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Efficacy of *Fagara zanthoxyloides* and *Kigelia africana* Extracts in Protecting Sugarcane Against Subterranean Termites

Lamidi, A. A. and Oni, M. O.

Department of Crop, Soil and Pest Management, Federal University of Technology, Akure, Ondo State, Nigeria

Correspondence: adexco2017@gmail.com

ABSTRACT

The efficacy of aqueous extracts from Fagara zanthoxyloides and Kigelia africana was evaluated and compared to the insecticide, Dichlorvos (DDVP), for controlling termite Infestation in sugarcane field experiment. The experimental materials used for the study were obtained from FUTA Teaching and Research farm and National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Oyo State. Results revealed that extract of F. zanthioxyloides at 60% concentration promoted the highest sprouted setts in the 4th, 5th and 6th weeks after planting (WAP). However, the control treatment showed the highest percentage sett establishment of 94.44% which was significantly dfferent from the botanical treatments. At 20th WAP, sugarcane treated with F. zanthoxyloides extract at 60% concentration produced the highest number of tillers which was significantly different from the other treatments. Similarly, this same treatment F. zanthoxyloides resulted in the highest number of leaves at 10th, 15 and 20th WAP and there were no signifant difference among the other treatments. For plant height evaluated, K. africana extract at 80% concentration recorded the highest values at the 10th and 15th WAP. The largest leaf area was observed in setts treated with F. zanthoxyloides extract at 60% concentration followed by its 40% concentration and they were significantly different from the other treatments. The study demonstrates that extracts from both K. africana and F. zanthoxyloides can effectively function as botanical termicides to protect sugarcane against subterranean termite Infestation in the field.

Keywords: *Fagara zanthoxyloides, Kigelia africana,* Sugarcane Sett, Temite Infestation, Termcidal.

Introduction

The battle for survival between human and insects has persisted since time immemorial, largely because they share the same sources. However, the ease with which insects reproduce and multiply coupled with their ability to cause infestation in both field and storage conditions has nearly won them the battle (Ogungbite *et al*., 2014). The widely accepted use of plant-based insecticides in the control of insect-pest of crops cannot be overemphasized owing to the numerous benefits confers on the crop, the users of the product and the environment. In an attempt to curb incessant use of chemical insecticides, crop protectionists have devised the alternative approach to combat the detrimental effects of synthetic chemical insecticides. Consequently, many medicinal plants and spices have been utilized as pest control agents (Ofuya and Dawodu 2002; Ashamo 2007). Many of these botanical solutions have been analyzed to be user-friendly exhibiting little or no mammalian toxicity (Elango *et al*., 2012), being safe to many non-target organisms (Asogwa *et al*., 2010; George *et al*., 2010; Issakul *et al*., 2011; Pavela 2013, 2014)

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and possessing the ability to be easily decomposed in the environment (Turek and Stintzing, 2013). In the quest to attain food security, there must be a push for a healthier crop protection method. This ensures that the food available in the market are safe for human consumption and able to meet their nutritional requirements.

Sugarcane (*Saccharum officinarum* L.) is one of the most important crops in the world due to the strategic position it occupies in the lives of many nations. Sugarcane contributes about 60% of the total world sugar requirement while 40% are from sugar beet (Onwueme, 2005). While its importance in the daily nutritional requirements of human beings cannot be underestimated, its cultivation is however faced with problem of termite infestation both during the sett sowing stage and active growth stage (Bhagawati *et al*., 2017).

Termites are polyphagous insect-pests that cause damage to commercial wood, fibers, cellulose sheets, papers, clothes, woolen and woody materials, millet, sugarcane and cereals during storage (Upadhyay *et al*., 2012). Termites affects man's crops, his wooden structures as well as forest products because of their ability to digest cellulose (Mahaipatro and Sreedevi, 2014). Subterranean termites are the major problem attacking sugarcane crop from its germination through shoot emergence and subsequently affects the quality of canes produced. Koto *et al*., (2000) reported that termites live in the soil and damage sugarcane by excavating through the cane setts, leading to the death of buds and young shoots. There is no gainsaying in establishing the fact that the nuisance caused by termites has a huge effect on man, his crops, and the environment. The pestiferous activities of termite have been tackled through the use of synthetic insecticide such as Cyclodiene (Buoe and Raina; 2003), Cypermethrin (Valles and Woodson; 2002), hydroquinone and indoxocarb (Hu; 2005). However, despite their efficacy, there is a need to redirect the control strategy by focusing more on the use of botanical insecticides. Therefore, this present work investigated the reduction of sugarcane losses by termite infestation through the use of extracts from *Fagara zanthoxyloides* and *Kigelia africana*.

Materials and Methods

Study Site/ Collection of Plant Materials

The experiment was carried out at the Teaching and Research Farm of the Federal University of Technology, Akure (FUTA). The two plant materials (*Fagara zanthoxyloides* and *Kigelia africana*) used for this experiment were obtained from NACGRAB Ibadan, Oyo State and the sugarcane setts for planting were from FUTA Teaching and Research Farm, while DDVP and distilled water were from department of Crop, Soil and Pest Management, FUTA.

Experimental Design and Land Preparation

The experimental design was a Randomized Complete Block Design (RCBD) with eight treatment levels. Each treatment was replicated three times and these are; K40, K60, K80, F40, F60, F80, DDVP and Control. The selected and cultivated soil was loamy soil and poultry manure was applied after making the bed manually before planting of the cane setts a week after using cutlasses.

Preparation of Plant Extracts

1 kg each of the two plant materials were immersed in distilled water at a sample: solvent ratio of 1:10 (w/v) for 24 hours at 60°C. The extracts were then filtered using the filter paper and air-dried before storing them at a room temperature prior to further experiments. Each of the extract were serially diluted into 40%, 60% and 80% concentrations which are low, medium and high concentrations respectively. The standard control for the research was DDVP and one control using distilled water.

Preparation of Sugarcane Setts/ Treatment Evaluated

Each cane setts were cut to consist of at least 2 nodes and they were all soaked into different concentrations of the two plant extracts under treatment and solution of standard control as shown below.

Kigelia africana (Lam.): evaluated at 40%, 60% and 80% concentration
Fagara zanthoxyloides (Lam.): evaluated at 40%, 60% and 80% concentration
Standard control (DDVP): 0.05% concentration
Control using distilled water.

Planting of Cane Setts/ Weed Control

The cut cane setts were horizontally planted on the already prepared beds using cutlass. The inter-row and intra-row spacing was 0.5m x 0.5m respectively and weeding was done manually every two weeks.

Data Collection

Data were collected on the following parameters; Sett sprouting; this was determined at 4, 5 and 6 Week after Planting (WAP), Percentage mortality by termite infestations (6 WAP), Number of Tillers (15 and 20 WAP), Plant height and Number of leaves (10, 15 and 20 WAP), Leaf Area (22 WAP) using metre ruler.

Statistical Analysis

All data were subjected to analysis of variance (ANOVA) using Minitab 17 software package and means were separated with Tukeys Test at 5% level of probability.

Results

Effect of Plant Extract on Set Sprouting of Sugarcane

The effects of plant extract on the set sprouting of sugarcane is presented in Table 1. Significant differences (p 0.05) were observed among the treatments evaluated. Extract of *Fagara zanthoxyloides* at 60% concentration had significantly highest germinated set on the 4th, 5th and 6th weeks after planting with values of 5.95, 6.30 and 7.95. DDVP had significantly lowest number of setts on the 4th and 5th weeks after planting. There were no significant differences between the control treatment, *Kigelia africana* extract at 80 % concentration and Fagara zanthoxyloides extract at 80 % concentration. However, Kigelia africana extract at 80 % concentration recorded the lowest number of germinated setts.

Table 1. Effect of plant extract on sett sprouting of sugarcane.

Plant extracts	Weeks after planting		
	4	5	6
K40	3.98ab	5.62ab	6.30abc
K60	4.00ab	4.32abc	7.67ab
K80	3.31b	3.96abc	4.67c
F40	3.65b	5.34ab	6.30abc
F60	5.95a	6.30a	7.95a
F80	2.31b	3.65bc	5.02c
DDVP	2.31b	2.96c	5.66bc
Control	3.31b	4.33abc	4.97c

Means in a column with the same letter(s) are not significantly different by Tukey's test at P≤0.05.

Legend: K40 *(Kigelia africana extract at 40 % concentration),* K60 *(Kigelia africana extract at 60 % concentration),* K80 *(Kigelia Africana extract at 80 % concentration),* F40 *(Fagara zanthoxyloides extract at 40 % concentration),* F60 *(Fagara zanthoxyloides extract at 60 % concentration),* F80 *(Fagara zanthoxyloides extract at 80 % concentration),* DDVP *(*Dichlorvos: Synthetic insecticide*),* Control *(*Distilled water*).*

Effect of Plant Extract on Percentage Termite Infestation

The effects of plant extract on the percentage termite infestation of sugarcane sett are reported in Figure 1. Significant differences (P ≤ ≤ 0.05) were observed among the treatments evaluated. Sugarcane sett treated with DDVP had significantly lowest infestation with a value of 33.30% infestation followed by F60.

Effect of Plant Extract on Number of Tillers of Sugarcane

The effect of plant extracts on number of tillers produced by sugar cane sett is shown in Figure 2.

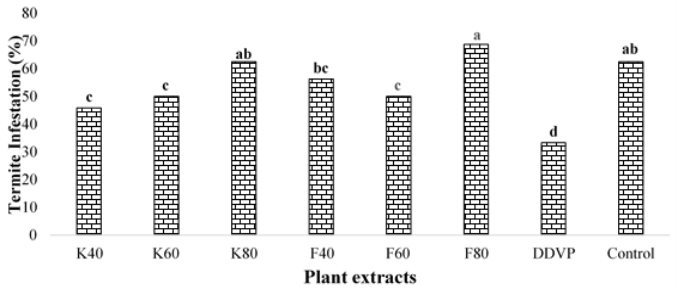

Figure 1. Effect of plant extract on percentage termite infestation of sugarcane. Bar columns with the same letter(s) are not significantly different by Tukey's test at P≤0.05.

Significant differences (p 0.05) were observed among the treatments at the period of evaluation. At the 15th week after planting, there were no significant

differences between DDVP and F40 as they recorded 1.28 each for number of tillers. At the 20th week after planting, F60 produced the highest number of tillers (4.00) which was significantly different from all other treatments while DDVP and control treatments

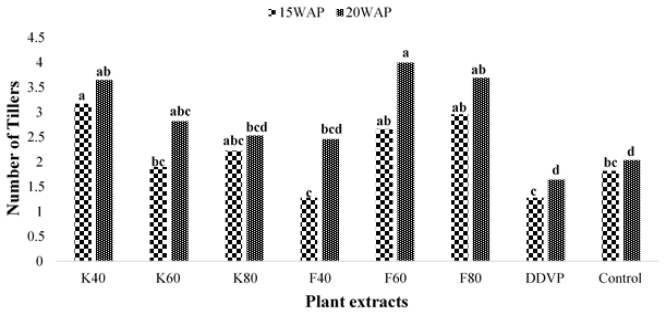

Figure 2. Effect of plant extract on number of tillers of sugarcane Bar columns with the same letter(s) are not significantly different by Tukey's test at P ≤0.05.

produced the significantly lowest number of tillers which were not significantly different from each other with values of 1.64 and 2.04 respectively.

Effect of plant extracts on number of leaves of sugarcane

The effect of plant extracts on number of leaves produced by sugar cane sett is shown in Table 2. There were no significant differences among treatments evaluated except for DDVP that recorded the significantly lowest number of leaves with values of 5.06, 6.30 and 7.45 respectively across the weeks after planting.

Table 2. Effect of plant extract on number of leaves of sugarcane.

Plant extracts	Number of leaves		
	10	15	20
K40	6.20a	7.84a	8.70a
K60	5.81a	7.24a	8.47a
K80	6.35a	7.67a	8.64a
F40	6.00a	7.62a	8.41ab
F60	6.35a	8.01a	8.94a
F80	6.25a	7.95a	8.88a
DDVP	5.06b	6.30b	7.45b
Control	6.20a	7.24a	8.64a

Means in a column with the same letter(s) are not significantly different by Tukey's test at P ≤ 0.05.

Effect of Plant Extract on Height of Sugarcane

The effect of plant extracts on height of sugar cane is presented in Table 3. Significant differences (P ≤ ≤0.05) were observed among the treatments evaluated. DDVP recorded the significantly lowest sugarcane height on the 10th, 15th and 20th weeks

Table 3. Effect of Plant Extract on Height of Sugarcane.

Treatment	Plant height/ Weeks after planting		
	10	15	20
K40	13.93d	24.60ab	33.87a
K60	14.50cd	22.70bc	23.77d
K80	19.43a	26.60a	29.93b
F40	17.73ab	27.30a	30.03b
F60	13.30de	24.83ab	27.77c
F80	16.10bc	21.57cd	22.80de
DDVP	11.67e	19.50d	21.97e
Control	14.77cd	21.73cd	24.53d

Means in a column with the same letter(s) are not significantly different by Tukey's test at P≤0.05.

after planting with values of 11.67 cm, 19.50 cm and 21.97 cm while K80 recorded the significantly highest height on the 10th and 15th week after planting.

Effect of Plant Extract on Leaf Area of Sugarcane

The effect of plant extracts on leaf area of sugar cane is presented in Figure 3. Significant differences ($P \leq 0.05$) existed among the treatments evaluated. F60 had the highest leaf area of 306.80 cm^2 at 22 WAP and was significantly different from the other treatments.

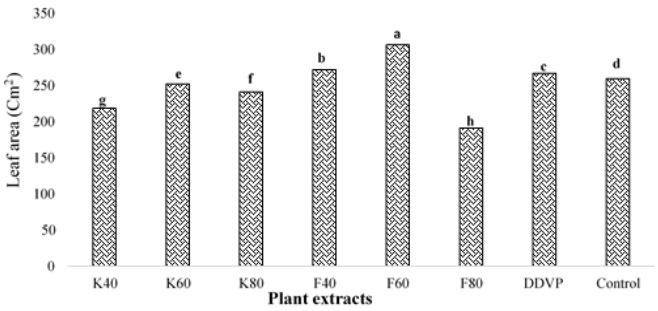

Figure 3. Effect of plant extract on leaf area of sugarcane Bar columns with the same letter(s) are not significantly different by Tukey's test at $P \leq 0.05$.

Discussion

The results of this research work showed that *F. zanthoxyloides* and *K. africana* have termicidal properties in the control of termites infesting sugarcane field. The result revealed that *F. zanthoxyloides* at 60% concentration recorded the highest number of setts. The phenolic compounds such as tannins, saponins, flavonoid present in the plant material which exhibit different mechanism of actions might have resulted in enzyme inhibition, oxidative phosphorylation reduction and iron deprivation in termites. This result agreed with the work of Oluwatosin *et al.,* (2019), who assessed oil of *Fagara zanthoxyloides* for active compounds effective against termite infestation. The high sett sprouted recorded for both plant extracts at relatively mild concentration might have been as a result of disruption of the normal respiratory activities of termites. This result is consistent with previous studies that demonstrated the efficacy of botanical extracts such as *Azadirachta indica, F. zanthoxyloides, Anacardium occidentale* and *Moringa oleifera* as protectants (Ogungbite 2015; Oni 2014; Oni and Ogungbite 2015). The low termite infestation recorded for the *Fagara zanthoxyloides* may be due to pungent compounds in the root, which could have irritated the termite's sensory organs and led to their death. This can be linked to the previous work of Ogwal-Okeng *et al.* (2003) who reported that *F. zanthoxyloides* root back induced seizure and substantial damage to the liver and kidney, resulting in mortality in mice that received large doses of the extract. The result from this study revealed an increment in growth parameters of sugarcane in terms of number of tillers, number of leaves and leaf area while *Kigelia africana* recorded the highest height at 80% concentration.

The observed reduction in termite infestation, resulting from the application of the botanical extracts, may have directly contributed to the improved sugarcane growth parameters by minimizing plant damage. Furthermore, it is possible that the extracts had a sublethal physiological effect on the termites. This hypothesis is supported by previous studies which indicate that certain botanical insecticides and synthetic pesticides can disrupt physiological processes in insects, including the alteration of hemolymph protein levels, potentially through the impairment of organ function (Oni *et al.,* 2022; Gowda *et al.,* 2010). Such physiological disruption could theoretically affect vital activities like reproduction.

Conclusion

In conclusion, the root extract of *Fagara zanthoxyloides* and fruit extract of *Kigelia africana* demonstrated high termicidal potential against termite infestation. The application of these extracts resulted in low percentage of termite infestation and a corresponding increase in the growth parameters of sugarcane. Statistical analysis revealed that relatively low to moderate concentrations of the extracts were sufficient to achieve this reduction in infestation in the treated cane setts.

Conflict of Interests

The authors have declared that no competing interests exist.

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