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EFFECTS OF *Azadirachta indica*, *Parkia biglobosa* AND SYNTHETIC INSECTICIDES ON *Sesamia calamistis* (HAMPSON) ON GROWTH AND YIELD OF MAIZE (*Zea Mays* L.) IN MAKURDI

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ABSTRACT

Zea mays, plays a crucial role in the dietary habits of numerous individuals residing in Nigeria. Several factors, including the presence of *Sesamia calmistis* and the effects of synthetic insecticides on beneficial insects and hazards to humans, contribute to the limitation of maize output. The study evaluated the effect of *Azadirachta indica* and *Parkia biglobosa* extracts on the control of *S. calamistis* and this experiment was carried out in two planting seasons of 2021 and 2022. The experiment was carried out at the Teaching and Research Farm, Joseph Sarwuan Tarka University, Makurdi. Three treatments; *A. indica*, *P. biglobosa*, Karate 5 EC (Lambda cyhalothrin 5 EC) and control were used. From the study, *A. indica* extract had a significant effect at $p<0.05$ on the insect population resulting in a significant increase in the yield parameters which includes the number 100 seed weight of the plant, yield in both 2021 and 2022 planting season with the mean value of 5298.21 and 5428.98 kg/ha respectively. The use of *A. indica* extract was observed to be effective in the control of insect population and leading to maximum productivity of maize low infestation by observing the maize plant with borers tunnels to be lower in *A. indica* extracts and Karate 5 EC plots with the mean value of 3.00 and 3.00 in 2021 planting season respectively at $p<0.05$. The percentage of dead hearts at 60 days after treatment in 2021 and 2022 cropping seasons was significant at $p<0.05$%, with the control plot having the highest percentage and *A. indica* having the lowest percentage, while there was no significant difference between *A. indica* extracts and karate 5EC. It is, therefore, recommended to maize farmers in Makurdi to utilize *A. indica* plant extract in combating maize pests.

Keywords: Botanical, *Azadirachta indica, Parkia biglobosa,* Extracts, Karate 5 EC

INTRODUCTION

Maize (*Zea mays* L.) belongs to the Family *Poaceae*. It is cultivated worldwide both for local and commercial purposes (Manu, *et al.*, 2019). Maize remains one of the most important cereal crops worldwide and it is also ranked third after rice and wheat in both production and consumption worldwide (Revilla, *et al.*, 2021). In Nigeria, the maize crop is the first among the cereal crops grown (Olaniyan 2015). It is the most cost-effective and highest-yield plant resource in the world. Insect infestations are increasing as a result of the expansion of maize production to meet its demand.

The maize stalk borer (*Busseola fusca* Fuller), the pink stemborer (*Sesamia calamistis* Hampson), the millet stem borer (*Acigona ignefusalis* Hampson), and the African sugar cane borer (*Eldana saccharina* Walker); are the most important stem boring species associated with maize production in Nigeria (Polaszek 1998; Balogun and Tanimola 2001). The damage of meristematic tissues produces dead heart, which is responsible for complete plant loss in maize and this is caused by *S. calmistis*, which feed on the leaves of plants and reduce the amount of photosynthetic plant tissue as a consequence (Mailafiya, 2012). The destruction of a plant's core pith or conductive tissues by stem tunnelling leads to a decrease in the plant's ability to take in nutrients, which ultimately results in a stoppage of grain filling (Mailafiya, 2012).

Farmers and researchers prioritize minimizing the number of maize pests. As a result, there is an increasing trend to produce crops using chemicals, such as insecticides, however these chemicals have been found to be harmful to both plants and the animals that consume them (Tembo *et al*., 2018). However, their widespread and long-term use resulted in insecticide resistance and biomagnification of insecticides, resulting in export restrictions (Leng *et al.*, 2011). Botanical pesticides have been reported to keep away the insect pest, and protect the crops due to their repellent properties toxicity, growth regulation, and structural modification, making them viable alternatives for crop pest management with minimal impact on the ecosystem, as they drive away the insect pest from the treated materials by stimulating olfactory or other receptors (Ahmad *et al.*, 2017; Kushram, 2017; Rattan, 2010). Botanical pesticides are considered effective in pest control because they have low or none pesticide residue making them safe for the people, environment and ecosystem (López-Castillo *et al.*, 2018). They are one of the alternatives to conventional pesticides and a subgroup of biopesticides in agricultural pest management (Stevenson *et al.*, 2017).

In order to alleviate growing public concerns regarding the effects of synthetic pesticides on human health and environmental impact much attention has been given to botanicals pesticides in recent decades (Frison, 2016). Alternative treatments to pesticides are often derived from the neem tree, *A. indica* (Sapindales: Meliaceae). Plant parts and extracts are used for insect repellents and biological insecticides (Moyin-Jesu, 2010). Better knowledge of eco-friendly insect pest management of maize, so for all these reasons, it is essential to search the sustainable control measures using natural compounds, hence the essence of this study.

MATERIALS AND METHODS

Experimental Site

A field experiment was conducted in the 2021 and 2022 cropping seasons from March to July at the Teaching and Research Farm, Joseph Sarwuan Tarka for 12 weeks. The study area is located at latitude 07°40'N to 07°50'N, longitude 08°40'E to 08°50'E with an average altitude of 97m above sea level. Makurdi is located in the Southern Guinea Savanna Agro-Ecological Zone of Nigeria.

Source of Planting Materials

The variety of maize used was SAMMAZ-48 which was obtained from the Institute for Agricultural Research, Zaria. The experimental variety was chosen because of its adaptability to and popularity in the research region. Planting was done by hand on the ridges that had been made.

Experimental Design and Treatments

The experiment was set up in a Randomized Complete Block Design (RCBD) with three replicates on a plot size of 4m x 4m. The treatment was *Azadirachta indica* and *Parkia biglobosa*, Karate and control (no pesticide application). The land was marked out into three replications at a spacing of 1.8m between one replication and another. Each replication consisted of nine plots with a spacing of 0.5 m between one plot and another, and each plot comprised of four rows measuring 4m long. Ridges were made 75cm apart. Planting was done 1 week after ridging. Three seeds were planted per hole and thinned to one plant per stand 7 days after sowing. Weed control was carried out manually by the use of hoe weeding and cutlass after two weeks of sowing to maintain a weed-free field. Harvesting was carried out manually by dehusking when the cobs were fully matured and the ears were dry.

Preparation of Botanical extracts

Botanical extraction was done in accordance with Emosairue, (2002) with some modifications on drying. The *A. indica* and *P. biglobosa* leaves were picked at the peak of freshness, washed under running water to eliminate any remaining soil, and then rinsed three times in distilled water to ensure cleanliness. The samples were then sliced thinly and dried for three to four weeks at room temperature on benches. Each plant species' dried components were ground into powder using a Philip blender and then sieved through a muslin at the Department of Crop Production, Jospeh Sarwuan Tarka University, Makurdi. The plant powder was then separated by type and stored at 4 ^{o}C in a container. Fifty (50) grammes of plant material in 100 millilitres of sterile distilled water was formulated to give 50% w/v in a 500-millilitre conical flask at 25 ^{o}C to 28 ^{o}C for 24 hours to generate crude plant extracts. Separately, the infusion was filtered through muslin into a 400 ml beaker, yielding a stock solution. Powdered soap was dissolved in 50 ml of gin and 250 ml of distilled water to create a solution that was used as a sticker. Chemical components in the solutions were preserved by using them the same day they were prepared.

Phytochemical screening

Phytochemical analysis of *A. indica* and *P. biglobosa* extract was conducted using the methodology published by Odebiyi and Sofowora (1978) for the detection of saponins, tannins, phenolics, alkaloids, steroids, triterpenes, phlobatannins, glycosides, and flavonoids. This approach was used for the identification of the following: saponins, tannins, phenolics, alkaloids, terpenoids, steroids, glycosides and anthraquinones.

Preparation of Synthetic insecticides

The Karate 5 EC was prepared according to the manufacturer's recommended method of preparation. *S. calamistis* was recommended at a rate of 1.5–2.0 mL/L. These were made and used on the same day.

Data collection

The following data were collected during the period of the two seasons from each experimental unit for analysis: Number of leaves per plant, Leaf Length, Dead heart, Days to first tasseling, Stover weight, Number of seeds per cob row and Number of the Exit hole. Data were collected from the three central rows in each plot (net plot) by avoiding the boundaries.

Data Analysis

Data collected in the two seasons were subjected to Analysis of Variance (ANOVA) and treatment means were separated using Fischer's Least Significance Difference at 5% probability level. SAS software was used for the analysis.

RESULTS AND DISCUSSION

Phytochemical Screening of *A. indica* and *P. biglobosa*

A qualitative analysis was performed on the phytochemical (Table 1.) makeup of both *A. indica* and *P. biglobosa*. The two botanical have the presence of secondary metabolites such as alkaloids, flavonoids, saponin, terpenoids etc.

Effect of insecticides on growth performance and leaf fodder damage of *Zea mays* due to stem borer (*S. calamistis*) infestation

Table 2 displays the impact of bioinsecticide on maize growth. At 45 and 60 days after planting, the mean number of leaves was not substantially different between the botanical and synthetic insecticides during the 2021 and 2022 planting seasons. While the leaf length was significant at 45 days after planting during the 2021 cropping season, where the synthetic insecticide value for leaf length was 27.10 cm, *A. indica* and *P. biglobosa* were not significantly different from it with values of 25.63 and 22.37 cm, respectively (p>0.05). At 45 and 60 days after treatment in the 2022 cropping season, there were significant differences between treatments, with Karate 5EC having the highest mean value on both days (27.10 and 33.30 cm). The leaf fodder damage percentage at 60 days after treatment was substantial in the 2021 and 2022 planting seasons, with the mean value of control showing a high value of damage and karate displaying a lower value of damage of 2.27 and 3.2%, respectively.

Influence of insecticides on maize reproductive stage and yield parameters due to stem borer (*S. calamistis*) infestation

The percentage of dead hearts at 60 days after treatment in 2021 and 2022 cropping seasons were significant at p<0.05%, with the control plot having the highest percentage of dead hearts and *A. indica* having the lowest percentage, whereas there is no significant difference between *A. indica* extracts and karate 5 EC (Table 2). Days to tasselling in 2022, the control plots had a value of 80 days, whereas the days to tasseling for synthetic karate were 64.32, which was substantially distinct from *P. biglobosa*, which had values of 74.00 in 2021 and 79.56 in 2022. One hundred seed weight mean value was substantially different in terms of the botanical compared to the control plot, with the control plot having the lowest mean value of 11.47 g and 10.2 g, and the cropping seasons 2021 and 202 being significant at p < 5%. Stem borer egress was statistically significant during the 2021 and 2022 planting seasons, and the control plot had the highest mean value of 14.00 and 15.67 in both years. There was also a statistically significant difference between bioinsecticides and synthetic insecticides. The lowest yield was recorded in 2021 planting season in the control plots which is 3285.39 kg/ha while *P. biglobosa* had a mean value of 4782.16 kg/ha which is significantly different at p<0.05 from the control plot but lower than the expected yield of Sammaz 48 which is projected to 7.8 kg/ha (Table 2). *A. indica* extract performed better than *P. biglobosa* in both 2021 and 2022 planting season with mean value of 5298.21 and 5428.98 kg/ha respectively and this was not significantly differently from Karate 5EC which had 5562.93 and 5559.34 kg/ha in 2021 and 2022 growing season.

Table 1: Phytochemical Screening of *A. indica* and *P. biglobosa* extract

Chemical Test	*A. indica*	*P. biglobosa*
Alkaloids	+	+
Anthraquiones	-	-
Flavanoids	++	-
Saponins	+++	++
Steroids	+++	+
Tannins	++	+
Glycosides	++	+
Terpenoids	+++	+

+++ High concentration; ++ Moderate concentration; + Low concentration; - Absent

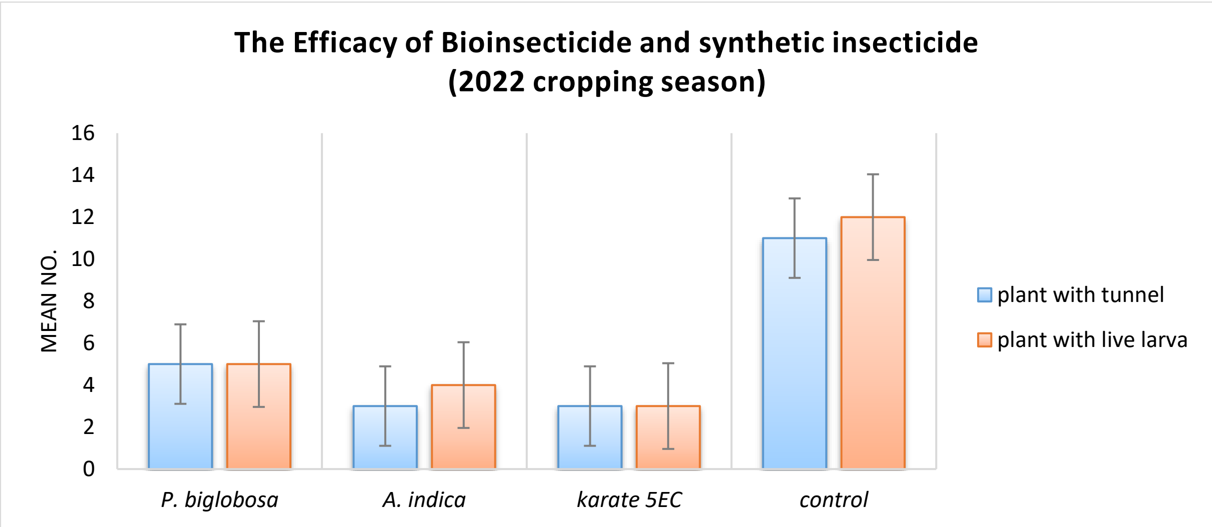

Figure 1: Showing the Efficacy of Bioinsecticide and synthetic insecticide on borer tunneling and number of live larva (2021 cropping season)

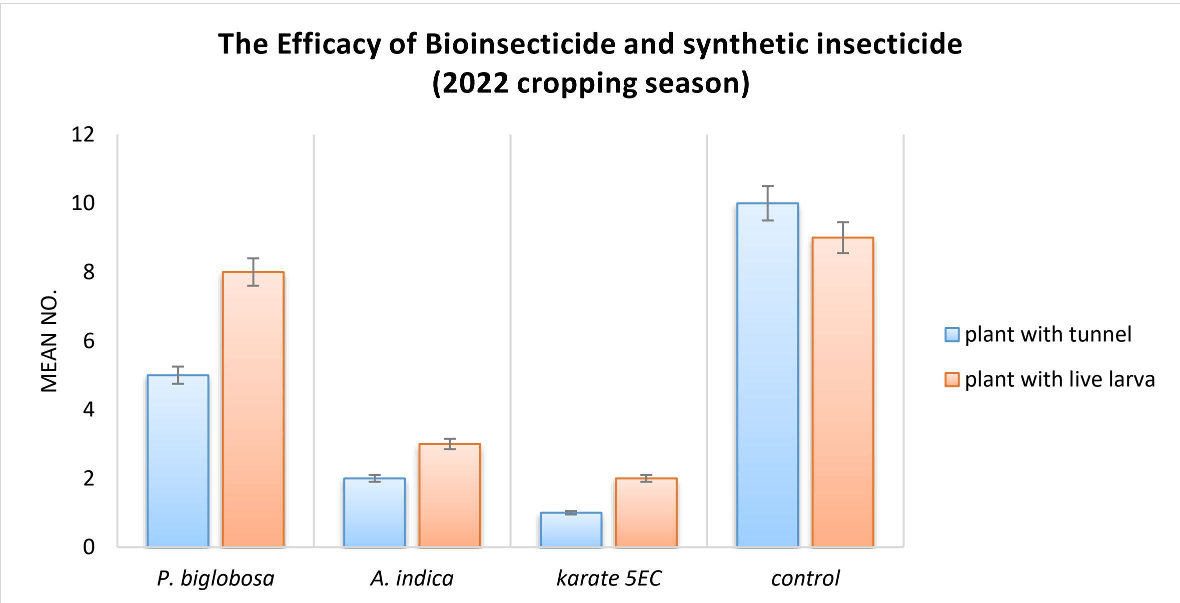

Figure 2: Showing the Efficacy of Bioinsecticide and synthetic insecticide on borer tunneling and number of live larva (2022 cropping season)

Table 2: Effect of insecticide on the vegetative parameters of Maize

Treatments	Number of Leaves				Leaf Length (cm)				Leaf folder damage (%)	
	2021		2022		2021		2022		2021	2022
	45	60	45	60	45	60	45	60	45	60
P. biglobosa	5.37	8.37	6.37	9.13	22.37	32	22.42	25.73	4.53	3.47
A. indica	6.03	8.87	6.33	9.33	25.63	31.97	25.63	32.7	4.93	3.4
Karate 5EC	6.43	8.6	6.43	10.13	27.1	34.07	27.1	33.7	2.27	3.2
Control	5.27	8.77	8.27	10.27	20.53	30.63	19.53	21.7	9.77	6.9
SEM	0.42	0.39	1.32	0.73	1.89	2.88	2.89	0.725	0.713	0.516
CV	12.5	0.89	9.5	12.9	13.7	15.5	10.17	12.9	21.2	21.1
LSD (5%)	1.359	5.5	3.359	2.36	6.16	9.38	3.16	2.364	1.645	0.730
	NS	NS	NS	NS	**	NS	**	**	**	**

NS- not significant; ** Significant at p<0.01; * significant at p<0.05; DAT- Days After Treatment

Table 3: Effect of insecticide on the reproductive parameters and yield of Maize

Treatments	% Dead Heart (DH)				Day to Tasseling		100 seed weight (kg/ha)		Stover Weight(kg/ha)		Exit Hole		Grain Yield Kg/ha	Grain Yield Kg/ha
	2021		2022		2021	2022	2021	2021	2021	2022	2021	2022	2021	2022
	45	60	45	60										
P. biglobosa	14.72	15.9	13.50	11.83	74.00	79.56	15.77	16.97	711.77	823.19	9.33	11.33	4782.16	4517.12
A. indica	10.67	9.70	11.50	9.20	68.67	65.24	21.53	20.42	1533.90	2098.34	7.33	5.01	5398.21	5428.98
Karate 5EC	7.23	6.77	7.70	6.95	65.33	64.32	20.50	22.55	1709.20	2138.20	8.33	5.63	5562.93	5559.34
Control	20.24	23.33	18.4	17.50	74.00	80.00	11.47	10.47	334.07	456.25	14.00	15.67	3285.39	3429.17
SEM	8.45	2.10	4.45	7.89	5.85	4.89	2.18	3.19	291.80	207.73	1.38	5.08	30.76	54.89
CV	22.00	12.20	12.32	12.34	14.40	12.63	20.30	10.98	47.10	32.76	33.10	12.65	22.23	12.98
LSD (5%)	6.67	6.85	4.67	4.67	19.08	5.13	3.01	4.72	951.5	617.32	4.52	3.73	519.34	467.32
	*	**	*	**	NS	*	*	*	**	**	**	**	**	**

NS- not significant; ** Significant at p<0.01; * significant at p<0.05; DAT- Days After Treatment

Discussion

According to the findings of Collares *et al*., 2023, the investigation revealed the existence of phytochemicals that exhibit insecticidal effects (Table 1). When compared to *P. biglobosa*, the concentration of secondary metabolites found in *A. indica* is much higher. *P. biglobosa* and *A. indica* plant extract reduce the percentage of dead heart which were significant (Table 2) also Karate 5EC was observed to be effective in reducing the percentage of dead heart at the late growth stage while *A. indica* was most effective in reducing the insect population in the reproductive stage. This finding agrees with Purwani *et al*., (2017) who reported that liquid biopesticide formulations from leaf extract could easily reduce the level of leaf damage due to attack of insect pests.

P. biglobosa and *A. indica* extract had a significant effect on the number of live larvae of *S. calamistis* per plant. The bioinsecticides utilized reduced insect population observed per plant. However, the least insect population was observed on maize treated with *A. indica*. The findings agree with Akhigbe (2021) and Tavares *et al*. (2010) who reported that *A. indica* extracts have effect in protecting the maize plants from stem borer infestation and its oil possesses an anti-feeding effect which increases larval mortality on Lepidoptera.

According to Lawal et al., 2010 and Nzanza et al., 2011, noticed that extract from *A. indica* is useful in enhancing plant growth and yields. The study revealed that leaf length increased significantly due to the use of *P. biglobosa* and *A. indica*. This result also agrees with the finding of Moyin-Jesu (2010) who noted that the balanced nutrient composition of neem leaf extracts especially % N, P, K, Ca and Mg would have also added to the nutrient supply of maize plant and aided their growth parameters of maize. The research findings also corroborates with Bruce *et al.* (2004) who also reported oviposition deterrence and low fecundity of *S. calamistis* and *Elderna saccharina* which was compared with the control experiments.

Moyin-Jesu (2010) reported that among the treatment extracts, modified *A. indica* leaf was the most effective in reducing insect population, number of tunnels per plant, this corroborates with our findings in the two cropping seasons where the *A. indica* was performing statistically significantly as a bioinsecticides. Treatments had no significant effect on the number of days to tasseling in 2021 but were significant in 2022. This may be attributed to inherent characteristics of the cultivars used or the environment in which the cultivar was grown.

Bioinsecticides exerted a significant effect on hundred seed weigh (Table 2). This result agree with the finding of Moyin-Jesu (2010) who noted that the balanced nutrient composition of neem leaf extracts especially % N, P, K, Ca and Mg would have also added to the nutrient supply of maize plant and aided their growth parameters and yield of maize. Bioinsecticide was observed to increase stover of maize significantly with the use *A. indica* plant extract being the most effective (Table 2). This finding agrees with Akhigbe (2021) who reported occurrence of established damages on the foliar part of maize caused reduced photosynthetic area which resulted to yield loss in the non-treated maize plants when compared to the treated maize plants Bioinsecticide exerted no significant effect on cob weight per hectare (Table 2). However, *A. indica* had the highest grain yield per hectare. This finding agrees with Akhigbe (2021) who reported occurrence of established damages on the foliar part of maize caused reduced photosynthetic area which resulted to yield loss in the non-treated maize plants when compared to the treated maize plants. Bioinsecticide had a significant effect on stover weight per hectare (Table 2). However, it was observed that Karate 5 EC and *A. indica* contribute greatly to the stover weight per hectare. This result agrees with the finding of Moyin-Jesu (2010) who noted that the balanced nutrient composition of neem leaf extracts especially % N, P, K, Ca and Mg would have also added to the nutrient supply of maize plant and aided their growth parameters and yield of maize. The finding agrees with the evidence reported by Akhigbe *et al*. (2021) who indicate that bioinsecticide (*A. indica* extract) reduces insect population, which in turn increases the growth performance parameters of crops.

CONCLUSION

Based on these data, it could be justified to draw the conclusion that aqueous extracts derived from botanical plants of *A. indica* and *P. biglobosa* have exhibited considerable reductions in stem borer occurrences as well as pest load in maize crops. The levels of effectiveness for the test applications of botanical pesticides, particularly those containing *A. indica* extract, were equivalent to those of the synthetic insecticide Karate 5EC. The use of aqueous extracts promises to lower the stemborer insect pest burden, in comparison to the untreated control, by corresponding grain yield improvements, according to the current research. *A. indica* and *P. biglobosa* are natural and sustainable alternatives to synthetic pesticides. Its potent insecticidal properties make it a great option for controlling a wide range of pests, including stem borers. *A. indica* and *P. biglobosa* disrupt the lifecycle of insects by inhibiting their nutrition, reproduction, and growth. In addition, is safe to use around humans, beneficial insects, and other animals because it poses no substantial risks and does not leave hazardous residues.

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