated by collecting late instar larvae from maize fields around the PG research farm. Larvae were reared on maize seedlings up to the pupal stage. Pupae were collected and placed in petri dishes inside adult emergence cages. Emerged adults were transferred to oviposition cages (20×15×15 cm) and provided with 50% honey syrup on cotton as food. Fresh maize seedlings were offered daily for oviposition, and eggs were collected daily and kept in containers for hatching. Neonates were fed on maize seedlings, and at the 2nd instar, transferred to bioassay trays to reduce cannibalism and reared on artificial diet recommended by International Maize and Wheat Improvement centre (CIMMYT).

2.2 Preparation of plant extract

Leaves of *Datura stramonium* and *Lantana camara* were collected from Dr. Sharadchandra Pawar College of Agriculture campus, washed, shade dried, and ground into fine powder. Each 200 g of leaf powder was soaked in 600 ml ethanol for 24 hours at room temperature, then filtered using muslin cloth and Whatman No.1 filter paper. The filtrates were concentrated using a rotary vacuum evaporator to obtain crude extracts, which were stored in sterilized amber bottles at 4 °C. (Prasoona *et al.*, 2022) [14]

2.3 Treatment application

The artificial diet mix method was assessed for the efficiency of seven compounds against second instar *S. frugiperda* larvae. The stock solutions of each treatments was prepared by dissolving respective formulations in distilled water. From this stock solution of desired concentration of all treatments were prepared by serial dilution *i.e*. 0.625, 1.25, 2.5, 5.0, 10 ml/ liter, respectively.

The artificial diet mixed with following treatments for each concentration was placed in clean rectangular plastic boxes with perforated lid. Ten larvae was considered as a one replicate and three replicates were performed for each treatment concentration, while an artificial diet mixed with water was used as the control. Second instar *S. frugiperda* larvae was collected from culture and released onto artificial diet.

The observations on larval mortality was observed at 24 and 48 h and final mortality was recorded 72 h after exposure to the treated artificial diet using a camel hairbrush. The larvae that was responding to the gentle touch of a camel hair brush was considered alive, while those who failed to move was considered as dead.

3. Results and Discussion

3.1 Cumulative mortality at 24, 48 and 72 Hours after treatment

Data from Table 1 and Fig 1, indicated that at 24 HAT, the study revealed that *Lantana camara* exhibited significant larval mortality against 2nd instar larvae. At 0.625 ml, the highest mortality was in *Lantana camara* (82.22%), followed by *Metarhizium anisopliae* (64.44%) and *Spinetoram* (64.44%). At 1.25 ml, *Lantana camara* led again (87.77%), followed by Spinetoram (70%) and *M. anisopliae* (65.55%). At 2.5 ml, *Lantana camara* showed highest mortality (94.44%), then Spinetoram (76.66%) and Emamectin benzoate (72.22%). At 5 ml, top were *Lantana camara* (95.55%), followed by Spinetoram (76.66%), and *M. anisopliae* (74.44%). At 10 ml, *Lantana camara* achieved 98.89% mortality, followed by Spinetoram (83.33%) and Emamectin benzoate (80%).

It is clear from Table 1 and Fig 2 at 48 HAT, at 0.625 ml, Highest was in *Metarhizium anisopliae* (88.89%) and *Lantana camara* (88.88%), followed by Emamectin benzoate (81.11%). At 1.25 ml, top treatments were *Lantana camara* (91.11%) and *M. anisopliae* (90%), followed by Emamectin benzoate (82.22%). At 2.5 ml, Highest was in *Lantana camara* (94.44%) and *M. anisopliae* (92.22%), followed by Emamectin benzoate (88.88%). At 5 ml, top were *Lantana camara* (96.66%) and *M. anisopliae* (95.56%), followed by Emamectin benzoate (93.33%). At 10 ml, best results were from *Lantana camara* (98.89%) and *M. anisopliae* (96.66%), followed by Emamectin benzoate (94.44%).

The data in Table 1 and Fig 3, at 72 HAT, among the different treatments at 0.625 ml, *Lantana camara* (91.11%) showed the highest mortality, followed by *Metarhizium anisopliae* (88.89%) and Emamectin benzoate (87.78%). At 1.25 ml, *Lantana camara* (94.43%) was most effective, followed by *Metarhizium anisopliae* (90%) and Emamectin benzoate (87.77%). At 2.5 ml, the highest mortality was observed in *Lantana camara* (97.78%), *Metarhizium anisopliae* (95.55%), and Emamectin benzoate (92.22%). At 5 ml, *Lantana camara* (98.89%) remained superior, followed by *Metarhizium anisopliae* (95.55%) and Emamectin benzoate (95.55%). At 10 ml, *Lantana camara* and Emamectin benzoate (98.89%) along with *Metarhizium anisopliae* (96.66%) showed the highest efficacy.

Findings are in close agreement with Melanie *et al.*, (2020) [10] where the bioassay test showed 6% lantana leaf ethanolic extract led to 80% mortality of *C. pavonana* 3rd instar larvae in 24 hours and 100% mortality at 48 and 72 hours. Similarly Khanal *et al.*, (2024) [5] observed the efficacy of various pesticides on third instar *Spodoptera frugiperda* larvae where results indicated that *Bacillus thuringiensis var. kurstak* (67%), *Metarhizium anisopliae* (62.5%), Spinetoram (100%), Emamectin benzoate (100%) mortality. More or less similar observation were also reported by Mallapur *et al.*, (2019) [9] looked into the laboratory and field evaluation of new insecticides against fall armyworm where they found that Spinetoram and Emamectin benzoate recorded 98.28 and 96.55% mortality, respectively. The current finding align with Phambala *et al.*, (2020) [12] who explored the potential of plants for managing the fall armyworm (FAW), *Spodoptera frugiperda* and reported that the topical application of plant extracts to fall armyworm larvae showed a strong dose response of 10% concentration of *Azadirachta indica* with a larval mortality of 60%. They also came to conclusion that *Azadirachta indica* act as the most potent feeding deterrent. Ahmed s (2023) [1] inspected the screening of management options and efficacy evaluations against fall armyworm, in this study *Azadirachta indica* caused a mortality of 71.6%, *Lantana camara* (65%), *Metarhizium anisopliae* (70%), Spinetoram (90%) mortality. Lima *et al.*, (2023) [8] inspected the growth inhibitory activities and feeding deterrence of solanaceae-based derivatives on fall armyworm where crude ethanolic extracts of *Datura stramonium* caused 77.5% mortality. Our findings are in close agreement with Lima *et al.*, (2021) [7] who found *Datura stramonium* with mortality of 25% after exposure.

Table 1: Cumulative mortality of 2nd instar larvae of *S. frugiperda* at different interval after different doses (0.625, 1.25, 2.5, 5.0,10 ml) of treatments

Sr. No	Treatment	24 hrs					48 hrs					72 hrs				
		Mean mortality (%) of 2nd instar larvae at different doses					Mean mortality (%) of 2nd instar larvae at different doses					Mean mortality (%) of 2nd instar larvae at different doses				
		0.625 ml	1.25 ml	2.5 ml	5ml	10 ml	0.625 ml	1.25 ml	2.5 ml	5 ml	10 ml	0.625 ml	1.25 ml	2.5 ml	5 ml	10 ml
1	*Azadirachta indica* 15000 ppm @ 4 ml/L	51.11 (45.63)*	53.33 (46.91)	58.89 (50.12)	63.33 (52.75)	73.33 (58.94)	54.44 (47.55)	60.00 (50.78)	66.66 (54.75)	72.22 (58.20)	76.66 (61.15)	61.11 (51.44)	70.00 (56.81)	73.33 (58.93)	74.44 (59.64)	76.66 (61.15)
2	*Datura stramonium* leaf extract 10% @ 10 ml/L	25.56 (30.35)	33.33 (35.26)	35.55 (36.60)	37.78 (37.92)	42.22 (40.52)	35.55 (36.50)	38.89 (38.58)	38.89 (38.58)	43.33 (41.16)	45.55 (42.45)	41.1 (39.87)	44.44 (41.81)	50.00 (45.00)	54.44 (47.55)	57.78 (49.48)
3	*Lantana camara leaf* extract 10% @ 10 ml/L	82.22 (65.20)	87.77 (69.84)	94.44 (76.51)	95.55 (77.99)	98.89 (86.49)	88.88 (70.83)	91.11 (73.21)	94.44 (76.51)	96.66 (81.50)	98.89 (86.49)	91.11 (76.50)	94.43 (76.51)	97.78 (82.99)	98.89 (86.49)	98.89 (86.49)
4	*Bacillus thuringiensis var. kurstaki* 1% WP @ 2 gm/L	23.33 (28.88)	24.44 (29.62)	31.11 (33.89)	36.67 (37.27)	38.89 (38.58)	23.33 (28.88)	25.55 (30.35)	32.22 (34.57)	36.67 (37.26)	42.22 (40.52)	27.78 (31.79)	32.22 (34.58)	32.22 (34.57)	36.67 (37.27)	44.44 (41.81)
5	*Metarhizium anisopliae* 1.15% WP @ 4gm/L	64.44 (53.39)	65.55 (54.07)	71.11 (57.52)	74.44 (59.64)	77.78 (61.89)	88.89 (70.73)	90.00 (71.72)	92.22 (74.36)	95.56 (78.00)	96.66 (81.51)	88.89 (70.74)	90.00 (71.73)	92.22 (74.36)	95.55 (78.00)	96.66 (81.51)
6	Emamectin benzoate 5% SG @ 0.5 gm/L	55.55 (48.19)	60.00 (50.77)	72.22 (58.20)	73.33 (58.94)	80.00 (63.49)	81.11 (64.47)	82.22 (65.08)	88.88 (70.83)	93.33 (75.36)	94.44 (76.51)	87.78 (69.57)	87.77 (69.84)	95.55 (78.00)	95.55 (78.00)	98.89 (86.49)
7	Spinetoram 11.7 SC @ 0.85 ml/L	64.44 (53.39)	70.00 (56.81)	76.66 (61.15)	76.66 (61.15)	83.33 (65.97)	73.33 (58.94)	80 (63.48)	83.33 (65.97)	85.56 (67.86)	86.67 (68.68)	80.00 (63.48)	80.00 (63.49)	84.46 (66.87)	86.66 (68.68)	91.11 (73.21)
8	Control	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
SEm±		0.93	1.24	0.98	0.98	1.55	1.67	1.54	1.72	2.03	2.21	1.30	1.47	1.96	1.59	2.68
CD at 5%		2.97	3.71	2.93	2.95	4.06	5.02	4.60	5.17	6.12	6.65	3.91	4.40	5.87	4.78	8.03
CV		5.14	5.85	4.28	4.12	3.96	6.58	5.06	5.25	4.02	3.62	4.79	4.75	4.63	2.84	3.97

*Figures within the parenthesis are arc sine transformed values

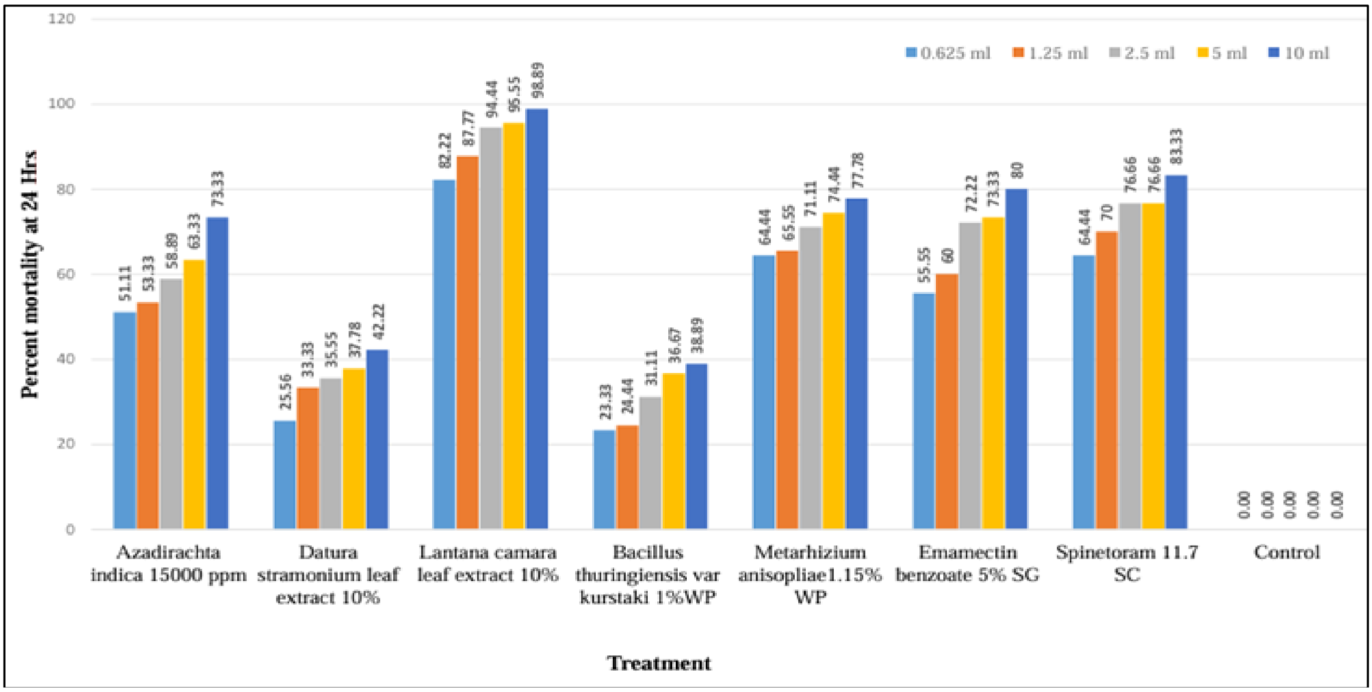

Fig 1: Cumulative mortality of 2nd instar larvae of *Spodoptera frugiperda* at 24hrs after different doses (0.625, 1.25, 2.5, 5.0, 10 ml)

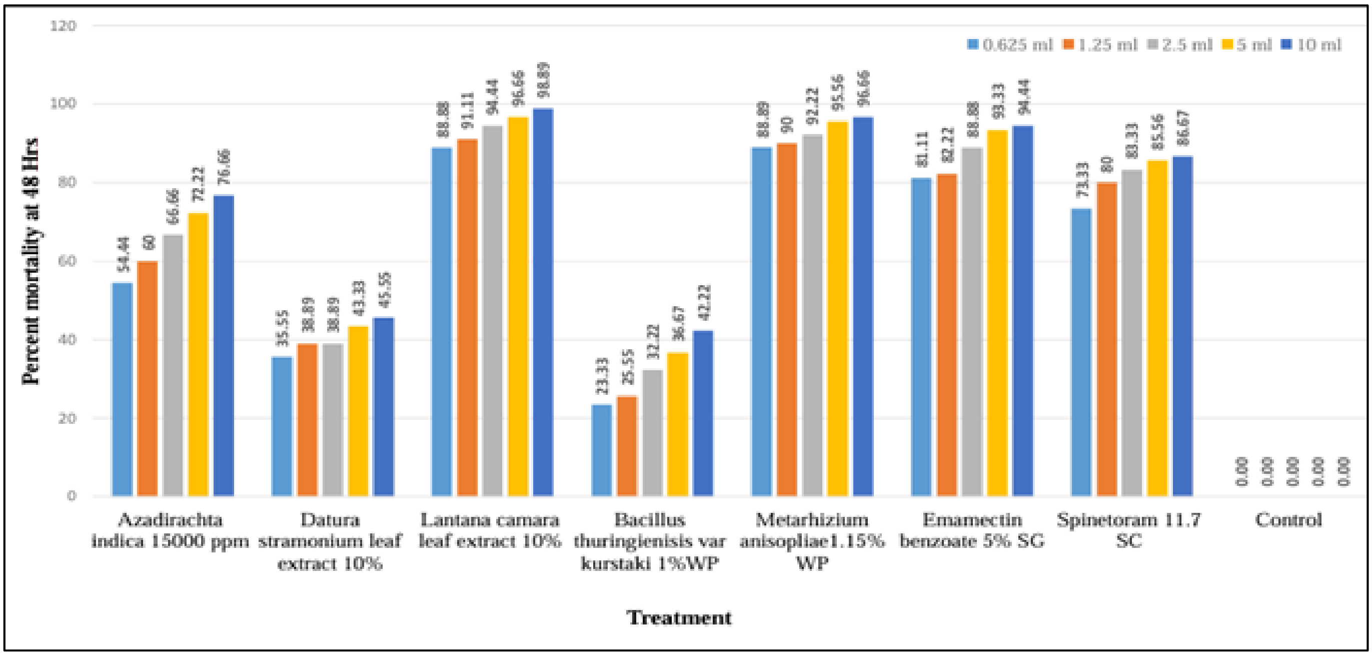

Fig 2: Cumulative mortality of 2nd instar larvae of *Spodoptera frugiperda* at 48hrs after different doses (0.625, 1.25, 2.5, 5.0, 10 ml)

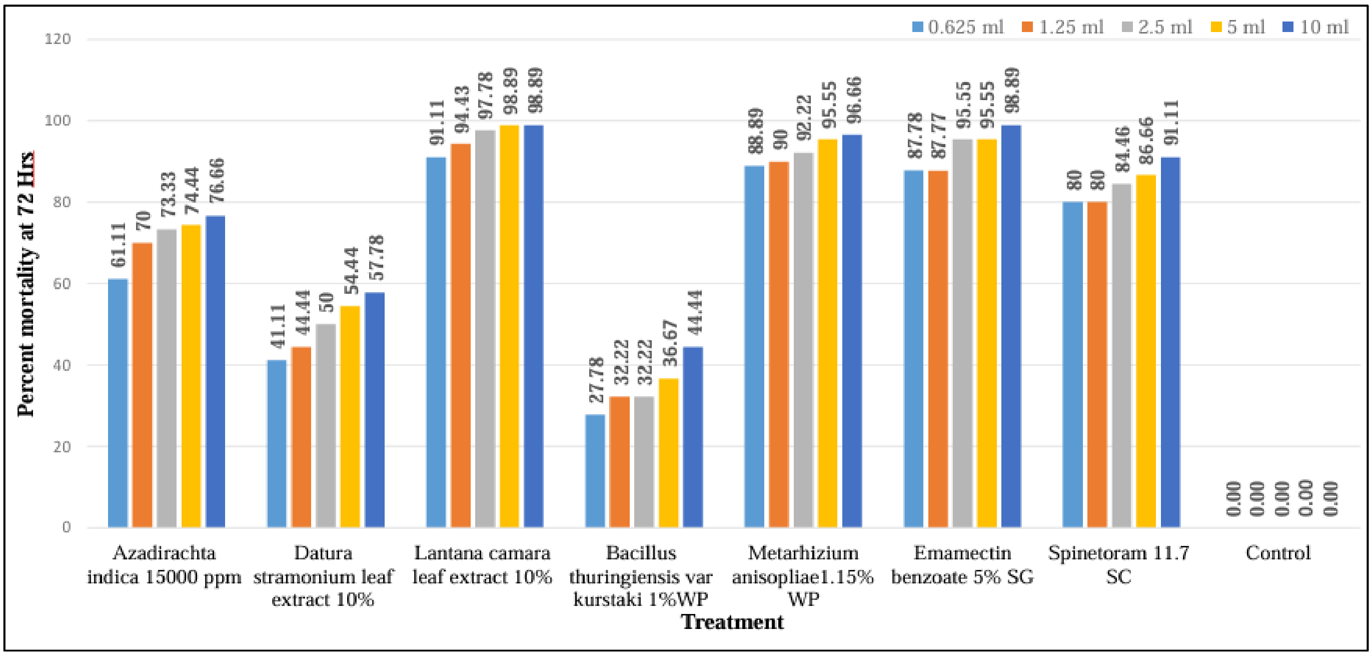

Fig 3: Cumulative mortality of 2nd instar larvae of *Spodoptera frugiperda* at 72hrs after different doses (0.625, 1.25, 2.5, 5.0, 10 ml)

4. Conclusion

Based on the results across all doses, it can be concluded that *Lantana camara*, *Metarhizium anisopliae* and Emamectin benzoate were consistently the most effective treatments in causing high mortality of 2nd instar larvae of *S. frugiperda*. Among these, *Lantana camara* showed the highest efficacy across all doses. This indicates that *Lantana camara*, hold strong potential for effective pest management. This targeted strategy offers insightful information for creating integrated pest management that successfully manage FAW while fostering ecological harmony. This research focuses on Integrated Pest Management (IPM), emphasizing the sustainable control of pest populations through a combination of plant-based extracts, microbial agents, and chemical interventions. By reducing reliance on chemical pesticides and promoting eco-friendly practices, the study aims to enhance crop protection while safeguarding environmental and human health.

5. References

1. Ahmed S. Screening of management options and efficacy evaluations against fall armyworm (*Spodoptera frugiperda* (J.E. Smith)) (Lepidoptera: Noctuidae) on maize in Assosa, Ethiopia. Journal of Entomology and Ornithology. 2023;1(1):000101.
2. Chimweta M, Nyakudya IW, Jimu L, Mashingaidze AB. Fall armyworm *Spodoptera frugiperda* (J.E. Smith) damage in maize: management options for flood-recession cropping smallholder farmers. International Journal of Pest Management. 2019;66(2):142-154.
3. Day R, Abrahams P, Bateman M, Beale T, Clottey V, Cock M, Witt A. Fall armyworm, impacts and

implications for Africa. Outlooks on Pest Management. 2017;28(5):196-200.
4. Early R, Gonzalez-Moreno P, Murphy ST, Day R. Forecasting the global extent of invasion of the cereal pest *Spodoptera frugiperda*, the fall armyworm. NeoBiota. 2018;40:25-50.
5. Khanal D, Subedi D, Banjade G, Lamichhane M, Shrestha S, Chaudhary P. Efficacy of different pesticides against fall armyworm *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) under laboratory conditions in Rupandehi, Nepal. International Journal of Agronomy. 2024;2024(1):7140258.
6. Kumar B, Karjagi CG, Jat SG, Parihar CM, Yathish KR, Singh V, Hooda KS, Dass AK, Mukri G, Sekhar JC, Kumar R, Sai Kumar R. Maize biology: An introduction. Technical Bulletin. New Delhi: Directorate of Maize Research, Indian Council of Agricultural Research (ICAR); 2012. p. 32.
7. Lima AF, do Prado Ribeiro L, Gonçalves GLP, Maimone NM, Gissi DS, de Lira SP, Vendramim JD. Searching for bioactive compounds from Solanaceae: lethal and sublethal toxicity to *Spodoptera frugiperda* and untargeted metabolomics approaches. Journal of Pest Science. 2021;94:1-13.
8. Lima AF, Ribeiro LP, Lira SP, Carvalho GA, Vendramim JD. Growth inhibitory activities and feeding deterrence of Solanaceae-based derivatives on fall armyworm. Agriculture. 2023;13(2):420.
9. Mallapur CP, Naik AK, Hagari S, Praveen T, Naik M. Laboratory and field evaluation of new insecticide molecules against fall armyworm, *Spodoptera frugiperda* (J.E. Smith) on maize. Journal of Entomology and Zoology Studies. 2019;7(5):729-733.
10. Melanie M, Hermawan W, Kasmara H, Panatarani C. Physicochemical characterizations and insecticidal properties of *Lantana camara* leaf ethanolic extract with powder application. AIP Conference Proceedings. 2020;2219(1):012059.
11. Montezano DG, Sosa-Gómez DR, Specht A, Roque-Specht VF, Sousa-Silva JC, Paula Moraes SD, Hunt TE. Host plants of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in the Americas. African Entomology. 2018;26(2):286-300.
12. Phambala K, Tembo Y, Kasambala T, Kabambe VH, Stevenson PC, Belmain SR. Bioactivity of common pesticidal plants on fall armyworm larvae (*Spodoptera frugiperda*). Plants. 2020;9(1):112.
13. Prasanna BM, Huesing JE, Eddy R, Peschke VM. Fall armyworm in Africa: A guide for integrated pest management. Mexico: International Maize and Wheat Improvement Center (CIMMYT); 2018. p. 45-57.
14. Prasoona US, Kolhe AV, Tathode VR, Tidke VN. Antifeedant activity of some botanicals against *Spodoptera frugiperda* (J.E. Smith) under laboratory condition. The Pharma Journal. 2022;11(1s):101-104.
15. Ranum P, Pena-Rosas JP, Garcia-Casal MN. Global maize production, utilization, and consumption. Annals of the New York Academy of Sciences. 2014;1312(1):105-112.