ORIGINAL RESEARCH ARTICLE

Effects of insecticidal plants leaves extracts on fall armyworm *(Spodoptera frugiperda)* infestation, growth and yield of maize *(Zea mays)*

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Abstract

Maize is a major cereal and staple food crop in most west and central African including Nigeria. Insecticides are chemical that are used to control insects either by killing them or by stopping them from their undesirable or damaging activities. The study was conducted at the Institute of Agricultural Research and Training (I. A. R. and T.) Experimental site Ibadan on Latitude 7.45538160° N, Longitude 3.85716511°.E and altitude 180.43m above sea level to determine the effect of insecticidal plant extracts on fall army worm (FAW) infestation and the growth and yield of maize. Seeds of extra early Hybrid maize EEPYAH 42 were sown at 2 seeds per hole at a spacing of 75 cm x 50 cm. The was laid out in a Randomized complete block design (RCBD) replicated 3 times. There were five treatments with one control, which were T1 –*Nicotiana tabacum* leaves extracts, T2- *Chromoleana odorata leaves extracts*, T3 - *Tithonia diversifolia* leaves extracts. T4 - *Cassia occidentalis* leaves extracts, T5 –*Azandirachta indica* leaves extracts, and T6 - control (no insecticide). Treatments were applied at 3 weeks after sowing (WAS) and 7 WAS. Data were collected on establishment count, number of egg mass, number of damaged leaves, number of non-damaged leaves, Fall armyworm (FAW) severity, 50% tasseling, plant and ear height, field weight i.e. weighing of harvested cobs, and grain yield using ANOVA, and the means were separated using DMRT at 5% probability level. Result of infestation on agronomic parameters at 4 WAS showed that there were no significant differences in the maize establishment count, including control, number of non-damaged leaves, egg mass count, and a slight difference in the number of damaged leaves. At 8WAS, there was no significant difference in the reproductive parameters observed. Effect of the botanical's insecticides on fall army worm infestation of maize showed that the severity was lower on T5 (1.80), followed by T4 (2.54), without significant differences ($p<0.05$). The severity was highest on control T6 (6.20a). There is

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a significant positive influence of organic insecticides on the yield and yield attributes of maize under fall armyworm infestation. The result further showed that the yield of maize was significantly lower at the control as shown on the number of ears at harvest, field yield, and grain yield on the control plot compared to other treatments (4.69), (0.52), and (0.41) and highest at T5(9.60), (1.42), and (1.13), respectively. From the findings, it is recommended that farmers may use organic insecticides, especially *Azadirachta indica* leaf extracts, to replace the expensive conventional insecticides and to reduce the adverse effects of their intake.

Key words: Bio insecticides, environmental sustainability, fall armyworm, maize yield.

1.0 Introduction

Maize (*Zea mays.* L.) belongs to the family poaceae. It is a major cereal and staple food crop in west and central African including Nigeria since its introduction through the West African coast (Ukwuru et al, 2018). Maize as a green crop can be roasted or boiled for consumption and when fully dried. It can be cooked and used in the form of maize flour, maize meal and general confectioneries such as bread, cakes and biscuit. Maize is also an important ingredient in livestock rations, the green plant may be cut before tasseling and used for silage (Adiaha, 2017, Olasehinde*et al*., 2023).Maize plant can grow on wide range of climatic conditions but if the temperature is high or if the humidity is low maize will not perform well as these condition damages the foliage and hampers pollination there by resulting in poor grain. Biotic constraints associated with low yield of maize include insect, diseases, plant parasitic nematodes, viruses and weeds. The fall armyworm (FAW) is an insect native to tropical and subtropical regions of the Americans and it is a key pest of maize among many other pests of maize (Abrahams et al., 2017). FAW Larvae can feed on more than 80 plant species including maize, rice, sorghum, millet, sugarcane, vegetable crops and cotton and can cause significant yield loses if not well managed (Prince et al 2020). FAW was first noticed in central and west African in early 2016 in Benin, Nigerian, Sao, Tonre, Principe, Togo and continued in the whole of mainland southern African, in Madagascar and Seychelles (Obemeyer*et al*., 2017).

The fall armyworm has a migratory behavior with a high dispersal capacity that allows the pest to quickly spread along the range of its host plants, also the life cycle of fall army worm varies according to the season. It completes its lifecycle in about 30 days during the summer, in 60 days in the spring and autumn, and in 80-90 days during the winter (Belay, 2011). The First and second instars feed on one side of the leaf skeletonizing it, whilst the final instars feed on most plant parts causing considerable damage (Abrahams *et al*., 2017). Currently, the pest is ravaging crops in over 20 African countries. The fall armyworm attacks more than eighty different plant species, including maize, a major food staple in Sub-saharan African upon which more than 300 million people depend (Cock et al., 2017). The ideal climatic conditions in tropical Africa and the abundance of suitable host plants enable fall armyworm to have several generations per year

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(Birhanu, 2019). Fall Armyworm is relatively new pest in Nigeria but it has become a major threat to maize production. The hazards caused by the insect is so enormous on maize crop that it can cause major yield loss or total crop failure in most cases, therefore posing great threat to the livelihood of majority of the farmer and national food Security.

The use of chemical insecticides has appeared to be the best way of controlling the fall armyworm in recent times. However indiscriminate and excessive use of chemical insecticides in controlling pests has induced resistance in *S. frugiperda* to pyrethroid, organophosphate, and carbamate compounds. Also spraying of insecticides release a fair volume of harmful vapours in the atmosphere and consequently create a certain degree of atmospheric pollution, chemical residues in food, biological disequilibrium among others (Prince et al, 2020). Insecticides are chemical that are used to control insects either by killing them or by stopping them from their undesirable or damaging activities (kabita, 2023). Pesticides obtained from plant materials are known to be very effective in insect pest control as they have repellant and anti-feedant properties among others and are less hazardous compared to the conventional pesticides, Plant that are available locally at no or minimal cost to the famers such as Siam, Neem etc. should be adopted.

The pattern of behavior of the pest in Nigeria is still being studied and there is need for information on the best organic insecticides to control the damage by fall army worm and increases maize yield without heavy dependency on inorganic chemicals. This study was carried out to investigate the effects of selected plants with insecticidal properties on fall army worm and yield of maize.

2.0 Materials and Methods

The study was conducted at the Institute of Agricultural Research and Training (I. A. R. and T.) Experimental site is Ibadan on latitude 7.45538160^0 N, Longitude 3.85716511^0.E and altitude 180.43m above sea level. The experimental field was ploughed and harrowed which provided conditions that were conducive for proper maize growth. The experiment was arranged in randomized complete bock design (RCBD) having 6 treatments and 3 replicates. EEPYAH – 42 – Extra early hybrid maize seed was sown at three seeds per hole at a spacing of 75cm by 50cm inter row and intra row respectively and later thinned down to two seed per stand where applicable. Fall Army worm was naturally allowed to infested the maize field by locating the experimental site close to Fall Army worm infested site. Leaf extract of selected plants were used as treatments, the plants are as stated below:

i. *Nicotiana tabacum* (T1)
ii. *Chromonaelaodoranta* (T_2)
iii. *Titoniadiversifolia* (T_3)
iv. *Cassia occidetalis* (T_4)

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v. *Azadiractha indica*(T_5)
vi. Control (T_6)

Treatments were prepared by cutting, drying and weighing 100 grams of leaves of each plant species, the leaves were macerated in 1 litre of water, they were then squeezed, filtered and poured into labeled gallons. The filtrate was subjected to fermentation for 24 hours before the application was made on the field at 3 weeks after planting. These were repeated for the second application which was carried out at 7 weeks after planting.

2.1 Data collection

Five samples were selected randomly and tagged on each experimental plot and data were collected on the tagged samples at 4 and 8 WAS.

Establishment Count: by counting the number of established seedlings from the total population. (Counted at 2 weeks after planting to ensure germination per plot).

Plant height (cm): measured with meter rule from the base of the plant to the tassel base

Ear height (cm): measured with meter rule from the base of the plant to primary ear node

Fall Army worm (FAW) severity damaged rating: rating for FAW damage using a scale of 1 – 9 (i.e.) 1 > highly resistance, 9 = highly susceptible

Number of damaged leaves: visual counting based on damaged leaves affected by FAW. Number of non-damaged leaves: visual counting of goods leaves not damage by FAW.

Number of FAW egg mass: counting of egg mass seen on each plant.

50% tasseling: number of days to 50% tassel formation in the population

Ear at Harvest: the number of cobs harvested.

Field Weight (kg): weighing of harvested cobs with weighing balance.

Grain Yield in Kg/plot: weighing of harvested grains with weighing balance.

2.2 Data analysis

The data collected were analyzed using analysis of variance (ANOVA), and means were separated using Duncan multiple Range test (DMRT) at 5% probability level

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3.0 Results

The results obtained at 4weeks after sowing (WAS)showed that: the number of maize plants stand that were established were not significantly different from each other across all the treatments, also there were no significant difference in the initial plant height across all the treatments. The highest damaged leaves (2.80) were observed on plot treated with *C. odorata,* although without significant difference compared to other treatment except for plot treated with *N. tabacum* that gives the least damaged leaves of 2.27(Table 1). There was no significant difference in the number of non-damaged leaves across all the treatments. The number of FAM egg mass seen was highest on plot treated with *C. odorata* and least on plot treated with *N. tabacum* without significant difference across all the treatment. Similar trend obtained in terms of egg mass seen was obtained on infestation severity (Table 1).

At 8 weeks after planting the effect of the leaves extract treatments on the numbers of days to 50% tasseling, plant height and ear height were not significantly different from each as there were no significant difference in their means (Table 2). At 8 WAS, the highest number of damaged leaves was observed on control plot (3.53) which was significantly higher compared to other treatments except plot treated with*T. diversifolia* (2.74), although without significant difference to the damaged leaves observed on *C.odorata* (2.54), (2.00) and *N.tabacum* (1.94). The least damaged leaves were observed on *A. indica* and it was significantly lower compared to other treatment except that of *T. diversifolia*. The highest number of non-damaged leaves was on *A. indica* and it was significantly higher compared to the non-damaged leaves on plot treated with *C. occidentalis, T. diversifolia* and *C. odorata*. The highest egg mass at 8WAS was observed on control plot (2.00) and it was significantly higher compared to all other treatments. The FAM rating was higher on control (6.20) showing higher severity which was significantly higher than all other treatments, this was followed by *C.odorata* and *T. diversifolia*(4.40, 4.80) respectively. The least severity was on plot treated with *A. indica* (Table 3).

There was no significant difference in the number of plants stand at harvest across all the treatment, although the least plant stand was found on control plot (Table 4). The highest maize ear at harvest was found on *A. indica* plot (9.60) and it was significantly higher compared to other treatments, this was followed by ears from *C. occidentalis* treatment (8.00), which was also significantly different from ears from other treatments. The least maize ear was obtained from control plot (4.69) although without significant different from ears obtained from *T. diversifolia* plot. Field yield and grain yield followed a similar pattern as ear at harvest in which the highest yield was obtained on plot treated with *A. indica* leaves extract and the least obtained on the control plot (Table 4)

Table 1: Effects of FAW infestation on maize after application of insecticidal plants leaves extracts at 4 weeks after sowing (WAS)

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reatment	Establishment count	Plant Height(cm)	Nos of damaged leaves	Nos of non-damage leaves	No of egg mass	Infestation Severity
T_1	32.22a	96.30a	2.27bc	4.73a	1.60ab	4.33ab
T_2	32.67a	102.33a	2.80a	4.60a	1.80a	4.80a
T_3	31.00a	94.62a	2.67ab	4.53a	1.67ab	4.40ab
T_4	33.33a	94.10a	2.53abc	4.80a	1.62ab	4.40ab
T_5	31.67a	102.57a	2.53abc	4.80a	1.67ab	4.40ab
T_6	32.67a	96.11[a]	2.67ab	4.87a	1.67ab	4.43ab

Means with the same alphabet are not significantly different at p<0.05 according to DMRT

Where: -TI-*N. tabacum, T2-C. odoranta,* T3-T. diversifolia
T4- C.occidentals, T5- A. indica, T6- Control

Table 2: Effects of FAW infestation on some reproductive parameter of maize after application of insecticidal plants leaves extracts at 8 weeks after sowing (WAS)

Treatment	50% Tasseling	Plant Height (cm)	Ear Height (cm)
T_1	52.33a	184.57a	82.07a
T_2	51.00a	186.80a	88.67a
T_3	51.33a	181.70a	82.87a
T_4	52.22a	183.20a	87.47a
T_5	51.33a	186.13a	85.57a
T_6	52.00a	184.23a	88.70a

Mean with the same alphabet are not significantly different at p<0.05 with DMRT
Where: -TI-*N. tabacum, T2-C. odoranta,* T3-T. diversifolia
T4- C. occidentals, T5- A. indica, T6- Control

Table 3. Effect of bio insecticides on FAW infestation of maize at 8 weeks after sowing

Treatment	Number of damaged Leaves	Number of non-damaged leaves	Number of egg mass	FAW severity rating
T_1	1.94bc	12.60ab	1.00b	2.94c
T_2	2.54b	11.00b	1.00b	4.40b
T_3	2.74ab	11.74b	1.00b	4.80a
T_4	2.00bc	11.70b	1.00b	2,54cd
T_5	1.33c	13.74a	1.00b	1.80d
T_6	3.53a	12.37ab	2.00a	6.20a

Mean with the same alphabet are not significantly p<0.05 with DMRT
Where: -TI-*N. tabacum, T2-C. odoranta,* T3-T. diversifolia
T4- C. occidentals, T5- A. indica, T6- Control

Table 4: Effect of organic insecticides on the yield and yield attributes of maize under fall armyworm infestation

Treatment	Plant at harvest	Ear at harvest	Field yield (kg)	Grain yield (kg)
T_1	21.44a	6.34c	0.70c	0.56c

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T_2	21.32	6.00c	0.69cd	0.54c
T_3	20.87	5.00d	0.59a	0.48cd
T_4	22.43	8.00b	1.03b	0.83b
T_5	24.21	9.60a	1.42a	1.13a
T_6	21.00	4.69d	0.52d	0.42d

Mean with the same alphabet are not significantly different at p<0.05 according to DMRT
Where: -TI-*N. tabacum, T2-C. odoranta,* T3-T. diversifolia
T4- C. occidentals, T5- A. indica, T6- Control

4.0 Discussion and Recommendation

Pesticides obtained from plant materials are known to be very effective in insect pest control as they have repellant and anti-feedant properties among others and are less hazardous compared to the conventional pesticides. The experiment was conducted to investigate the potential of some leaf extract in controlling or reducing the adverse effect of fall armyworm on growth and yield of maize, the result shows that all the treated plots performed better than control plot. This is corroborated by Safia and Aoumeur (2014) they reported that plants have Potentials as a source of insecticides. FAW infestation was reduced on all the plants that received treatment while the highest level of damaged were observed on control plot. This is because the leaves extracts possess some compound such as nicotine, pyridine, alkaloids, tannin etc. Selbe*et al* (2014) reported that such compounds function as pesticides by making the plant environment unfavorable for insect. The higher number of damaged leaves compared to non-damaged leaves and FAW egg mass observed initially may be due to the concentration of the leaves extract at first application which may not be enough to control the insect adequately.

Out of all the selected leaves extract used in the experiment, *Azadirachtaindica* controlled the fall armyworm better than others, this may be due to the fact that Neem has an anti feedant properties and insect growth disruptor. According to work of Chaudhary *et al* (2017) Azadirachtin (a chemical compound found in *Azandirachta indica*) is one of the prominent biopesticides and it is encouraged for Agricultural use, also Azadirachtin is effective as biopesticides because of its low toxicity and residual impact on other animal and man.

It can be recommended from the experiment that farmers can use organic insecticides like *Nicotiana tabacum, Chromonaelaodoranta*, Titoniadiversifolia, Cassia Occidetalis and especially *Azadiractha indica* leaves extracts to substitute for expensive conventional insecticides and to reduce the danger posed by chemical pollution to human and the environment.

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