THE POTENTIALS OF EUPATORIUM ODORATUM, AGERATUM CONYZOIDES, AND ZANTHOXYLUM ARMATUM EXTRACTS IN THE CONTROL AND DRY MATTER YIELD OF MAIZE INFESTED WITH ARMY WARM (SPODOPTERA FRUGIPERDA)

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ABSTRACT

The study was carried out at the Teaching and Research Farm of the Federal Polytechnic, Ado-Ekiti to examine the potentials of *Eupatorium odoratum, Ageratum conyzoides*, and *Zanthoxylum armatum* Extracts in the control and dry matter yield of two *varieties* of maize infested with army warm. The experiment was measured from the ploughed and harrowed farm land in a 5x2 factorial combination arranged in a Randomized Complete Block Design (RCBD) and replicated 5 times to make a total of 50 plots. Each plot had an average length of 100m. Standard ridge were properly prepared by ploughing and harrowing the land, then plots of 16 m^2 were marked out; 2 seeds of maize were planted per hole at the depth of 5 cm and spacing of 60×90 cm. The treatments consisted of using the leaves and stems of Eupatorium odoratum, (EO), Ageratum conyzoides, (AC), Zanthoxylum armatum (ZA) and Cypermethrine insecticide (C1), incorporated in the study for comparison with the extract and the untreated check.as control (CL). The seeds of the two maize varieties used for the study were; Oba Super 6 (an improved maize) and Obatanpa (an indigenous maize) which were obtained from the National Cereal Research Institute (NCRI) Ibadan. Parameters evaluated included, plant height, leaf area, stem girth, cob girth and cob length, number of cob/plant, number of seed/cob, seed yield. In addition, Number of infested plant before treatment application, Number of plants observed, percentage damage after treatment application and percentage of effective control per treatment were also recorded using the standard procedure of data estimation. Data collected were subjected to One-way analysis of variance (ANOVA) and Duncan Multiple Range (DMR) Test at 5% level of probability. The result shows that percentage damage after treatment application was significantly lower under the application of Cypermethrine insecticide for both Oba super 6 (9.1%) and Obatanpa, (11.5%) over other treatments. This was closely followed by the application of *Eupatorium odoratum* which had a lower percentage damage of (12.5%) for Oba super 6 and (16.7%) for Obatanpa. The highest percentage damage was however recorded for the control. Similarly, the percentage level of effective control was significantly higher with application of Cypermethrine insecticide for Oba super 6 (82%) and Obatanpa (77%). The findings of this study revealed that all three plants extract significantly reduced army worm infestation in maize, with *E. odoratum* recording the highest effectiveness. Oba Super 6 variety had a lower incidence of army worm infestation than Obatanpa. Also, *E. odoratum* resulted in a higher dry matter yield in both maize varieties. Further research is needed to evaluate the impact of these plants on yields and to determine the optimal methods for incorporating them into crop production systems.

Keywords: Plant Extracts, Army worm, Maize varieties, Dry matter yield

INTRODUCTION

Maize is an essential food crop in Africa and is prone to various pests and diseases with army worm (*Spodoptera frugiperda*) being one of the most devastating agricultural pests (FAO, 2018a, FAO, 2018b). The conventional use of synthetic pesticides presents various challenges, including negative impacts on the environment and human health (Tetera *et al.,* 2011). Therefore, natural alternatives, especially from medicinal plants, are excellent options for managing army worm infestation. (CABI, 2018a). Army worm infestations have become a major concern for farmers worldwide, causing significant reductions in crop yield and ultimately leading to food insecurity. (Vitale *et al.,* 2007). The fall armyworm (Spodoptera frugiperda) is a particularly destructive pest that targets maize, a vital crop

for global food security. (FAO, 2018a). In recent years, the use of synthetic pesticides to control armyworm infestations has proven ineffective, harmful to both human health and the environment, and has contributed to the emergence of pesticide-resistant strains of the pest. As a result, research into alternative methods of armyworm control has become increasingly important. Plants contain numerous secondary metabolites that can be utilized for their pesticidal properties. *Eupatorium odoratum, Ageratum conyzoides, and Zanthoxylum armatum* are three species that have demonstrated potential in the prevention and control of army worm infestations and can improve the dry matter yield of maize (Matoke *et al*, 2019).

Eupatorium odoratum, colloquially known as bitter bush and commonly known as peacock flower plant is a medicinal herb that has been traditionally used for its anti-inflammatory and analgesic properties (Eshun, 2020). Recent studies have shown that the leaves and stems also possesses insecticidal properties, making it a potential alternative to synthetic pesticides in controlling army worm infestations.(Yao *et al*, 2020) The extracts of the leaves and stems of *Eupatorium odoratum* have shown to exhibit a dose-dependent mortality effect on insect pest of crops. It has been reported to possess insecticidal and repellent properties against a range of insect pests such as mosquito, housefly, and termites. The essential oils from the leaves and stems, extracted through hydro distillation, showed a significant reduction in the development and fecundity of *Aedes aegypti* and *Anopheles quadrimaculatus*. These essential oils are effective against the feeding behavior of the larvae of *Culex quinquefasciatus*. The plant extracts also showed insecticidal properties against various stored grain pests such as *Sitophilus oryzae*, *Tribolium castaneum,* and *Rhyzopertha Dominica*. *Ageratum conyzoides*, commonly known as goatweed, is another plant species that has been explored for its pesticidal properties. It contains chemicals such as flavonoids, phenolic acids, and alkaloids that can act as natural insecticides. (Mukherjee *et al*, 2018). Studies have reported the insecticidal potential of *Ageratum conyzoides* extracts and their ability to reduce the damage caused by insect infestations. The plant is known for its insecticidal and repellent properties. The leaves and stem of the plant contain alkaloids that have potent insecticidal properties, making it an effective pesticide against various insect pests. The seeds of the plant have been used traditionally in Nepal to repel insects such as mosquitoes and houseflies. The plant's extracts of leaves and stems also possess repulsive properties against a wide range of insect pests (Mushtag and Asghar, 2015).The plant also inhibits oviposition in insects such as the housefly. Thus, the plant can be used as a natural pesticide to control insect pests in crops (Asante *et al*, 2017)

Zanthoxylum armatum, commonly known as the prickly ash plant used in traditional medicine for various ailments, is another species that has been tested for its insecticidal properties (Yayi-Ladekan *et al*, 2017). Research studies have found that the leaves and stems of *Zanthoxylum armatum* contains numerous compounds that exhibit pesticidal properties against several insect pests, including army worms (Gotep *et al*, 2019). Moreover, while these plants serves as an alternative to synthetic pesticides, the use of plant extracts may reduce crop losses caused by army worms and aid in the quest for pesticides with less environmental harm (Asante *et al*, 2019). Additionally, the application of extracts could trigger the defense mechanism of the host plant, resulting in increased maize yields (Yayi-Ladekan *et al*, 2017).

MATERIALS AND METHODS

The study was carried out at the Teaching and Research Farm of the Federal Polytechnic, Ado-Ekiti, a humid rainforest zone of Southwest Nigeria. The mean annual rainfall ranges between 1300-1600 mm and with an average temperature of 30ºC. The relative humidity ranges between 85 % during the rainy season and less than 60 % during the dry season. The study was carried out in May, 2018 due to the preponderance and high frequency of occurrence of insect pest infestation in the study area.

Land preparation and sowing

A portion of land was cleared in a farm field in the early rainy season of 2018. It was subsequently ploughed and harrowed to soften the land. The experiment was conducted on the ploughed and harrowed farm land. The experiment was a 5x2 factorial combination arranged in a Randomized Complete Block Design (RCBD) and replicated 5 times to make a total of 50 plots. Each plot has an average length of 100m. Standard ridge were properly prepared by ploughing and harrowing the land, then plots of 16 m^2 were marked out; 2

seeds of maize were planted per hole at the depth of 5 cm and spacing of 60×90 cm. The treatments consisted of using the leaves and stems of *Eupatorium odoratum,*(EO), *Ageratum conyzoides*, (AC), *Zanthoxylum armatum* (ZA) and Cypermethrine insecticide (C1), incorporated in the study for comparison with the extract and the untreated check.as control (CL). The seeds of the two maize varieties used for the study were; Oba Super 6 (an improved maize) and Obatanpa (an indigenous maize) which were obtained from the National Cereal Research Institute (NCRI) Ibadan.

Preparation of treatments

The five treatments were *Eupatorium odoratum,* (EO), *Ageratum conyzoides*, (AC), *Zanthoxylum armatum* (ZA), Cypermethrine Insecticide, (CI) and the control (CLT). The two maize varieties tested were Oba Super 6 and Obatanpa. Plant extracts were obtained by crushing fresh plant leaves which were plucked fresh and shade dried at room temperature so as to make sure that the process of drying did not affect the potency of the active ingredient. Then, pestle and mortar was used to pound the leaves to pulverize them so that the active ingredient in the leaves can be freely released in water. Afterward, 1kg each of the pounded leaves and stems were socked in 2L of distilled water and the mixtures were allowed to stand for 24 h after which the mixtures were filtered using a cloth filter to obtain a homogenous substance that was used for spraying as described by (Wahedi *et al*., 2013). Flavonoids were determination using the method described by Boham, *et al*., (1974). The Alkaloids were determined using Harborne method of (1973) while saponin was determined as described by Obdoni *et al.*, (2001). Tannin determination was done using the method of Fohn-Denis calorimeter as described by Kirk *et al*., (1998). Spraying was done with a hand sprayer at two weeks interval for a period of 10 weeks. Army worm count was carried out using a sweep-net method, while dry matter yield was assessed at harvest. Cypermethrine however is a synthetic pyrethroid that lasts longer than natural pyrethrum and provides long-lasting control and prevention on insect pest on the field. The insecticide was applied in the morning once in every two weeks, at the rate of 175 ml in 10 L of water. Spraying started from 2 weeks after planting and did not stop until the 10 weeks after planting when the insect pest does not have much harmful effect on the plant any more. In addition, 1L each of the extract was applied on the tested maize variety every two weeks until the 10th week after planting.

Parameters evaluated

Parameters evaluated included plant height, leaf area, stem girth, cob girth and cob length, number of cob/plant, number of seed/cob, seed yield. The number of maize cobs were also counted and recorded during harvest. The maize cobs were shelled and dried to constant weight in an oven at 30°C to 35°C before weighing the yield quantity in t/ha were recorded while the percentage yield gained was determined by subtracting the amount of the control yield from the treatment yield, and subsequently calculating the percentage. Percentage damage before and after treatments were calculated using the formula

The percentage damage was calculated as;

$$\%\ damage = \frac{Number\ of\ infested\ plants}{Number\ of\ plants\ observed} \times 100$$

(Gomez & Gomez, 1984).

Other parameters measured were;

Number of infested before treatment application, Number of plants observed, percentage damage after treatment application and percentage of effective control per treatment.

Data Analysis

Data collected were subjected to One-way analysis of variance (ANOVA) and Duncan Multiple Range (DMR) Test. Standard deviation, Standard error and Correlation Coefficient were used to establish the mean differences at 5% level of probability, using SPSS Version 16.0.

Result and Discussion

The findings of this study as shown in Table 2 and 3 has shown that all three plants extract significantly reduced army worm infestation in maize, with E. odoratum recording the highest effectiveness. Oba Super 6 variety had a lower incidence of army worm infestation than Obatanpa. Also, E. *odoratum* resulted in a higher dry matter yield in both maize varieties. The result in Table 2 shows the number of holes and infestation of army worm on maize plants before and after application of treatments. The result shows that percentage damage after treatment application was significantly lower under the application of Cypermethrine insecticide for both Oba super 6 (9.1%) and Obatanpa, (11.5%) over other treatments. This was closely followed by the application of *Eupatorium odoratum* which had a lower percentage damage of (12.5%) for

Oba super 6 and (16.7%) for Obatanpa. The highest percentage damage was however recorded for the control. Similarly, the percentage level of effective control was significantly higher with application of Cypermethrine insecticide for Oba super 6 (82%) and Obatanpa (77%). This was closely followed by application of *Eupatorium odoratum* extract application for Oba super 6 (75%) and Obatanpa (67%) while application of extracts of *Ageratum conyzoides* followed with the control having the lowest effective control percentage. The result in Table 3 shows the potentials of different plant extracts on growth and yield characters of two maize varieties. The result shows that EU significantly performed better for both maize varieties. Higher yield was recorded for EU for Oba super 6 (6.9t/ha) and Obatanpa (5.5t/ha). This was closely followed by application with Cypermethrine for Oba super 6 (5.7t/ha) and Obatanpa (4.9t/ha) while AC was significantly better than extract of ZA for both growth and yield characters the tested maize varieties. The result shows superior performance of Oba super 6 variety over Obatanpa for most of the growth and yield characters for all the treatments imposed. The control however, gave the lowest result in the study area. These findings suggest the potential of *Eupatorium odoratum* (Vell.) as a natural pesticide to control insect pests of crops (Emran *et al*, 2019) while *Ageratum conyzoides* which is observed for its repellent, pungent smell and potent chemosterilant properties and antimicrobial and insecticidal properties closely followed. According to (Gotep, *et al*, 2019), the leaves of these plants have a pungent smell, which repels insects such as mosquitoes and whiteflies. Studies have reported that the essential oils from these plants inhibited the growth and development of the larvae of Aedes aegypti (Neenah, 2016, Pereira, *et al* 2016). The essential oils exhibited by these extracts also showed larvicidal activity against Anopheles stephensi and Culex quinquefasciatus (Adekunle, 2019). The findings suggest the potential of *Ageratum conyzoides* as a natural pesticide due to its repellent and chemosterilant properties.

According to (Koffi *et al*, 2019), *Zanthoxylum armatum* is a Poisonous, Repulsive, and Inhibits oviposition in insects. The findings of this study suggest that E. odoratum, *A. conyzoides*, and *Z. armatum* have the potential to control army worm infestation in maize and increase dry matter yield (Shah, *et al*, 2017, Nisar, *et al*, 2015). Therefore, these medicinal plant extracts should be considered as natural alternatives to synthetic pesticides to manage army worm pests in maize production. Further studies should aim to optimize the extraction processes and investigate the safety of these natural products for human consumption and the environment. Numerous studies have demonstrated their effectiveness against a range of insect pests, including aphids, lepidopteran larvae, spider mites, and stored grain pests. Additionally, some of the compounds found in these plants, such as limonoids and 3-alkyl-2-methoxypyrazines, have been shown to have insecticidal properties (Owolabi *et al*, 2017). These plants have the potential to reduce the use of chemical pesticides, making them a safe and eco-friendly alternative to control insect pests. It is important to note, however, that the effectiveness of these plants can vary depending on the target pest, the crop, and the mode of application. The results of this study aligned with previous studies on the effectiveness of medicinal plant extracts in pest management. *E. odoratum, A. conyzoides*, and *Z. armatum* are natural sources of bioactive compounds known for their pest control properties. The significant reduction in army worm infestation by these extracts indicates their potential as alternatives to synthetic pesticides. The higher dry matter yield recorded in maize treated with E. odoratum further highlights the benefits of plant-based pest management strategies.

Conclusion and Recommendations

The result shows that percentage damage after treatment application was significantly lower under the application of Cypermethrine insecticide for both Oba super 6 (9.1%) and Obatanpa, (11.5%) over other treatments. This was closely followed by the application of *Eupatorium odoratum* which had a lower percentage damage of (12.5%) for Oba super 6 and (16.7%) for Obatanpa. The highest percentage damage was however recorded for the control. Similarly, the percentage level of effective control was significantly higher with application of Cypermethrine insecticide for Oba super 6 (82%) and Obatanpa (77%). This was closely followed by application of *Eupatorium odoratum* extract application for Oba super 6 (75%) and Obatanpa (67%) while application of extracts of *Ageratum conyzoides* followed with the control having the lowest effective control percentage. In addition, superior performance of Oba super 6 variety over Obatanpa for most of the growth and yield characters for all the

treatments imposed. The control however, gave the lowest result in the study area. Therefore, further research is needed to determine the optimal formulations and application methods for each plant and pest combination. Additionally, some of these plants may have negative impacts on non-target organisms or on the environment if used inappropriately. Careful consideration should be taken to evaluate the potential risks of using these plants and to develop integrated pest management strategies that incorporate both natural and synthetic pesticides. In terms of their impact on dry matter yield, there is limited research on the effects of these plants on crop productivity. However, some studies have suggested that they may have positive effects on yields due to their allelopathic properties and ability to repel or deter pests. Further research is needed to evaluate the impact of these plants on yields and to determine the optimal methods for incorporating them into crop production systems.

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Appendix

Table 1: Physico-chemical properties of the soil at experimental site

Properties	value
PH	6.95
Total N (%)	0.38
Available P (mg/kg)	16.1
Ca^{2+} (Cmol/kg)	5.4
Mg^{2+} (Cmol/kg)	2.5
K^{+} (mg/kg)	24.9
Na^{2+} (Cmol/kg)	0.34
Organic carbon (%)	2.14
Organic matter (%)	2.15
Particle size distribution	
Sand	62.80
Silt	12.0
Clay	25.20
Texture	Sandy loam
Bulk density)g/cm^3)	1.32

Table 2: Number of holes and infestation of army worm on maize plants before and after application of treatments

Treatments	Variety	**Number of plants infested Before Treatment Application**	**Number of plants observed**	**% damage before treatment Application**	**Number of plants infested After Treatment Application**	**% damage After Treatment Application**	**% level of Effective Control Per treatment**
EO	Oba Super 6	12.0^{c}	50.0	24.0^{d}	3.0^{c}	12.5^{d}	75.0^{b}
	Obatanpa	15.0^{c}	50.0	30.0^{c}	8.0^{c}	16.7^{d}	66.7^{c}
AC	Oba Super 6	11.0^{c}	50.0	22.0^{d}	7.0^{c}	27.3^{b}	45.5^{f}
	Obatanpa	9.0^{c}	50.0	18.0^{d}	6.0^{c}	22.2^{c}	55.6^{e}
ZA	Oba Super 6	6.0^{c}	50.0	12.0^{e}	4.0^{c}	33.3^{b}	33.4^{g}
	Obatanpa	10.0^{c}	50.0	20.0^{d}	8.0^{c}	20.0c	60.0^{d}
CI	Oba Super 6	11.0^{c}	50.0	22.0^{d}	3.0^{c}	9.1^{d}	81.8^{a}
	Obatanpa	13.0^{c}	50.0	26.0^{c}	5.0^{c}	11.5^{d}	77.0^{b}
CLT	Oba Super 6	35.0^{b}	50.0	70.0^{b}	35^{b}	50.0^{a}	-
	Obatanpa	40.0^{a}	50.0	80.0^{a}	40^{a}	50.0^{a}	-
SD		11.04	NA	23.18	14.39	21.72	28.89
SE±		3.49	NA	7.32	4.56	6.87	9.13
CV (%)		77.80	NA	71.5	146.9	115.6	45.64

Means carrying the same superscript along the same columns are not significantly different at 5% probability level.SD-Standard Deviation.CV-Coefficient of Variability.(EO): *Eupatorium odoratum,(AC):Ageratum conyzoides*.(ZA): *Zanthoxylum armatum*.(CL):Cypermethrine Insecticide.(CLT):Control. *WAP- weeks after planting. WAT- weeks after treatment.NA-Not applicable*

Table 3: The potentials of organic extracts on growth, yield and yield characters of two maize varieties at harvest

Treatments	Variety	Plant height (cm)	Leaf area (cm^2)	Stem girth (cm)	Cob Girth (cm)	Cob Length (cm)	Number of cob/plant	Number of seed/cob	Seed yield (t/ha)
EO	Oba Super	180.3^{a}	339.0^{a}	63.5^{a}	77.1^{a}	24.7^{a}	4.0^{a}	246.9^{a}	6.9^{a}
	Obatanpa	178.8^{a}	327.6^{a}	61.9^{a}	71.9^{a}	23.4^{b}	3.0^{ab}	238.5^{a}	5.5^{b}
AC	Oba Super	179.5^{a}	311.9^{a}	55.3^{b}	70.5^{a}	23.9^{b}	2.0^{b}	241.0^{a}	5.0^{b}
	Obatanpa	167.5^{b}	301.0^{a}	51.8^{b}	66.8^{b}	21.0^{d}	3.0^{b}	224.7^{a}	4.4^{c}
ZA	Oba Super	150.7^{c}	280.3^{b}	48.9^{c}	64.2^{b}	22.1^{c}	2.0^{a}	232.3^{a}	4.2^{c}
	Obatanpa	148.0^{d}	347.7^{a}	49.0^{c}	61.0^{b}	21.4^{d}	2.0^{b}	215.5^{a}	3.8^{d}
CI	Oba Super	179.6^{a}	343.9^{a}	64.2^{a}	74.9^{a}	24.8^{a}	3.0^{a}	258.6^{a}	5.7^{b}
	Obatanpa	167.5^{b}	326.9^{a}	61.3^{a}	71.1^{a}	22.6^{c}	3.0^{ab}	241.4^{a}	4.9^{c}
CLT	Oba Super	160.8^{b}	261.0^{b}	44.9^{c}	66.3^{b}	21.5^{d}	2.0^{b}	226.6^{a}	3.6^{d}
	Obatanpa	158.4^{c}	238.1^{b}	40.9^{c}	62.5^{b}	20.5^{e}	2.0^{b}	213.9^{a}	2.8^{e}
SD		14.97	42.29	7.88	5.11	1.41	0.69	1.28	1.51
SE±		4.73	13.36	2.49	1.62	0.45	0.22	3.89	0.48
CV (%)		8.3	12.4	12.26	6.63	5.15	30.18	5.08	21.89

Means carrying the same superscript along the same columns are not significantly different at 5% probability level.SD-Standard Deviation.CV-Coefficient of Variability.(EO): *Eupatorium odoratum,(AC):Ageratum conyzoides*.(ZA): *Zanthoxylum armatum*.(CL):Cypermethrine Insecticide.(CLT):Control. *WAP- weeks after planting*