Laboratory Evaluation of neem (*Azadirachta indica* Linn (Meliaceae)) Seed Powder and Seed Oil for the Control of *Sitophilus zeamais* (Coleoptera: Bruchidae) on Stored Maize.

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Abstract

The effect of neem (*Azadirachta indica*) seed powder and seed oil in the control of *Sitophilus zeamais* were tested using Tricel (synthetic chemical) as treated control, and untreated control were also used to compare their efficacies. Daily mortality count was noted for about 3 days, while the F1 generation emergence and weight loss by the grains were subsequently noted. Data collected was subjected to Analysis of Variance (ANOVA), and the treatment means were compared using LSD at 5% probability level (P=0.05). The results indicated that neem seed powder and seed oil showed some insecticidal properties against *S. zeamais,* with oil proving to be more effective. The results also showed that treatments at all levels were effective in progeny reduction of *S. zeamais* and weight loss by maize grains as a result of *S. zeamais* feeding. Hence, recommended that farmers should put the practice of using *A. indica* as an alternative to the dangerous and highly persistent chemical insecticides.

Key words: *Azadirachta indica,* F1 emergence, Maize, Mortality, and *Sitophilus zeamais*

Introduction

Maize weevil *Sitophilus zeamais* (Coleoptera: Curculionidae) is one of the most destructive pests of stored cereal grains especially maize *Zea mays* (Ofuya and Lale, 2001). It is a cosmopolitan pest of sound and wholesome grains in both tropic and temperate regions of the world. *S. zeamais* secondarily attacks other crops such as rice, guinea corn (sorghum) yam products, groundnut, cowpea, millet, cassava flour, cocoyam and beniseed in Nigeria (Nwana, 1993).

Maize (*Zea mays*) is the most important cereal widely distributed over the world after wheat and rice with regard to cultivation areas and total production (Sturtevant, 1994). It is used in industry as raw material for the manufacture of baking flour, beer, oil, pharmaceuticals, and constitutes a staple food to humans in many regions of the world (Arannilewa, 2007).

However, due to the significant increase in the human population, and the consequent increase in the amounts of food and grains produced, there is a need to protect the maize from *S. zeamais.*

Various forms of control have been employed. The most popular being the chemical method which relies heavily on the use of synthetic insecticide and fumigants. This unfortunately is costly, toxic to its users, presents undesirable effects on non-target organisms, aids development of resistant strains and is generally not environmental friendly (Jembere, *et al*., 1995; Okonkwo and Okoye, 1996).

Farmers, through a long history of battle against stored product pests have learnt how to exploit natural resources or to implement accessible methods that would lead to a degree of population suppression of pests (Anon, 1991). Traditional methods usually provide cheap and feasible ways of post-harvest handling of the crops. Basically, farmers should be fairly aware that hygienic practices are essential for successful storage that is through clearing of bins or granaries, avoidance of mixing infected grains with healthy ones, burning crop residues after-harvest, sealing cracks and holes in muddy structures and any other practice that ensures that crop is stored in a clean and uncontaminated environment (Anaso *et al*., 2004).

There is an increasing interest in discovering pesticidal compounds in plants (Chitwood, 2002). Many compounds that have pesticidal activity may be less likely to cause environmental problems than synthetic pesticides and may be more readily available and therefore less costly (Ande *et al*., 2010).

Azadirachta indica, for hundreds of years has been used by Indian farmers because of its pesticidal, antifungal and antifeedant properties (Ruscoe, 1972; Jilani and Malik, 1973; Leuschner, 1975). Active components have been isolated from neem and these include the triterpenoids, azadirachtin (Butterworth and Morgan, 1971) and melantriol (Lavie *et al*., 1967). Azadirachtin, a complex limonoid, is the main component with antifeedant and toxic effects in insects (Govindachari *et* a*l.*, 2000). It is naturally safe and biodegradable product which is extensively used in various parts of the world as insecticide (Anaso and Lale, 2000). Neog and Bora (1999), reported that neem oils are the control agents against *Sitophilus zeamais* and can play a vital role in stored grain protection and application of neem cake significantly reduced the gall index, egg masses and population of *S. zeamais* through mortality. In this study, neem seed products (neem seed powder, neem seed oil and neem seed aqueous extracts) were evaluated for their toxicological activities on adult *S. zeamais.*

Materials and Methods

Source of plant material

Neem seeds *Azadirachta indica* were collected from the College of Health Technology Michika; Mubi Campus, Mubi North Local Government, Adamawa State, Nigeria.

Treatments and Source

Neem seed powder: 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: 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.

Synthetic Chemical: Tricel (Chlorpyriphos, 48%, E.C) a synthetic chemical was procured from an Agrochemical Store in Mubi market, Adamawa State.

Maize grains: Clean maize grains were procured from Mubi market and were dried to a constant weight in an oven at 30-35^{0}C for 14 days. This was subsequently air-dried for about 1 hour and was wrapped tightly in a polythene bag and stored in a deep freezer for 14 days.

Insect's culture: The initial stock of maize weevils *Sitophilus zeamais* was obtained from the already infested maize grains in a storage room in Mubi. This was maintained on maize in 500cm^3 jar under a laboratory conditions for about 4 days, and thereafter were removed and the grains were allowed to stand under laboratory conditions. This helped in raising adult weevils of uniform size and age.

Method of Application

Four replicates of each of the treatments were constituted as follows: 0.5g, 1.0g and 1.5g for the powder; 0.5ml, 1.0ml and 1.5 ml for neem seed oil and Tricel. Powder treatment samples were added to 10 grams of the maize in a $300cm^3$ rearing plastic jars. The mixture was stirred vigorously to ensure a uniform coating of the grain by the powder treatment samples. Thereafter 10 newly emerged adult *S. zeamais* were introduced into the plastic jars and were covered by muslin cloth using rubber-ring to stop the insects from escaping and for proper ventilation. The control jars also contained 10g of the grains and 10 newly emerged adult weevils but no treatment was added. For neem seed oil and Tricel, four replicates of each were constituted as follows: 0.5ml, 1.0ml and 1.5ml were first introduced into the plastic jars. Thereafter, 10 grams of maize grains was added before 10 newly emerged adult *S. zeamais* were introduced. Filter paper was used to separate the treatments from direct contact with the grains (Wahedi *et al*., 2013).

Data collection

Mortality

Adult *Sitophilus zeamais* mortality was investigated daily for 3 days after treatment. This was performed by emptying the contents of the rearing jars and the number of death individuals noted. The contents of the jar were subsequently put back after the death insects were retrieved.

F_1 Emergence

F_1 generation emerged 8 weeks after treatment. The total number of emergence from the rearing jar was calculated and recorded.

Weight Loss

After 1 week, the weight loss by grain was measured as the difference between the initial weight of the grain and the final weight.

Statistical Analysis

Data collected was subjected to Analysis of Variance ANOVA, and the treatment means were compared using LSD at 5% probability level (P>0.05).

RESULT

Mortality of *S. zeamais*

Table 1 shows the effect of NSP, NSO and Tricel on the mortality of adult *S. zeamais*. NSO at 1.5ml after 24Hrs recorded 100% mortality (10.00±0.00) equal to the synthetic chemical (Tricel). Generally, neem seed products performed significantly better than the control (untreated) which recorded 0.50±0.58, 1.25±0.50 and 1.75±0.96 adult *S. zeamais* mortality after 24Hrs, 48Hrs and 72Hrs respectively, indicating their effectiveness as biopesticide. Among the neem seed products, neem seed oil (NSO) performed significantly better than neem seed powder (NSP).

Table 1: Mortality of adult *S. zeamais* in maize incorporated with NSP, NSO and Tricel

Treatment	Concentration	Hours of Treatment (Mean±SD)		
		24	48	72
Control	0.00	$0.50±0.58^a$	$1.25±0.50^a$	$1.75±0.96^a$
NSP	0.5g	$5.50±2.65^b$	$4.50±2.65^b$	$0.00±0.00^b$
	1.0g	$5.50±0.58^b$	$4.00±0.82^b$	$0.50±0.58^b$
	1.5g	$6.75±0.50^b$	$3.25±0.50^{ab}$	$0.00±0.00^b$

NSO	0.5ml	6.75±2.75[b]	3.25±2.75[a]	0.00±0.00[b]
	1.0ml	8.50±3.00[bc]	1.50±3.00[a]	0.00±0.00[b]
	1.5ml	10.00±0.00[b]	0.00±0.00[b]	0.00±0.00[b]
Tricel	0.5ml	10.00±0.00[b]	0.00±0.00[b]	0.00±0.00[b]
	1.0ml	10.00±0.00[b]	0.00±0.00[b]	0.00±0.00[b]
	1.5ml	10.00±0.00[b]	0.00±0.00[b]	0.00±0.00[b]

Values are means of four replicates. Means carrying the same superscript are not significantly different from each other at P=0.05. Where NSP= Neem Seed Powder, and NSO= Neem Seed Oil.

F1 emergence and weight loss by the grains

Table 2 shows the effect of NSP, NSO and Tricel on adult F1 emergence of *S. zeamais* and also the weight loss by the maize grains. NSO again performed significantly better than the NSP with NSO only recorded 1.00±0.82 F1 emergence at 0.5ml treatment concentration, while NSP recorded 1.00±1.41, 0.75±0.96 and 0.75±1.50 at 0.5g, 1.0g and 1.5g respectively. Although, there was no emergence in the control treated (Tricel) (0.00±0.00), it was not significantly different from NSP and NSO when compared with the control untreated (5.50±2.65). Similarly, although control treated (Tricel) recorded only 0.03±0.05 weight loss at 0.5ml concentration, it was not significantly different from NSP and NSO when compared with the control untreated (0.75±0.19).

Table 2: Adult F1 emergence of *S. zeamais* in maize incorporated with NSP, NSO and Tricel

Treatment	Concentration	Adult emergence (Mean±SD)	Weight loss (Mean±SD)
Control	0.00	5.50±2.65[a]	0.75±0.19[a]
NSP	0.5g	1.00±1.41[b]	0.10±0.08[b]
	1.0g	0.75±0.96[b]	0.10±0.14[b]
	1.5g	0.75±1.50[b]	0.03±0.05[b]
NSO	0.5ml	1.00±0.82[b]	0.08±0.10[b]
	1.0ml	0.00±0.00[b]	0.00±0.00[b]
	1.5ml	0.00±0.00[b]	0.00±0.00[b]
Tricel	0.5ml	0.00±0.00[b]	0.03±0.05[b]
	1.0ml	0.00±0.00[b]	0.00±0.00[b]
	1.5ml	0.00±0.00[b]	0.00±0.00[b]

Values are means of four replicates. Means carrying the same superscript are not significantly different from each other at P=0.05. Where NSP= Neem Seed Powder, and NSO= Neem Seed Oil.

Discussions

Table 1 shows the effect of treatments on the mortality of *Sitophilus zeamais*. Greatest number of mortality was recorded after 24hours of treatment. The control showed the least number (0.50±0.58), while the synthetic chemical (Tricel) recorded 10.00±0.00 (100%) mortality within 24hours at all levels. Neem seed oil at 1.5ml concentration recorded 10.00±0.00 (100%) mortality confirming the efficacy of neem seed products against *S. zeamais*. Generally, neem seed products performed equal activity with Tricel especially after 24hours of treatment.

Table 2 shows the effect of neem treatments on adult emergence of *S. zeamais*. No emergence was recorded in Tricel as well as neem at 1.0ml and 1.5ml of neem seed oil. The control recorded the highest number (5.50±2.65) of adult *S. zeamais* emergence. Compared with the control, the treatments significantly reduced the emergence of *S. zeamais*.

This coincides with the findings of Yusuf *et al*., (1998) who earlier reported that leaf powder of neem moderately caused mortality in adult *S. zeamais*, reduced F1 emergence and weight loss, as well as Lale and Abdulrahman (1999) who also reported that neem seed oil was significantly more effective in reducing adult emergence of *C. maculatus* on treated cowpeas than the neem seed powder..

Meanwhile, all the treatments were not significantly different from each other when compared to the control in suppressing weight loss by the grains. The control recorded the highest value (0.75±0.19), indicating the efficacy of the treatments on *S. zeamais*. This agrees with the finding of Malik and Naqvi (1984), who reported antifeedant activity in azadirachtin isolated from fruit against stored product insects.

Conclusively, this study further revealed the potency of neem (*Azadirachta indica*) especially for its toxic effects, reducing adult emergence and also prevented *S. zeamais* from feeding. Therefore, sustainable use of this biopesticides especially in this part of the country will enhance better maize production and storage.

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