LAUCER 1(2):1-6 LAUTECH Crop and Environmental Reviews
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Control of Field Insect Pest of Maize (*Zea mays* L.) with Selected Plant Extracts

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Abstract
Crop protection is facing economic and ecological challenge due to human and environmental hazards resulting from the abuse of synthetic insecticides. Therefore, this study was conducted at Ladoke Akintola University of Technology Teaching and Research Farm Ogbomoso, Nigeria, to determine the insecticidal efficacy of Moringa oleifera, Petivera alliacea and their combination against insect pests of maize. Lambda cyhalothrin and untreated plots were included in the treatments; which were arranged in randomized complete block design and each treatment was replicated three times. Data were collected on the number of larvae of Musician nigrivenella, number of cobs, and number of damage cobs, and grain yields (t/ha). The result shows that M. oleifera and P. alliacea had the same insecticidal effects on M. nigrivenella. Combination of the two tested plant extract with Lambdachyalothrin separately effectively performed better than application of the single plant extracts. However, application of single plant extracts compete effectively with their combination with Lambdacyhalothrin in respect to number of cobs, damage cobs, cobs yield and grain yields. All the treatments had significant higher cob (4.83-5.13 t/ha) and grain yield (3.55-4.84 t/ha) than what was obtained in the untreated plots (1.96 t/ha and 0.26 t/ha, respectively). Therefore, plant extracts can be used in the management of insect pest of maize.

Keywords: Moringa oleifera, Petivera alliacea, M. nigrivenella, Lambdacyhalothrin, Maize.

Introduction
Maize is an important cereal crop throughout the world which belongs to the family Poacea. Originated in America and later introduced to Europe, China, and all over the world (Smith et al., 2004). However, it has been described as the third leading crop after rice and wheat (Sandhu et al., 2007) and as a major source of food in the world (Siyuan et al., 2018). The main problem in the cultivation of this crop is lack of soil fertility (Gume et al., 2007) and insect pest infestations (Chabi-Olaye et al., 2006; Tavares, 2010).

Fall Armyworm (Spodoptera frugiperda), FAW, is an insect native to tropical and subtropical regions of the Americas. The larvae can feed on more than 80 plant species, including maize, rice, sorghum, millet, sugarcane, vegetable crops and cotton (Figuerido et al., 2006). FAW cause significant yield losses if not well managed. However, fall armworm is recently being considered as major insect pest of maize in Nigeria especially in the Southern part of the country with larval stage being the destructive stage. However, another devasting insect is maize cob borer, M. nigrivenella Ragonot (Lepidoptera: Pyralidae), is a commonly occurring pest which occasionally causes serious crop damage on maize (Moyal and Tran, 1991; Bosque-Pérez and Mareck, 1990; Gounou et al., 1994; Sétamou et al., 1998) and cotton (Silvie, 1993) in West Africa. Although there are other major insect pests of Maize but the kind of economic damage done to this crop is not comparable to that of S. frugiperda and M. nigrivenella.

Due to the destructive potentials of the aforementioned insect pests, their control becomes imperative in other to get a reasonable high yield. In the course of controlling the insect pests attack, environmental implication of the management strategy has to be considered. In Nigeria, farmers solely depend on the use of synthetic insecticides such as Oganochlorine, Organophosphate, Carbamate and Pyrethroids due to their effectiveness against field insect pests. But literatures have shown that the aforementioned classes of synthetic insecticides cause environmental hazard (Pitaswart, et al., 2003; Rameshawar, 2010) and their availability is also a serious concern to our local farmers. These facts suggest that the alternatives have to be provided and tested against field insect pests, and the widely proclaimed alternative is the use of secondary metabolites (Isman and Grieneisen, 2013). Botanical insecticides are natural chemicals

extracted from plants to control insect pests. Most of these insecticides are environmentally friendly and are within the reach of the farmers (Isman, 2008). Many plants have been tested and found to be effective against certain insect pests with the knowledge of the chemistry of the tested plants but most of these findings are conducted under the laboratory. Isman, 2017 put forward that the reported insecticidal plants should be evaluated under field condition against different crops. However, the result under field condition will be used to convince the farmers on the need for natural insect pest control. Effort towards the commercialization of the insecticidal plants will be encouraged due to the result obtained from the laboratory and field condition, this may eventually reduce the quantity of synthetic insecticide being used. Meanwhile, some problems have been pointed out against the commercialization and synthesis of the discovered plant based insecticides such as variable efficacy, inability to be effective as synthetic insecticide under field condition, this is partially due their easy bio-degradation of the bio-active compounds in the environment and washing away of the applied plant extracts during raining season (Yolic et al., 2018; Alao et al., 2020). However, environmentalists as well as entomologists are demanding for safe use of insecticides from farmers and the governments not minding the yields obtain from the cultivated crops, in view of this request, use of secondary metabolites is a welcome development in modern faming practice.

Moringa oleifera Lam (Moringacea) is a highly valued plant, distributed in many countries of the tropics and subtropics (Anwar et al., 2007). Several reports have indicated the medicinal as well as insecticidal properties of the phytochemicals isolated from M. oleifera. Various plant products of this plant have also been reported as larvicidal and repellent against mosquito (Sukumar et al, 1991). The Petiveria belongs to the Phytolaccaceae which is considered as the most primitive family of the Caryophyllales, comprising about 17g eneraand120 pan tropical species widely distributed throughout the American continent (Duarte and Lopes, 2005). Among the species of Petiveria, the most popular is Petiveria alliacea L. It is a perennial shrub with a rigid and straight stem, reaching a height of up to 5–150 cm (Duarte and Lopes, 2005; Almanza, 2012). According to indigenous medicine, the root, powder and leaf of P.alliacea have been associated with several therapeutic properties, such as diuretic, antispasmodic, emmenagogic, analgesic, anti-inflammatory, antileukemic, antirheumatic, anthelminthic, antimicrobial and depurative properties (Duarte and Lopes,2005; Lima etal.,1991). Extract or pure metabolites from roots extracts of P. alliacea have showed insecticidal and acaricidal properties (Lyndon et al., 1997; Alao and Adebayo, 2011). Meanwhile, there is dearth of information on effects of these tested medicinal plants in the control of field insect pests of maize.

Materials and Methods

Experimental site: The field experiment was conducted in the cropping season of 2017 and 2018 at Ladoke Akintola University of Technology (LAUTECH) Teaching and Research Farm, Ogbomoso, Nigeria. This region is on longitude 403'E and latitude 1005'N. The region can be described as humid tropical falls in Southern Guinea Savannah of Nigeria.

Experimental Design and Management

Experimental land were ploughed and harrowed once. Sixteen plots were arranged and demarcated in a Randomized Completed Block Design with three replicates. The plot size was 3 m x 3 m with a planting space of 1 m x 1 m between and within the plant rows respectively. Maize variety (Oba-Super 4) was planted .Two to four seeds of maize were planted per hole which was later thinned to one plant per stand after two weeks of planting given a total plant population density of 16 plant stands per plot . Other agronomy practices were duly followed.

Plant Extracts Formulations

The leaves of M. oleifera and root of P. alliacea respectively were washed to remove sand, dust and chemical contaminants. The leaves and root of the tested plant parts were air dried for 24 days to reduce the level of the moisture contents. Each of the plant was crushed with electric blender and 1000 g of crushed plants were later soaked in a 10- litre bucket containing 2000 ml of water for 12 hours. Filtration was done with muslin cloth and filtrates collected were stored in a 5-litre keg for further use. The 33.3% of active ingredient (filtrates collected) was separately diluted with adjuvant substances, Teapot (11.11%), Nitrosol (22.22%), Salt (22.22%) and Black soap (11.11%). Hence, the mixture was equivalent to 100 ml. This formulation is in line with the established procedure by Olaniran et al., 2016. Mixture of the tested plant extracts with Lambdachyalothrin was done by diluting 20% each of the plant extract filtrates with 0.5 ml of Lambdachyalothrin which is the half of the manufacturer's recommended rate.

The unsprayed plots and synthetic insecticide (Lambdacyhalothrin) applied at manufacturer's recommended rate (1 ml) were included for comparison. Each concentration of both synthetic and botanical insecticides was further diluted with 1000 ml of water to achieve the same spraying volume.

Treatment Application

Application of the treatments commenced immediately after 50% of the emerged tarsel. Cypermethrin was sprayed twice before the emergency of the tarsel in other to control to stem borer and fall army worm. One hundred (100 ml) was measured from stock solution which was later diluted with 900 ml of water. Foliar application was done with hand-held sprayer (2-litre capacity) and ensured it had contact with target with maize cob. The spraying was done early in the morning to avoid photo-degradation of the extracts (Adebayo, 2003). Application of the treatments was done three times at seven days interval.

Data Collection and Analysis

Data were collected on larvae of corn borer after harvesting, twenty samples of maize cobs were randomly selected from each treatments including control. The maize husks were opened carefully and the larvae in each maize cobs were determined by removing the larvae into the glass vial containing 30% alcohol and the number of larvae were counted. Maize grains were threshed from the cobs from which one thousand grains (1000) were counted and weighed. Damage grains were also determined from the 1000 grains and calculated in percentage. Weight of Maize cobs and grain yield were determined and converted into t/ha. The larvae collected were transformed using arcsin transformation. Data collected were subjected to Analysis of variance (ANOVA) and significant means were separated with Ducan multiple range text at 5% probability level

Results

Effects of Insecticides on Number Harvested Cobs and Damaged Cobs

Table 1 Shows effect of insecticides on the number of damaged and undamaged cobs. Significant different was not detected among the treated maize plants on the number of harvested maize cobs whereas untreated plants had the least number of cobs (30). Similar result was detected on number of damage cobs whereas untreated plant had the highest damage cobs (70.3%).

Effects of Insecticides on Yield (t/ha) and Grain (t/ha)

The result presented on table 2 indicates that the tested plant extracts had the same significant effects on cob yield when compared with the other applied treatments but untreated plants had least significant cob yield (1.96 t/ha). No significant different was detected between plants treated with M. oleifera and P. alliacea in respect to maize cob yield (4.83 and 5.13 t/ha respectively). Least grain yield was obtained in untreated plants (0.26 t/ha). Application of P. alliacea resulted into higher grain yield (4.04 t/ha) than M. oleifera (2.55 t/ha) meanwhile combination of the tested plant extracts with Cypermethrin was significantly effective as single application of Cypermethrin in respect with grain yield.

Table 1: Effect of insecticides on number of harvested cobs and damaged cobs

Treatments	Maize Cobs	
	Number Of Cobs	Damage Cobs (%)
Lambdacyhalothrin	40^{a}	23.6^{b}
Control	30^{b}	70.3^{a}
Moringa oleifera	31^{a}	40.0^{b}
Petiveria alliacea	33^{a}	39.0^{b}
Lambdacyhalothrin+*M. oleifera*	42^{a}	34.3^{b}
Lambdacyhalothrin+P. alliacea	44^{a}	35.0^{b}

**Means with the same superscripts are not significantly different ($p<0.05$)*

Table 3: Effect on insecticides on yield and grain parameters (t/ha)

Treatments	Maize cobs	
	Cob Yield (t/ha)	Grain (t/ha)
Lambdacyhalothrin	4.86^{a}	4.29^{a}
Control	1.96^{b}	0.26^{c}
Moringa oleifera	4.83^{a}	3.55^{ab}
Petiveria alliacea	5.13^{a}	4.04^{a}
Lambdacyhalothrin+*M. oleifera*	5.06^{a}	4.84^{a}
Lambdacyhalothrin+P. alliacea	5.03^{a}	4.51^{a}

**Means with the same superscripts are not significantly different (p<0.05)*

Response of Mussidia nigrivenella Larvae to Insecticides Application

As presented in table3, significant different was detected among the treatments and control against the larvae of M. nigrivenella. However, the tested plant extracts exhibited the same significant effects in the control of this insect. Mixture of each of the tested plant extracts with Cypermethrin also had significant insecticidal control of M. nigrivenella when compared with the single application of Cypermethrin whereas highest larvae of M. nigrvenella infestation was detected in an untreated plants.

Table 4: Effect of insecticide on number of *Mussidia nigrivenella* larvae

Treatments	Stem borers (larvae) Larvae
Lambdacyhalothrin	6.67[c]
Control	16.00[a]
Moringa oleifera	9.67[b]
Petiveria alliacea	10.67[b]
Lambdacyhalothrin+moringa	5.00[c]
Lambdacyhalothrin+petivera	6.67[c]

**Means with the same superscripts are not significantly different (p<0.05)*

Discussion

Plant based insecticides are naturally occurring insecticides which are often slow-acting crop protectants but proved to be safe to humans and environment than the synthetic insecticides (Isman, 2006; Akhtar et al., 2008). In view of this, two plant extracts were tested (M. oleifera and P. alliacea) and their mixture with synthetic insecticide (Cypermethrin) separately against the larvae of M. nigrivenella of maize. The data suggest that the tested plant extracts exhibited insecticidal effects on the observed insect pest. This is an indication that the tested plant extracts can be used to suppress the maize cob borer insect. However, these plant extracts have been tested against other field insect pests of crops and found to provide adequate protection for those crops under the field condition, for instance, M. oleifera and T. vogelii were reported to have had 54% efficacy against field insect pests of watermelon. Also, P. alliacea and T. vogelii were established by Alao et al., (2011) against post-flowering insect pests of cowpea. Piper guinensis and M. oleifera have been reported to have possessed insecticidal properties against Trogodamer granarium (Babarinde et al; 2011). Meanwhile, the effectiveness of M. oleifera and P. alliacea can be attributed to their insecticidal active compounds.

Synthetic insecticides have been reported to have had quick effects on the field insect pests due to their persistence in the environment (Nkechi et al., 2018) but the persistence nature resulted into environmental hazard (Sande et al., 2011; Wimalawansa and Wimalawansa, 2014). The data obtained indicate that plant extracts were not as effective as synthetic insecticide (Cypermethrin) in the control of M. nigrivenella. This can be linked to low persistence of the tested plant extracts due to rainfall, relative humidity and sunlight which reduced the insecticidal of plant based insecticides (Rameshawar, 2010; Yolic et al., 2018). The report also has it that botanical produce crop command higher price in the market than synthetic insecticides (Misra, 2014). In view of this, there is possibility that the maize grains from this research work will meet up with the standard organic practices. Also, in other to reduce the negative impact of the synthetic insecticide, the two plant extracts were combined separately with Cypermethrin and it was observed that their effect on the observed insect pest was comparable with the single application of the synthetic insecticide (Cypermethrin). There is no doubt about that this approach will reduce the quantity of synthetic insecticide that goes into the environment since the half of the manufacturer's recommended rate was mixed with the tested plant extracts and plant extracts have been reported not to have left residues on the treated crops (Dubey et al., 2008). This gives impression that botanical treated crops are safe for human consumption.

According to Adebayo (2003) and Isman (2017), the sole aim of local farmers is high yield and most of our local farmers pay little attention to the management practices of insect pests. However, this experiment shows that the botanical treated plants had the same significant effects on maize grain yield while the untreated plants had the least grain yield (0.26 t/ha). Therefore the use of these tested plant extracts is a welcome development in the pest management program of maize cultivation.

Conclusion

This experiment clearly shows that M.oleifera and P.allaicea can be used in the management insect pests of maize. The two tested plant extracts were not effective as synthetic insecticide therefore plant extracts can be used in the control of field insect pests of maize especially in the organic farming

system. Their combination with synthetic insecticides will reduce the quantity of the synthetic insecticides which go into the environment thereby reduce the level of environmental pollution cause by the application of insecticides.

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