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The Efficacy of Some Plants Extracts on Fallarmyworm (*Spodopterafrugiperda, J.E. Smizh) in Sudan*

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Abstract

The Fall armyworm worm (FAW) (Spodopterafrugiperda) is one of the important economic pests which goes on several field crops and causes serious damage. The aim of this study was to look for efficient, less cost and environmentally friend plant extract for controlling Fall armyworm worm in cereal crops. A Complete Randomized Block Design (CRBD) experiments with three replications were conducted in the laboratory to investigate the insecticidal effects of four plant extracts consisting of ethanolic extract of Neem (Azadirachta indica) seeds, Black pepper (Piper nigrum) seeds, Usher (Calotropis procera) leaves and water extracts of Argel (Solenostemma argel) leaves on larvae of the Fall armyworm (FAW) (Spodoptera frugiperda). Newly emerged larvae of FAW were treated topically by 4 concentrations (10, 25, 50 and 75%) of each extract, and then the larval mortalities were calculated after 24, 48 and72 hrs. The results showed the highest concentrations (75%) of the three ethanolic extracts gave higher mortality percentages (100%) after 72 hrs of exposure, compared with other concentrations. Also, these were not significantly different from the recommended dose of the standard pesticide "Spinosad". On the other hand, Argel water extract showed no effect on the (FAW) larvae. It is recommended that this experiment to be replicated under different environments.

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Introduction

The Fall Army Worm (FAW), *Spodoptera frugiperda*, J.E.Smith, is an insect pest native to tropical and subtropical regions of the Americas[1]. Studies carried out on this pest showed that, it is a polyphagous insect of enormous agricultural importance. The Larvae can feed on more than 350 plant species. It can produce several generations per year, and the moth can fly up to 100 km per night [2].

FAW was first detected in Central and West Africa in the early 2016, and further reported and confirmed in the whole mainland of Southern Africa [3]. By the beginning of 2018, its distribution has extended to more than 60 African countries[4]. In Sudan, the pest was recorded for the first time in July 2017 on Hybrid Maize in the experimental farm of AlDamazin Research Station (Blue Nile State-Sudan) [5,6]. Also, it was recorded in the same year on Maize in Gadarif State [7]. Later surveys carried in Sudan in 2018 showed that FAW became one of the main pests, causing damage in eight more States in the country.

Due to the problems and hazards arising from the application of inorganic insecticides to control FAW, nowadays organic insecticides are used. However, many studies to control FAW were carried out using plant extracts. The earlier studies have evaluated the control of FAW in Maize in screenhouse and open field experiments in Malawi and Nepal using plant extracts like Nicotiana tabacum, hot pepper, Artemesia, Cymbopogon citratus, Azadirachta indica and Lippia javanica (2015, 2019, 2020) [8,9,10]. In the same line, the present study was carried out to test the efficacy of the extracts of four indigenous plants in Sudan, these are the Neem (*Azadirachta indica*), Black pepper (*Piper nigrum*), Usher (*Calotropis procera*) and Argel (*Solenostemma argel*), against larvae of FAW. However, the main objective were to look for easy, economic and environmental safe measure of control and to attain food security and stability to the farmers.

Materials and Methods

Experiments were conducted in the laboratory of the College of Agricultural Studies - Sudan University of Science&Technology, Shambat, Khartoum- Sudan during 2018-2019,where the extracts of four plants, Neen (*Azadirachta indica*), Black pepper (*Piper nigrum*), Usher (*Calotropis procera*) and Argel (*Solenostemma argel*), were chosen for application against immature stages of FAW (*S. frugiperda*). Neem seeds and Usher leaves were collected from Shambat area, and Argel leaves and Black pepper were obtained from the local market. All these materials were washed and dried under laboratory conditions for 48 hrs. Then, they were ground to a fine powder by an electric blender (Moulinex), and the powders were kept in tight containers to be used later.

Neem seeds, Black pepper seeds and Usher leave powder extracts were prepared by using Ethanol according to the method described by Sukhdev et al. (2008)[11]. Samples of each plant powder were soaked with absolute Ethanol. Extraction was carried out for three days, with daily filtration and evaporation of the solvent under reduced pressure using rotary evaporator apparatus. Samples were exposed to air in an evaporating dish till complete dryness. A stock concentration was prepared for each extract and serial dilutions were made to prepare 4 different concentrations for the bioassay treatments.

Moreover, aqueous extraction was also carried out according to the method of [11], with slight modification. The extract was prepared by mixing 2.5gm of the leaves powder in 10 liters of water, and the mixture was left for 24 hrs. Then, it was strained through a cotton cloth and kept as a stock solution for later use. Also, 4 concentrations were prepared for the bioassay tests.

For preparing laboratory bioassays, four groups, each of 15 recently hatched larvae of (FAW) were placed in Petri-dishes, each contained a piece of fresh maize leaf which previously immersed for 5 seconds in each of the four different concentrations (10, 25, 50 and 75%) of each extract. Another group, of 15 larvae, was used as a control with each concentration, and was placed in a Petri-dish contained fresh maize leaf, treated with Ethanol, and with distilled water with Argel extract. A group of 15 larvae was added to each replicate, and was treated with the recommended dose of a standard pesticide, Spinosad [Tracer Spinosad, Chemimport Company Ltd, Sudan]. The experiments were arranged in a complete randomized block design experiment (CRBD), and the test containers were kept in

Table 1. Mean Mortality of larvae of *S. frugiperda* treated by Topical Application of Neem Seeds ethanolic extract (Shambat-Sudan-2018).

Concentrations	No. of Larvae	After 24hrs		After 48hrs		After 72hrs	
		No. of dead Larvae	Mean % Mortality	No. of dead Larvae	Mean % Mortality	No. of dead Larvae	Mean % Mortality
10%	15	2 (1.6)	13.6 (3.8) ^{c}	5 (2.3)	33.3(5.8) ^{b}	10 (3.2)	66.6(8.2)^{ab}
25%	15	4 (2.1)	26.33 (|5.1) ^{b}	6 (2.5)	40(6.4) ^{b}	9 (3.1)	60(7.8)^{ab}
50%	15	4 (2.1)	26.33(5.1) ^{b}	6 (2.5)	40(6.4) ^{b}	9 (3.1)	60(7.8)$^{a\ b}$
75%	15	12 (3.5)	80 (9.0) ^{a}	14 (3.7)	93.3(9.7) ^{a}	15 (3.9)	100(10.02) ^{a}
(Standard)	15	10 (3.2)	66.6 (8.2)^{a}	14 (3.9)	93.3(9.7) ^{a}	15 (3.9)	100(10.02)^{a}
Control	15	0 (0.7)	0 (0.07) ^{d}	0 (0.7)	0 (0.7) ^{c}	0 (0.7)	0(0.07)^{b}

Means followed by the same letter(s) are not significantly different at P≤0.05. Means between brackets are transformed by (√ × + 0.5).

Table 2. Mean Mortality of larvae of *S. frugiperda* treated by Topical Application of Black Pepper Seeds ethanol extract (Shambat,2018)

Concentrations	No. of Larvae	After 24hrs		After 48hrs		After 72hrs	
		No. of dead Larvae	Mean % Mortality	No. of dead Larvae	Mean % Mortality	No. of dead Larvae	Mean % Mortality
10%	15	3(1.7)	20(4.5) ^{bc}	6 (2.5)	40(6.4) ^{b}	15(3.9)	100(10.0) ^{a}
25%	15	1(1.1)	6.6(8.2) ^{bc}	9 (3.1)	60(7.8)^{ab}	14(3.8)	93.3(9.7) ^{a}
50%	15	5(2.3)	33.3(5.8) ^{ab}	10(3.2)	66.6(8.2) ^{ab}	15(3.9)	100(10.0) ^{a}
75%	15	3(1.7)	20(4.5)^{bc}	6 (2.5)	40(6.4) ^{b}	15(3.9)	100(10.0) ^{a}
(Standard)	15	9(3.1)	60(7.8) ^{a}	11(3.4)	73.3(8.6)^{a}	15(3.9)	100(10.0) ^{a}
Control	15	0 (0.7)	0(0.07) ^{c}	0 (0.7)	0(0.07) ^{c}	0 (0.7)	0(0.07)^{b}

Means followed by the same letter(s) are not significantly different at P≤0.05Means between brackets are transformed by (√ × + 0.5)

Table 3. Mean Mortality of larvae of *S. frugiperda* treated by Topical Application of Usher Leaves ethanol extract (Shambat, 2018)

Cocentrations	No. of Lar-vae	After 24hrs		After 48hrs		After 72hrs	
		No. of dead Larvae	Mean% Mortality	No. of dead Larvae	Mean% Mortality	No. of dead Larvae	Mean% Mortality
10%	15	3(1.7)	20(4.2) [b]	6 (2.5)	40(6.4)[a]	15(3.9)	100(10.0)[a]
25%	15	1(1.1)	6.66(8.2) [b]	9 (3.1)	60(7.8)[a]	14(3.8)	100(10.0)[a]
50%	15	5(2.3)	33.3(5.8) [ab]	10(3.2)	66.6(8.2)[a]	15(3.9)	100(10.0)[a]
75%	15	7 (2.7)	64(8.0) [a]	10(3.2)	66.6(8.2)[a]	15(3.9)	100(10.0)[a]
(Standard)	15	9(3.1)	60(7.8)[a]	11(3.4)	73.3(8.6)[a]	15(3.9)	100(10.0)[a]
Control	15	0 (0.7)	0[a](0.07)[b]	0 (0.7)	0(0.07)[b]	0 (0.7)	0(0.07)[b]

Means followed by the same letter(s) are not significantly different at P≤0.05Means between brackets are transformed by (√ × + 0.5)

Table 4. Mean Mortality of larvae of *S. frugiperda* treated by Topical Application of Argel Water extract (Shambat, Sudan, 2018.)

Concentrations	No. of Larvae	After 24hrs		After 48hrs		After 72 hrs	
		No. of dead Larvae	Mean% Mortality	No. of dead Larvae	Mean% Mortality	No. of dead Lar-vae	Mean% Mortality
10%	15	0 (0.7)	0(0.07) [b]	0 (0.7)	0(0.07) [b]	1 (1.1)	6.66(2.6)[b]
25%	15	0 (0.7)	0(0.07)[b]	1 (1.1)	6.7(2.6)[b]	2 (1.6)	13.3(3.8) [b]
50%	15	1 (1.1)	6.66(2.6)[b]	1 (1.1)	6.7(2.6)[b]	3 (1.7)	20(4.5)[b]
75%	15	0 (0.7)	0(0.07)[b]	0 (0.7)	0(0.07)[b]	1 (1.1)	6.66(2.6)[b]
(Standard)	15	10 (3.2)	66.6(2.6)[a]	13 (3.7)	86.6(9.5)[a]	15 (3.9)	100(10.0)[a]
Control	15	0 (0.7)	0(0.7)[b]	0 (0.7)	0(0.7)[b]	0 (0.7)	0(0.7)[b]

Means followed by the same letter(s) are not significantly different at P≤0.05Means between brackets are transformed by (√ × + 0.5)

the laboratory, at a temperature of (27±2) ^{0}c and a R.H. of (56±2)%. Each treatment was replicated three times. Larval mortality was recorded after 24, 48 and 72 hrs. Criteria of larval mortality: the larval color changed from brownish to dark, then larva became sluggish, and finally died. The collected data were analyzed by Analysis of Variance (One Way ANOVA) using SPSS program (version 20), and the means were separated using Tukey test.

Results and Discussion

In this study the bioassay tests showed the ethanolic extracts of the three plant species, the Neem, Black Pepper and Usher, were effective against the FAW larvae.

The extensive studies carried out during the last decades proved the potential of plant extracts as alternative insect pest control agents [12,13]. Concerning the FAW, Rioba, et al.; (2019) in their review stated that, 69 plant species were found as effective control agents against FAW in various parts of the world. Likewise, In the present study the results of the bioassay tests showed that, the ethanolic extracts of the three plant species, e.g. Neem, Black Pepper and Usher, (shown in Tables 1- 3) were effective against the FAW larvae.

Considering table 1, the highest concentration of Neem ethanolic extract (75%) caused 100% larval mortality after 72 hrs of exposure, which was significantly different compared with other concentrations. However, it was not significantly different from the recommended dose of Spinosad. This result is almost in full agreement with those of Sisay et al.[9], who stated that, three botanical extracts, including Neem showed equal efficacy with that of four synthetic insecticides against larvae of FAW after72 hours.

The above table 2, the efficacy of the Black pepper extracts showed that, the two high concentrations (75 and 50%) also caused 100% larval mortaliy of FAW, which was comparable to that of the standard pesticide spinosad. These results are also comparable to that of Celis et al. [12] who mentioned that, methanolic extracts of six Piper species caused larval mortality of FAW similar to that obtained by the insecticide Chlorpyrephos.

The results of bioassay tests of Usher leaves extract shown in table 3 indicated that almost all concentrations caused 100% larval mortality of FAW similar to that of Spinosad. This efficacy of Usher extracts is similar to that of Santos [13]. Moreover, Rioba et al. [14] showed that, morality of FAW larvae increased by feeding on maize leaves impregnated by Usher leaves extracts.

On the other hand, the results of table 4 indicated that the Argel water extract was not effective on FAW larvae.

The present study is the first one that indicated the effectiveness of three plants' extracts against FAW in Sudan. The results obtained by their highest concentrations after 72 hours were comparable to that of the standard insecticide Spinosad. The strong insecticidal activity of Spinosad against many insect pests, particularly of Lepidoptera, was reported in previous studies by Salgado[15] and Huang et. al [16].

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Based on the results of the present study,which showed the equal efficacy of the plant extracts and the pesticide Spinosad, it is worth considering the costs of the FAW control by each group, and the impact on the Environment. The price of "100 ml of Spinosad" in the Pesticide Market in Khartoum State equals to 750 SDG, while the price of one Pound of Black pepper in the local market is equal to 500 SDG. In comparison, Tens of Kgs of Neem seeds, or of Usher leaves, can be collected "free of charge "at any time from the open fields in Khartoum State.

Conclusion and Recommendations

Many studies proved the efficacy of plant extracts against a number of economically important pests worldwide. This study also showed the efficacy of the extracts of three plants (Neem, Black pepper and Usher) against the larvae of FAW. Furthermore, this study proved that plant extracts are more economic and environmentally safe compared to synthetic pesticides.

Therefore, the study recommends more studies to explore the potentiality of other indigenous plants which can save the hard currency and reduce the environmental hazards.

References

1. European Plant Protection Organization (EPPO) (2021). *Spodoptera frugiperda.* EPPO datasheets on pests recommended for regulation. 10pp.
2. Montezano, Débora G.; Specht, Alexandre; Sosa-Gómez, Daniel Ricardo; Roque-Specht, Vânia F.; Sousa-Silva, José Carlos; PaulaMoraes, Silvana V. de; Peterson, Julie A.; and Hunt, Tomas. (2018). "Host Plants of *Spodoptera fugiperda* (Lepidoptera: Noctuidae) in the Americas". African Entomology, 26 (2): 286- 300.
3. Goergen, G.; Kumar, P.L.; Sankung, S.B.; Togola, A, and Tamò, M. (2016). First Report of Outbreaks of the Fall Armyworm *Spodoptera frugiperda*(J E Smith) (Lepidoptera, Noctuidae), a New Alien Invasive Pest in West and Central Africa.PLoS ONE, DOI: 10.137/journal.pone.0165632.
4. FAO. (2018). Integrated Management of Fall Armyworm on Maize. A Guide for Farmer Field Schools in Africa F A O, Rome, 130 pp.
5. Elnour,O.A.; Amir, A. Malik; Eisa, Y. Adam; Ayman, E. A. Mansor ; Ahmed Hassan; Ensaf, S. Mohammed and Hayder A. Mohammed. (2017). First Report of the Fall armyworm, *Spodoptera frugiperda* (J.E.Smith) (Lepidoptera :Noctuidae) in the Sudan. 97Th Meeting of the National Pest and Disease Committee, ARC, Wad Medani , Sudan, 9PP.
6. Abrahams, P.; Bateman, M.; Beale, T.;Clottey, V.; Cock, M.;Colmenarez, Y.; Corniani, N.; Day, R.; Godwin, J.; Gomez,J.;Gonzalez, M.P.; Murphy, S..; Oppong-Mensah, B.; Phiri, N.; Pratt, C.; Selvesrti, S. and Witt, A. (2017). Fall Armyworm : Impacts and Implications for Africa. Evidence Note (2). CABI, 144 PP.
7. Gadarif Research Station.(2017). Report of Field Pests (Annual Report, 2017). (Unpublished), Gadarif Research Station, Gadarif, 66pp.
8. Silva M.S.;Broglio, S.M.F.;Trindade, R.C.P.;Ferrreira, E.S.; Gomes, I.B. and Micheletti, L.B. (2015). Toxicity and application of neem in fall armyworm.Comunicata*Scientiae 6: 359-364.*
9. Sisay B.;Tefera.;Wakgari, M.; Ayalew, G.; Mendesil, E. (2019). The efficacy of selected synthetic insecticides and botanicals against fall armyworm,*Spodoptera frugiperda* in maize.Insects Vol. 10: 45 – 59.
10. Phambala, K.; Tembo, Y.; Kasambala, T.; Kabambe, V; Stevenson, P.Cs andBelmain, S.R. (2020). Bioactivity of Common Pesticidal Plants on Fall Armyworm larvae (*Spodopterafrugiperda*). Plants, Vol. 9: 112 – 121.
11. Sukhdev. S. H; Suman. P. S. K; Gennaro.L and Dev. D. R (2008). Extraction technologies for medicinal and aromatic plants. United Nation Industrial Development Organization and the International Centre for Science and High Technology. 116pp
12. Pavela, R. (2016). History, presence and perspective of using plant extracts as commercial botanical insecticides and farm products for protection against insects. A Reiew. Plant Protection Science, Vol. 52 (4): 229 – 241.
13. Khan, S.; Taining, C.N.T.; Bonneure, E. *et al.* (2017). Insecticidal activity of plant derived extracts against different economically important insect pests. Phytoparasitica, Vol. 45: 113 – 124.
14. Celis, F.; Mendoza, C.; Roa-B, A. and Delgado-A, W. (2014). Effect of Piper Extracts in Fall armyworm, *Spodopterafrugiperda* (J.E.Smith), under Semi-Controlled Conditions. ActaHorticulture , Vol. : 49 – 54.
15. Santos, B.A. (2012). Bioactivity of Plant Extracts on *Spodopterafrugiperda*(J E Smith) (Lepidoptera: Noctuidae). M.Sc. Thesis, State University of Montes Clavos,Januaba, Brazil.
16. Rioba, N.B. and Stevenson P.C. (2020). Opportunities and Scope for Botanical Extracts and Products for the management of Fall Armyworm (*Spodopterafrugiperda*) forsmallholders in Africa. Plants, Vol. 9: 207 – 223.
17. Salgado, V.l. (1998). Studies on the mode of action of Spinosad insect symptoms and physiological

correlates. Pesticides Biochemistry and Physiology, 60: 91 – 102.

18. Huang, F. and Subramanyam, B. (2007). Effectiveness of Spinosad against Seven major stored grain insects on Corn. Insect Science, 14: 225 – 230.