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Efficacy of Five Botanicals in the Management of Fall Armyworm *Spodoptera frugiperda* J.E Smith (1993) (Lepidoptera: Noctuidae) Larvae on Some Maize Varieties in Port Harcourt, Rivers State, Nigeria

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ABSTRACT: *The extracts of five locally used plants were evaluated for their efficacy in the management of Fall Army Worm Spodoptera frugiperda, on fifteen maize varieties (Oba Super 2, Oba Super11, Oba Super 3, Oba Super 98, Oba Super 6, Sammaz 29, Sammaz 17, Sammaz 45, Sammaz 15, Sammaz 14, K11, SC645, SC651, SC510, SC719) cultivated in the Teaching and Research Farm of the Rivers State University. The experiment was laid out in a Randomised Complete Block Design (RCBD) and replicated five times. The treatments were Ethanolic extracts of Zingiber officinale (Ginger), Tetrapleura tetraptera (Ohihio or Gum tree), Curcuma longa (Tumeric), Piper guineense (Uziza or West African black Pepper) and Xylopia aethiopica (Udah or Guinea pepper) and a Control (untreated plot). Parameters analyzed were degree of infestation (No-damage; mild-damage; average damage; severe-damage and very severe-damage), percentage of survived plants, Larval population, number of cobs, weight of cobs with husk and weight of cobs without husk. Z. offinale (Ginger) was significantly different in potency (P<0.05) from the other botanicals, it had "no damage" maize plants with 97.5%/ha survival and had the lowest mean larval population (6.0/ha), the highest mean number of cobs per plot (12.3/ha) and highest fresh weight of cobs with husk and without husk (2.0kg/ha and 1.8kg/ha respectively). This is significantly different from the Control that had "very severe damage' maize plants, 78% survived maize plants, highest mean for larval population (17.5/ha), lowest mean for number of cobs/ha (6.8/ha), fresh weight of cobs with husk and without husk (1.0kg/ha and 0.8kg/ha) respectively. This was followed by the maize plants treated with Guinea pepper (Udah) extract which had "severe damage" maize plants with 85% plant survival and a mean larval population of 15.3/ha, the mean number of cobs (7.0/ha) and mean fresh weight of cobs with and without husk as 1.3kg/ha and 1.0kg/ha respectively. Maize treated with turmeric and gum tree extracts had "mild damage" maize plants with 90% and 87.5% plant survival respectively and they had respective values for mean larval population as 15.0/ha and 12.3/ha, mean number of cobs as 9.8/ha and 8.0/ha, same value for mean fresh weight of cobs with husk as 1.8Kg/ha and mean fresh weight of cobs without husk as 1.0Kg/ha and 1.5Kg/ha, respectively. Plants treated with Uziza extract had an "average damage" with 82.5% survived plants, 14.0/ha of mean larval population, 7.3/ha as the mean number of cobs and then 1.5kg/ha and 1.0kg/ha as the mean fresh weight of cobs with and without husk. The level of potency exhibited by each botanical on FAW larvae was in descending order of Z. officinale >C.longa >T. teraptera >P. guineense >Xylopia aethiopica >Control. Thus these plant extracts and Z. offinale in particular have proven to be highly potent larvicides that could be incorporated in the integrated management of S. frugiperda larvae in maize and possibly in the management of other field crop pest.*

KEYWORDS: Efficacy, *Spodoptera frugiperda*, larvae, botanicals, Management and Maize

INTRODUCTION

Zea mays of the Poaceae plant family commonly known as maize is a global crop grown in both the tropical, subtropical and temperate climates, with a higher production in the areas that are tropical and subtropical (Botiri and Hake, 2007). The maize plant contains distinct male and female blooming sections; unlike all other significant grain crops and has about 50 species of maize, having different colours, grain shapes, sizes and textures. The white, yellow, and red colour maize types are the commonest types. The white and yellow types are the most prefered types. There are about seven classes of maize: Dent corn (*Zea mays* Indentata Sturt), Flint corn (*Zea mays* indurate Sturt), Popcorn (*Zea mays* Everta Sturt), Sweet corn (Zea *mays* Saccharata Sturt), Flour corn (*Zea mays* amylace Sturt), Popcorn (*Zea mays* tunicate Sturt), Waxy corn (Zea mays ceratina Kulesh) and Baby corn (Zea mays) (Botiri and Hake, 2007).

Maize is an important grain in the world that is used by both food industries and animal feed industries (Botiri and Hake, 2007). It is the most significant and cost-effective source of glucose in the United States. Starch makes about 70% –72% of the dry weight of maize kernels, making it the main commodity used to store carbs (Botiri and Hake, 2007). Maize is considered a food security crop in different parts of Africa because it can easily be produced in different regions year-round depending on weather condition. The main reasons for the increasing production are the increasing population pushing food scarcity to new heights and the hike in demand for maize in other sectors (FAO, 2017).

Nigeria harvested nearly about 12.75 million metric tons of dry maize grain in 2021, putting her in the rank of Africa's highest maize producers (FAO, 2017). However, the threat of the Fall Army Worm infestation in maize is rapidly spreading across Nigeria and the other African regions and is a nightmare with huge economic implication (FAO, 2017).

The Fall Armyworm *Spodoptera frugiperda* (Lepidoptera: Noctuidae) is a polyphagous insect pest which was first reported in the United States and spread to Argentina and the Caribbeans (the Americas' tropical areas) (Bessong *et al.*, 2021; Goergen *et al*., 2016). *S. frugiperda* is a plant and crop pest whose larvae feed voraciously on over 100 plant species from 27 families (Goergen *et al*., 2016). Generally, *S. frugiperda* feeds on the foliage of the plant and on the corn ears during heavy infestations (Ansah *et al.*, 2021). The foliar damage is known by ragged feeding and deposition of frass by the side of the whorls, causing terrible nightmare, to maize farmers.

It is a major pest of maize plant which is currently ravaging maize farms in over 21 nations, (Abrahams *et al.*, 2017; Bessong *et al.*, 2021; Tindo, 2017). 2016 saw the first reports of an attack by the fall army worm on maize in Africa: Nigeria and Sao Tome, Benin, Togo, Ghana, Ethiopia, Zimbabwe, Mozambique, Malawi, Namibia, South Africa and Zambia (FAO, 2017; Goergen, *et al*., 2016) and a significant damage on maize crop that has destroyed the livelihood of farmers, was recorded. Reports of 100% damage have been received from the following states of Nigeria: Ogun, Ekiti, Abia, Osun, Ondo, Kwara, Jigawa, Katsina and Rivers state (to mention but a few), from Agricultural Development Programme (ADP) offices and other farmers (Ansah *et al.*, 2021; I.A.R&T, 2017 and Odeyemi, 2018).

The use of conventional pesticides has remained effective in the management of this pest, however, its adverse effect and associated environmental risks calls for a wide cry immediate alternative. Therefore, the integration of cultural, biological, host plant resistance and chemical methods that are environmentally friendly, economically viable, and socially suitable should be employed to reduce the number of pests to manageable levels. This would also reduce the amount of chemical pesticides that are released into the environment and save cost (Ansah *et al*, 2021; Odeyemi, 2018). The incorporation of botanicals in the integrated pest management practices of insect pests is a promising innovation, easily accessible and ecologically friendly pest management strategy to combat pest issues in order to preserve or enhance yields and guarantee food security while minimizing the high cost and possible risks of the synthetic pesticides (Pedigo and Rice, 2006; Sarfraz and Keddie, 2005).

Plants have a huge variety of bioactive phytochemicals originating from their secondary metabolites that can supplement or replace the conventional synthetic chemical pesticides due to the wide range of selection pressures (Pedigo and Rice, 2006). Current research confirms that some plant essential oils not only repel insects, but possess insect toxins and anti-feedant properties against field and stored product insects. Botanical pesticides have been made from natural substances such the Neem plant (*Azachdirata indica*) which can act as a repellant, anti-feedant or growth inhibitors of insects from different orders and families like the diptera and the Lepidoptera (Okwute, 2012). Also plants parts of *Tetrapleura tetraptera*, *Monodora myristica*, *Aframomum melegueta* were used as botanical powder toxins and growth inhibitors in the control of *Dermestes marculatus* beetle in dried cat fish (Amadi and Dimkpa, 2018). Other botanicals such as Turmeric (*Curcuma longa*); Uziza seeds (*Piper guineense*); Uda (*Xylopia aethiopica*) seeds; Ginger (*Zingiber officinale*), have been reported to have insecticidal properties and have been implicated in the management of some insect pests.

Essential oils of the *Piper guineense* displayed strong toxicity to larvae of *Acrae eponina* Cramer, the adult cotton stainer *Dysdercus superstitiousus* Fab, flea beetle *Ootheca mutabilis* Sahlberg, and the pod sucking bug *Riptortus dentipes* Fab on cowpea. Similarly, Ekesi (2000) emphasized that crude aqueous extracts of black pepper seeds drastically reduced egg viability of the legume pod borer *Maruca vitrata*. Ewete *et al.*, (1996) and Kayode *et al*., (2020) reported that *P. guineense* seed products are also effective against the European corn borer *Ostrinia nubilalis* Hubn., thrips, larvae of *Maruca vitrata*, nymphs and adults of the pod sucking bug complex on cowpea dominated by *Clavigrallatomento sicollis* Stal. Laboratory evaluation of the repellent and anti-feedant properties of aqueous extracts of *P. guineense* against the banana weevil *Cosmopolites sordidus* (Germar) displayed potent repellent and feeding deterrent activities of the extracts (Inyang and Emosairue, 2005). A petroleum ether extract of the roots of *P. guineense* had insecticidal potency against the house fly *Musca domestica* L. (Kayode *et al.*, 2020).

The efficacy of ethanol leaf extract of ginger and turmeric was assessed against the fourth instar larvae of *Aedes aegypti*, under laboratory conditions. Both extracts had moderate activity against *Aedes aegypti* larvae, but the combined treatment of both leaf extract had the highest activity as it killed all the larval population within 24 hours (Khanra *et al*., 2018).

The compound *ar*-turmerone extracted from the rhizome and leaf of tumeric has been used as a low cost botanical insecticide for integrated management of cabbage looper *Trichoplu siani* in vegetable production (De Souza *et al.,* 2016). The same *ar*-tumerone in turmeric was toxic to some lepidopteran insects like *Plutella xylostella* larvae, caused 100% and 82% mortality at 1,000 and 500 ppm, respectively (Hoi-Scon *et al.*, 2001).

Extracts of *Xylopia aethiopica* have toxic and repellent potency against *Tribolium castaneum* (Herbst) and *Sitophilus zeamais* (Motschulsky) respectively and as such can be used to preserve various grains and cereals from such insect infestation on storage (Babarinde and Adeyemo, 2010; Kouninki *et al.,* 2007).

Having reviewed the different levels of efficacy in some botanicals, it was interesting to evaluate the effects of *Z. officinale, T. tetraptera, C. longa, P. guineense and X. aethiopica* on *Spodoptera frugiperda* larvae on maize plants in the field. These are economical, easily biodegradable and safe to handle as organic farming have become commendable.

MATERIALS AND METHODS

This study was carried out at the teaching and Research farm of the Rivers State University Port Harcourt, located within latitude 4^0 5^1N and longitude 7^0 0^1 E with an elevation of 18m above sea level (FAO, 1984). Seeds and pods of the five different plants bought from the Oil mill market in Port Harcourt, were oven dried at a temperature of 30^0C for 30 minutes and allowed to cool, then were ground with an electric blender and then allowed to cool again before storing in air-tight plastic containers for use.

25g of each of the plant powders were separately poured into five bottles, each containing one litre of ethanol (98%). The different contents in the bottles were vigorously stirred and allowed to settle for 24 hours. The different ethanol extracts were then separately filtered into different 10 litre containers and each diluted with 6 litres of water, properly mixed and used to treat the maize plants in the labeled plots. The concentration of the extracts used was 3.5g/l.

A set of choice experiment of a complete randomized block design was set up on a plot size of 13.4 by 16.1m^2. There were six plots (five plots for the five different treatments and one plot for control), each plot contained fifteen subplots (representing the fifteen maize varieties). The size of the subplots was 1.4 by 1.4m^2 with a 70cm space between subplots and a 1m between each plot. Plots 1 to plot 5 were treated with Treatment 1(T1): *Zingiber officinale* (Ginger); T2: *Curcuma longa* (Turmeric)*;* T3*: Xylopia aethiopica* (Uda) seeds T4: *Piper guineense* (Uziza) seeds; T5:

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Tetrapleura tetraptera (Ohio-Ohio) respectively. The sixth plot was the Control which was the untreated plot.

Unripe *Tetrapleura Tetraptera* Fruit On the Tree

Dry, Ripe and Matured *T. tetraptera* fruit

Piper guineense seeds

Tumeric Rhizome

Ginger Rhizome

Xylopia aethiopica fruits

Figure 1. The Five Plants (Botanicals) used in the Experiment: *Zingiber officinale* (Ginger); *Curcuma longa* (Turmeric); *Xylopia aethiopica* (Uda) seeds; *Piper guineense* (Uziza) seeds; *Tetrapleura tetraptera* (Ohio-Ohio).

Extracts of the botanicals were each used to treat the 15 maize varieties bi-weekly from two weeks after planting, and for three months. The different extract preparations were applied to plants by using a knapsack spray dispenser to spray the solution on the leaves and whorls of the different varieties of maize.

Various parameters were taken include Larval population: Larval population was determined by counting and recording the number of larvae found on the plants on each subplot biweekly, for 3 months and the number per hectare calculated. Number of survived Plants: The number of plants that survived plants after three months were counted and percentage calculated. Number of cobs: The number of cobs produced by the different maize varieties on each subplot was recorded and cobs per hectare calculated. Weight of cobs: Fresh cobs with husk were weighed on a 50kg scale and recorded. The husks were removed and fresh cobs weighed again and weight recorded and calculated per hectare.

Collected experimental data were summarized and arranged using excel spreadsheet. All data fully normalized using square root transformation and analyzed with general linear model analyses of variance using Minitab 16 (Minitab Inc. USA). Significant means separated using Tukey method at 95% confidence interval level.

RESULTS

Experimental results showed that the effect of Plant Extracts (botanicals) on the management of *S. frugiperda* larvae on the maize plant varieties were significantly different ($P<0.05$). Plots without botanical treatment (Control) had "very severe damaged" maize plants with the highest mean larval population of *S. frugiperda* as 17.5/ha, the lowest percentage value of survived plants of 78%, lowest number of cobs as 6.8/ha, then the weight of cobs with husks and without husk as 1.0Kg/ha and 0.8Kg/ha (Table 1 and Figure 2). This was significantly different from the rest of the treated plots.

Plot treated with *Z. officinale* (Ginger) recorded "no damage" maize plant, lowest mean number of larvae/ha (6.0) and highest percentage value of survived plants (97.5%), this was significantly different ($P<0.05$) from the other Studied plant extracts. It also had the highest number of cobs (12.3/ha), weight of cobs with husk (2.0Kg/ha) and weight of cobs without husk (1.8Kg/ha). *T. tetraptera* was insignificantly different from *P. guineense* and *C. longa* but significantly different from *Z. officinale* and *X. aethiopica* with a mild damage, 87.5% plant survival, larval population of 12.25/ha, 8.0/ha for number of cobs and then weight of cobs with and without husk as 1.8Kg/ha and 1.5Kg/ha respectively. The maize plot treated with turmeric, experienced mild damage with 90% survived plants, 15.0/ha as larval population, the number of cobs was 9.75/ha, 1.8Kg/ha and 1.5Kg/ha for weight of cobs with husk and without husk.

Table 1: The Efficacy of Botanicals on S. frugiperda Infestation on Maize and its yield.

Biocides	Degree of infestation	Percentage (%) of survived plants	Number of Larvae/ ha	Number of Cobs/ha	Weight of Cobs with husk (kg/ha)	Weight of Cobs without husk(kg/ha)
Zingiber officinale	No-damage	97.5[a]	6.0[e]	12.25[a]	2.0[a]	1.8[a]
Curcuma longer	Mild damage	90.0[b]	15.0[bc]	9.75[b]	1.8[ab]	1.0[a]
Xylopia Aethiopica	Severe damage	85.0[d]	15.25[b]	7.0[d]	1.3[bc]	1.0[a]
Piper guinensis	Average damage	82.5[cd]	14.0[c]	7.25[d]	1.5[a-c]	1.0[a]
Tetrapleura tetraptera	Mild damage	87.5[bc]	12.25[d]	8.0[c]	1.8[bc]	1.5[a]
Control	Very severe damaged	78.0[e]	17.5[a]	6.8[d]	1.0[c]	0.8[a]

Means that do not share a letter within the same column are significantly different (p<0.05), using Turkey's method at 95% confidence level.

Plot treated with *X. aethiopica* extract experienced severe damage with 85% survived plants, 15.25 larvae/ha, number of cobs as 7.0/ha and the weight of cobs with or without husk as1.3Kg/ha and 1.0Kg/ha respectively.
Plot treated with *P. guineense* extract had average damaged maize plants with 82.5% survived plants, a larval population of 14.0/ha, mean number of cobs as7.25, weight of cobs with husk and without husk was 1.5Kg/ha and 1.0Kg/ha respectively.

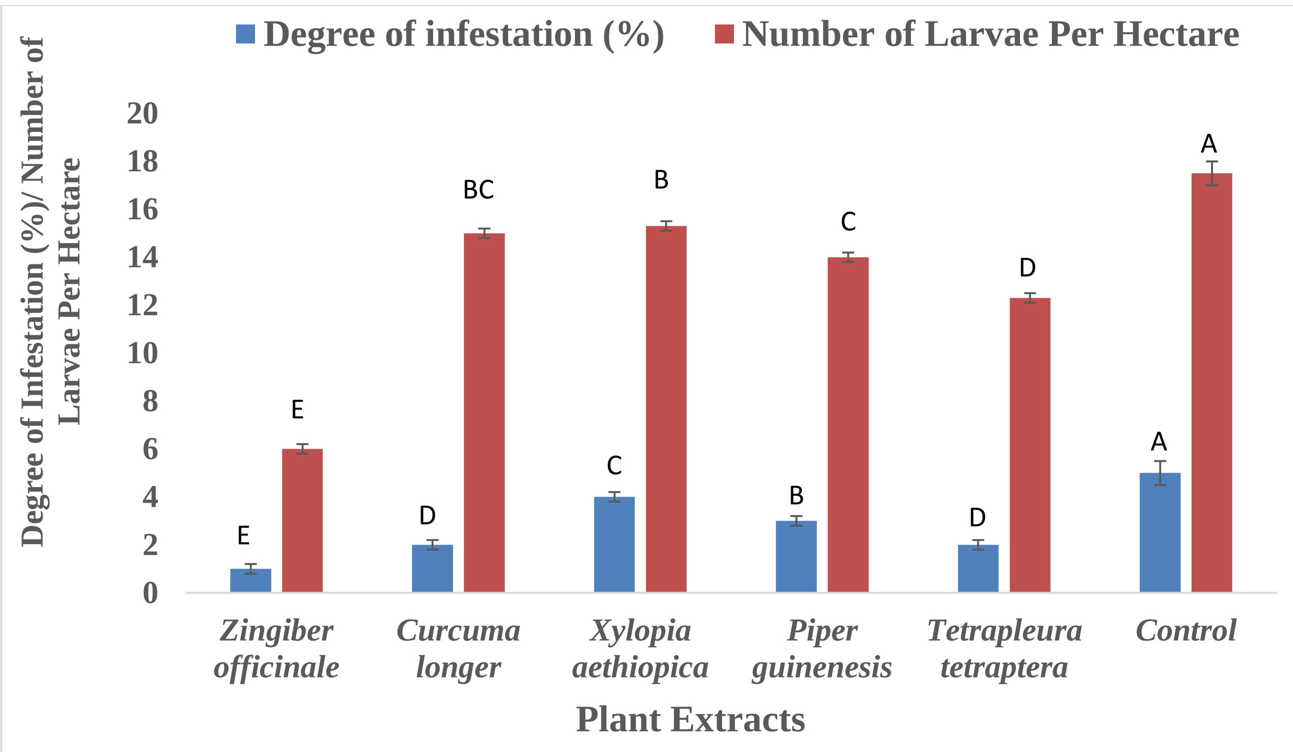

Figure 2. Efficacy of the Botanicals on *S. frugiperda* Infestation and Larvae population on cultivated Maize in the field. Bars that do not share a letter within the same parameter are significantly different (p<0.05), using Turkey's method at 95% confidence level.

DISCUSSION

The experimental result revealed that the studied plant extracts are efficacious in the management of *S. frugiperda* larvae on cultivated maize. Considering the percentage survival of the plant at the end of the experiment, the efficacy ranking of the botanicals was as follows: *Zingiber officinale* > *Curcuma longa* > *Tetrapleura tetraptera* > *Xylopia aethiopica* > *Piper guineense* > Control.

Zingiber officinale (Ginger) proved to be highly potent in the management of the FAW on all the treated maize varieties as the plot treated with ginger had the least larval population with the highest percentage of survived plants and harvested cobs. This could be attributed to the phytochemical content of ginger. Mbaveng *et al*., (2017) and Syafitri *et al.*, (2018), reported that essential oils from ginger contain bioactive compounds that are volatile such as monoterpenoids and sesquiterpenoids (e.g zingiberine) and non-volatile ones such as zingerone. Madresh *et al.*, (2018) proved that the essential oil from *Z. officinale* had 45% insecticidal and 61% repellent activity against adult form of *Culex theileri* Theobald mosquitoes. Hamada *et al.*, (2018), emphasized that ginger has insecticidal properties when its essential oil was used in the control of *Spodoptera littoralis*, where the larval and pupal duration was remarkably prolonged, and the percentage hatchability of eggs was significantly reduced. Similarly, the essential oil from the rhizome of *Z. officinale* was isolated by hydro distillation and its repellent, toxic and developmental inhibitory activities were determined against wheat flour insect pest *Tribolium castaneum* (Chaubey, 2011). The filter paper repellency assay of *Z. officinale* essential oil repelled the adults of *T. castaneum* significantly at different concentrations. Adults of *T. castaneum* were fumigated with the essential oil of ginger and it caused mortality. Fumigation with sublethal concentrations viz. 40 and 80% of 24-h LC_{50} of the essential oil significantly reduced the oviposition potential of the adults and inhibited development of larvae to pupae and the pupae to adults. All the responses were found concentration-dependent (Chaubey, 2011). The insecticidal potency of four crude extracts from *Z. officinale* rhizome was effective in the management of second instar larvae of *Spodoptera litura*, *Spodoptera exigua* and *Spodoptera frugiperda and* the hexane extract exhibited the strongest toxicity to *S. exigua* followed by *S. frugiperda* (Kanta *et al.*, (2023). It is note-worthy that the potency of ethanol extract of ginger on the reduction of *S. frugiperda* larval population on the maize plots enabled the plant to grow healthily and produced more cobs compared to the rest botanicals.

The ethanol extract of *Tetrapleura tetraptera* in this research, inhibited the larval infestation on the maize varieties as it reduced the larval population to 12.25/ha with a consequential mild damage. Ojewole and Adewumi, (2004) stated that *T. tetraptera* is a good source of tannins, alkaloids, saponins, steroids and phenolic compounds which have insecticidal potency in varying degrees. Aina *et al.*, (2009) reported the aqueous and ethanol extracts of *T. tetraptera* caused 42.78% and 59.17% mortality of *Anopheles gambie* mosquitoe larvae, both extracts proving to be very effective larvicides. *T. tetraptera* powder was used as an effective larvicide, when 2g, 4g, 6g, 8g, and 10g of *T. tetraptera* powder were used to treat dried cat fish (*Clarias gariepinus*) against larvae of *Dermestes maculatus* which resulted into 100% mortality for all the concentrations at 27 and 24 days after treatment and with an LC_{50} of 1.94. Also the progeny development did not go beyond the larval stage for all the concentrations of *T. tetraptera* powder used (Amadi and Dimkpa, 2018).

This experimental result revealed that ethanol extract of tumeric proved to be a potent insecticide as the plants treated with it had 90% survival and suffered a consequential mild damage. This could be attributed a lot of bioactive chemicals constituents of tumeric such as Curcumin and *ar*-tumerone (De Souza *et al.,* 2016). The compound *ar*-turmerone extracted from the rhizome and leaf of tumeric has been used as a low cost botanical insecticide for the integrated management of cabbage looper *Trichoplu siani* in vegetable production (De Souza *et al.,* 2016). Essential oil of turmeric had a repellent and growth inhibiting effect on rust red flour beetle (Asawalam and Arukwe, 2004). Kurma *et al.,* (2017) reported turmeric as a cheap, health and eco-friendly household insecticide by using turmeric as fresh juice, powdery rhizome and its essential oils on the leaf of crops and grains for protection. Turmeric has been used effectively in the library and museums to fumigate books and artifacts, protecting them from insects (Kurma *et al.,* 2017). Pesticides prepared from turmeric were used in the form of extract and powder on adult Dermestid spp. The extract was tested at different concentrations while the powder was used for treatment at percentages upon 100g dry fish. The adult Dermestes spp. showed the highest rate of Repellency, while the larvae showed mere resistance against the pesticide (Ulfat *et al.*, 2019). Similarly, in this current experiment, the potency of turmeric ethanol extract in the inhibition of *S. frugiperda* larval population was lower compared to *T. tetraptera* treated plot however turmeric plot had a higher plant survival and yield. This may be attributed to the phytochemical contents of turmeric which would have encouraged the growth performance of the plant.

Xylopia aethiopica ethanol extract from this experiment, performed relatively well in the inhibition of *S. frugiperda larvae* with 85% survived plants though with severe damage. Nguemtchouin *et al.,* (2010), earlier reported that *X. aethiopica* has insecticidal properties as its essential oils were used for pesticides to protect cereals against insect attack, although the extract had low persistence because of the relative high volatility and biodegradability of the essential oils. Similarly essential oils of *X. aethiopica* have been used as repellent against mosquito and housefly and antifeedants against termites (Soh *et al.* (2013). Babarinde and Adeyemo, (2010); Kouninki *et al.* (2007), reported that the extracts of *Xylopia aethiopica* have toxic and repellent potency against *Tribolium castaneum* and *Sitophilus zeamais* respectively and as such can be used to preserve various grains and cereals from such insect infestation in storage.

The experimental findings also revealed that *P. guineense* was another promising insecticide that gave 82.5% survived plants with average damage and *S. frugiperda* larval population of 14.0/ha. *P. guineense* among other secondary metabolites that it contains, has neurotoxic piperamides and lignans (Kayode *et al*., 2020; Scott *et al.* 2005). Gbewonyo *et al.* (2010), also reported the effect of *P. guineense* seeds extracts on the management of insect pest of cowpea plant. However, it was unusual that the plots treated with undiluted concentrated aqueous solution of *P. guineense* repeatedly had one of the highest levels of *S. frugiperda* larval damage in the current experiment. A viable reason could be that *P. guineense* is a stomach poison and not a repellant; therefore insects could feed on the treated plant and die later. Akihdeno *et al.*

(2021) reported similar result on the toxicity of *P. guineense* powder on the protection of beans seed and the high mortality of *Callosobruschus maculatus* on the stored beans.

The experimental results importantly revealed that the plots treated with ginger extract had the best yield performance, highest mean values for the number of cobs, weight of cobs with husk and without husk. This proves that ginger *Z. officinale* is a very potent and safe plant insecticide. The potency of *Curcuma longa*, *T. tetraptera*, *Piper guineense* and *X. aethiopica* on the degree of infestation were not significantly different. This was the reason for mild (*C. longa* and *T. tetraptera*), average (*P. guineense*) and severe (*X. aethiopica*) infestation of all the plants treated with the four different plant extracts. *C. longa* treated plants had more larvae infestation on them as against plants treated with *P. guineense* and *T. tetraptera* but the order of survived plants treated by these three botanicals was: *C. longa* > *T. tetraptera* > *P. guineense. C. longa* performed better than the two, though it had a higher mean value of larval population. Although *X. aethiopica* had severe, yet it had more surviving plants than *P. guineense.* Looking at the yield performance of *C. longa, T. tetraptera, P. guineense* and *X. aethiopica*, the mean values for number of cobs was *C. longa >T. tetraptera >P. guineense >X . aethiopica.* The mean value for weight of cobs with husk for maize plants treated with *C. longa* and *T. tetraptera* was insignificantly different though the latter had more mean value for weight of cobs without husks. The values for weight of cobs without husk for *C. longa, Piper guineense* and *X. aethiopica* treated maize plants were insignificantly different.

CONCLUSION

The five plant extracts investigated are all potent at different levels in the inhibition of *S. frugiperda* larvae on cultivated maize and could be further investigated and incorporated in the integrated pest management program for the efficient and economical management of *S. frugiperda.*

Considering the percentage survival of the plant at the end of the experiment, the efficacy ranking of the botanicals was as follows: *Zingiber officinale* > *Curcuma longa* > *Tetrapleura tetraptera* > *Xylopia aethiopica* > *Piper guineense* > Control.

The experimental results importantly revealed that the plots treated with ginger extract had the best yield performance, highest mean values for the number of cobs, weight of cobs with husk and without husk. This proves that ginger *Z. officinale* was the most viable potent botanical among the five studied plant extracts.

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