

Efficacy of Neem Seed Extracts on Maize Stem Borers Infestation and Yield Performance as Affected by Stem Borers

ABSTRACT

Maize is cultivated throughout the ecological zones of Nigeria, and it is demonstrated with a high yield potential in savanna regions. It is cultivated under a broad range of climatic conditions. Maize is the most cost-effective and highest yield plant resource in the world. It serves as a material for the production of livestock forage; fodder and feed in sub-Saharan Africa. Lepidopteran stem borers are a major pest of maize and can cause losses between 10-70% in maize. Field bioassays were conducted to determine efficacies of neem seed kernel extracts in the control of maize stem borers. The results showed that neem seed kernel extracts significantly ($P=0.05$) reduced stem borer damage on maize plants in terms of dead hearts and stem borer holes; reduced the infestation and development of the stem borers and also significantly ($P=0.05$) increase grain yield by 6.98% (NSO), 5.63% (NSP), and 4.45% (NSAE) above the control (untreated). The order of the efficacy of neem seed kernel extracts is: NSO>NSP>NSAE. It is suggested that neem as biopesticides, may be suitable as alternatives to synthetic pesticides which are not eco friendly, and toxic to users, for the management of maize stem borers, especially in Nigerian.

Key Words: Efficacy, neem, maize, stem borer, yield.

Introduction

Maize (*Zea mays* L.) belongs to the Family of Gramineae. It is cultivated worldwide both for local and commercial purposes [1]. Maize remains one of the most important cereal crops worldwide [2], and it is also ranked third after rice and wheat in both production and consumption worldwide [3]. In Nigeria, maize crop is the first among the cereal crops grown [3]. Cultivated throughout the ecological zones of Nigeria, maize is also demonstrated with a high yield potential in savanna regions [4]. It is the most cost-effective and highest yield plant resource in the world [2]. It serves as a material for the production of livestock forage, fodder and feed in sub-Saharan Africa [2], and a raw material for manufacture of many industrial products [5] and recently being used as biofuel [5].

The most important field pests of maize are lepidopterous stem and cob borers belonging to the families of Noctuidae and Pyralidae [6]. Several species of maize stem borers have been reported worldwide. The most common ones are *Sesamia calamistis* (Lepidoptera: Nuctuidae), *Eldana saccharina* (Lepidoptera: Pyralidae), *Busseola fusca* Fuller (Lepidoptera: Noctuidae) and *Chilo partellus* (Lepidoptera: Pyralidae). Stem borers have reported to cause great damage to crops across Africa. Stem borers cause considerable yield losses of maize and sorghum [7]. Yield losses due to stem borers range from 10 to 100% [8]. The initial damage of stem borers is caused by feeding on the leaf tissues, followed by tunneling and feeding within the stem, and sometimes the maize cobs [8].

Controlling these insect pests is difficult because most part of their life cycles is spent inside the plant which serves as a physical protection to insecticide application [9], and are costly and are environmentally not friendly [10].

However, the use of botanicals for the control of agricultural pests are considered environmentally friendly; besides they are cheap, readily available and affordable which is an important factor for farmers in developing countries especially, Nigeria. More so, the interest in the use of biopesticides is on the increase in the recent years particularly in cropping system, where the use of natural enemies are being emphasized as a major component of integrated pest management [11]. The efficacies of botanicals are largely demonstrated in insect management and have been advocated for use by resource poor farmers [12].

The neem tree *Azadirachta indica* A. Juss (Meliaceae), has been widely studied because it presents a great number of compounds with insecticides properties which can effectively reduce the population of several insect pests [13]. It is generally believed that the bioactivity of neem is due to its complex limonoids that suppressed the feeding, growth and reproduction aspects of the pest insects [14], and thus have been used in many integrated pest management programs [15]. Therefore, in this study, the effects of neem seed kernel extracts on maize stem borer control, and yield performance as affected by stem borers, were evaluated.

Materials and Methods

Study Location

The study location is Bazza, in Michika Local Government Area, located on 13°12'E to 13°34'E and 10°22'N to 10°45'N (Figure 1). The average annual rainfall of Michika is 753.5mm, and characterized by two climatic seasonal patterns, the wet season which runs between May to October and the dry season which runs between November to April [16]. The heaviest rain is experienced between July and August. During the rainy season, the relative humidity is high [17]. Highest temperature of about 34°C is recorded in the months of March and April, while lower temperature of about 15°C is experienced in the months of December and January. Michika is also typical characteristic of the Sudan savanna, with low grasses and scattered trees.

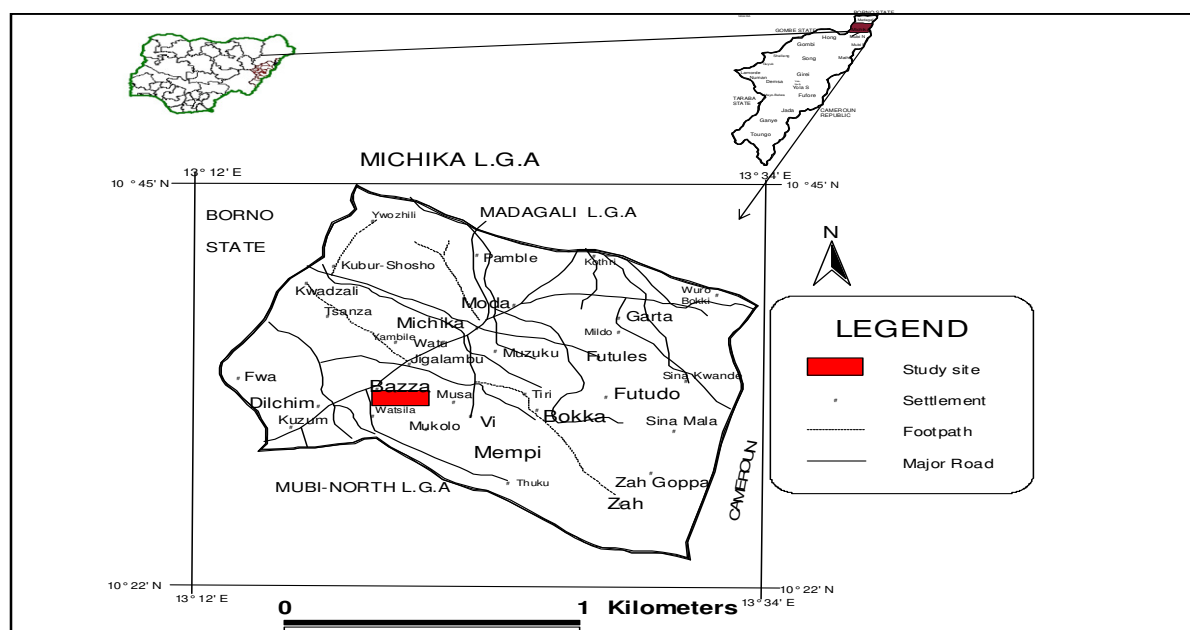


Figure 1: The Map of Michika L.G.A. Showing the Study Site (Bazza). In the Inset is the Map of Adamawa State, and Nigeria.

Source of Treatments (Neem Seed Extracts)

The neem seed treatments were sourced as follows:

Neem seed powder (NSP): The neem seeds collected were sun-dried for seven (7) days and decorticated to remove the kernels. The kernels were ground into fine powder using electric blender and were stored in a bottle with screw cap top.

Neem seed oil (NSO): A portion of the powder was mixed thoroughly while adding hot water in little quantity. The mixture continues until oil comes out of the dough. This was collected and was stored in a bottle with screw cap top under laboratory conditions.

Neem seed aqueous extract (NSAE): 75g portion of the powder sample was subsequently constituted by soaking it in a litter of distilled water. It was allowed to stand for about 24 hours and thereafter, filtered through double folds of Muslin cloth to obtain the filtrate. This filtrate formed the aqueous neem seed extract [18].

Source of maize seeds

Clean maize seeds were obtained from a farmer in Bazza. The seeds were treated using Dress Force (20% imidacloprid, 20% metalaxyl-M, 20% WS Tebuconazole) before planting.

83 Experimental Design

84 The experimental design used was 4 x 4 factorial arranged in a Randomized Complete Block
85 Design (RCBD), with four replicates. The size of each plot is 6m x 2m as shown below:

Replicate 1	Replicate 2	Replicate 3	Replicate 4
NSAE	NSO	NSP	CTRL
NSP	CTRL	NSAE	NSO
NSO	NSAE	CTRL	NSP
CTRL	NSP	NSO	NSAE

86 *Where CTRL = Control (Untreated)*

87 Preparation of Land and Sowing

88 A portion of land was cleared in a farm field in Bazza in July, 2013. It was subsequently ploughed
89 and harrowed to soften the land. The number and size of plots used for the experiment was measured
90 from the ploughed and harrowed farm land as shown above before planting. The planting took place
91 immediately after the land preparation. About 3 to 4 seeds were planted per hole, but after germination,
92 they were subsequently thinned to two per hill, and urea fertilizer was applied at three weeks and six
93 weeks interval after planting [19].

94 Method of Treatments Application

95 The application of treatments started four weeks after planting, and it continued subsequently
96 with three days interval of ten times application in all, as described below:

97 **NSP:** This was applied manually using hands, and it applied on the leaves and whorl of the maize plants.

98 **NSO:** This was applied using hand pump. It was applied on the entire plants' stem as well as the leaves.

99 **NSAE:** This was also applied using hand pump separately from the one for NSO, but similar method.

100 Data Collection

101 Data were collected on the following parameters for each treatment: Dead hearts, borer holes,
102 yield quantity, percentage yield gained and number of stem borer (larvae, pupae and adults), as follows:
103 Number of dead hearts were recorded as observed over time; the borer holes count was done prior
104 before harvest-the entire maize stems were stripped off their covering leaves and were observed for the
105 incidence of borer holes. The number maize cobs were also counted and recorded during harvest. The
106 maize cobs were shelled and dried to constant weight in an oven at 30°C to 35°C before weighing the
107 yield quantity in grams (g), while the percentage yield gained was determined by subtracting the amount
108 of the control yield from the treatment yield, and subsequently calculating the percentage. Number of

stem borers were also noted and recorded by uprooting the maize plants and dissecting each of the stem for the incidence of stem borers, immediately after the cobs were harvested.

Data Analysis

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

Results

Table 1 shows the incidence of dead hearts and borer holes on the experimented maize plants. The result shows that there is no significance difference between the treatment (Neem extracts) and the control (untreated) in the incidence of dead hearts at 5% probability level. Although the neem extracts showed some promising effects especially in NSO and NSAE where no dead heart (0.00 ± 0.00) was recorded respectively. The number of borer holes noted on the stem of the maize plants followed similar trend with the results noted for dead hearts incidence, as the control recorded the highest (4.25 ± 1.17). NSO and NSAE were also superior in the reduction of the incidence of borer holes just as in the case of the incidence of dead hearts.

In Table 2, the number of stem borer infestation is shown. There is no significance difference ($P=0.05$) between the neem extract treated maize plants and the control (untreated) maize plants in the infestation of both the larval and pupal stages. Meanwhile, in the adult stage, the control recorded a significantly higher (3.50 ± 1.00) number of adult stage infestation than the neem treatments as shown.

There is a significance relationship between the stem borer's incidence and the grain yield performance. Although, there is no significance difference ($P=0.05$) in the number of maize cobs recorded during the harvest between the control and the neem seed treated plots, plots treated with neem seed extracts produced significantly higher quantity of grain yield than the untreated plots (control) as shown in Table 3. Percentage yield gained also indicated the efficacy of the neem seed kernel extracts in protecting the maize plants in the field. Neem seed oil recorded a percentage yield gained of 6.98 ± 6.0 , followed by NSP (5.63 ± 4.49), and then NSAE (4.45 ± 2.38).

Table 1: Incidence of dead hearts and borer holes on the maize plants.

Treatments	No. Dead hearts	No. of borer holes
CTRL	0.75 ± 0.96^a	4.25 ± 1.71^b
NSP	0.50 ± 0.58^a	2.75 ± 0.96^{ab}
NSO	0.00 ± 0.00^a	1.50 ± 1.29^a
NSAE	0.00 ± 0.00^a	1.75 ± 1.50^a

Values are means of four replicates. Means carrying the same superscript alphabet along the columns are not significantly different at 5% probability level.

Table 2: Stem borer infestation on maize plants

Treatments	Stem Borers		
	Larval Stage	Pupal Stage	Adult Stage
CTRL	2.75±2.22 ^a	1.50±1.29 ^a	3.50±1.00 ^b
NSP	2.50±1.00 ^a	1.75±0.96 ^a	1.25±1.26 ^a
NSO	0.75±0.96 ^a	1.25±1.89 ^a	1.75±1.26 ^{ab}
NSAE	1.25±1.26 ^a	2.00±0.82 ^a	1.50±1.00 ^a

Values are means of four replicates. Means carrying the same superscript alphabet along the columns are not significantly different at 5% probability level.

Table 3: Effect of stem borer infestation on the yield performance of maize

Treatment	No. of Maize Cobs	Yield Quantity (g)	% Yield Increase
CTRL	3.00±0.82 ^a	18.30±1.71 ^a	0.00±0.00 ^a
NSP	4.00±1.16 ^a	23.38±4.12 ^b	5.63±4.49 ^{ab}
NSO	3.75±3.20 ^a	24.48±3.66 ^b	6.98±6.08 ^b
NSAE	3.25±0.50 ^a	22.18±2.35 ^{ab}	4.45±2.38 ^{ab}

Values are means of four replicates. Means carrying the same superscript alphabet along the columns are not significantly different at 5% probability level.

Discussion

The results showed that neem seed extracts were effective in controlling the maize stem borers. The studies revealed that maize plants treated with neem seed extracts recorded fewer or no dead hearts when compared with the control as shown in Table 1. Although the neem treatments and the control did not differ significantly, the control had the highest (0.75±0.96) incidence of dead hearts. Similar trend was seen in the case of borer holes infestation by the maize stem borers. The neem seed kernel treatments were able to suppress the stem borers from tunneling the stems of the maize plants when compared with the control (untreated) as shown in Table 1. This further confirms the insecticidal properties of the neem seed kernel, especially in the control of stem-borers activities on maize plants. Neem seed kernel extracts have been reported as an antifeedant and insect growth regulator against many insect pests [20]. This agrees with Bhanukiran and Panwar [21], who reported the control of pests of several field crops and stored products using neem derivative. The growth regulatory effect is the most important physiological effect of neem on insects. It is because of this property that neem has emerged as a source of insecticides [22]. Antifeedant activity of neem seed kernel has been attributed to the tetranortriterpenoid and azadirachtin, in the extract [23],[24].

In Table 2, the results revealed that there is no significance difference (P=0.05) between the neem extract treated maize plants and the control (untreated) maize plants in the infestation of both the

larval and pupal stages. And in the adult stage, the control recorded a significantly higher number of adult stem borers than the neem seed treatments. This further confirms the efficacy of neem seed kernel as a growth regulator against insect pests [20]. The insecticidal activities of the neem seed suppressed the development of the stem borers in maize and therefore could be the reason for the fewer number of adult stem borers recorded when compared with the control.

Although there is no significant difference in the number of maize cobs recorded between the control and the neem seed kernel treatments, the control recorded the least (3.00 ± 0.82). Similar results were also shown for the yield quantity and percentage yield gained. Percentage yield gained also indicated the efficacy of the neem seed kernel extracts in protecting the maize plants in the field (Table 3). Neem seed oil recorded a percentage yield gained of up to 6.98%, is an indication of the importance of the use of botanicals in protecting maize in the field against stem borer infestation, which could result in yield lost as shown from the result of this studies. The order of the efficacy of the neem seed kernel extracts is: NSO>NSP>NSAE.

The result generally showed the efficacy of neem seed kernel extracts in the control of stem borers of maize. This also agrees with Bhanukiran and Panwar [21] and Ogah et al. [22], who reported neem seed kernel, reduced the infestation as well as the activities of stem borers on rice. It also corroborates the findings of Okirikata and Anaso [25] and Anaso [26], where neem kernel powder significantly protected sorghum against pink stalk borer (*Sesamia calamistis* Homps) in Nigeria Savanna, as well as whorl larva, stem borer and panicle insect pests of sorghum in Nigeria respectively.

Conclusion

In conclusion, It is suggested that neem as biopesticides, may be suitable as alternatives to synthetic pesticides which are not eco friendly toxic to users, for the management of maize stem borers, especially in Nigerian. The result also showed that there will be a substantial yield increase if stem borer infestation and activities can be protected in the field, especially with biopesticides, such as neem.

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