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Effect of *Moringa oleifera* Leaf Powder and Seed Oil on Insect Pests of Stored Maize and Cowpea

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ABSTRACT: The leaf powder of *Moringa oleifera* was applied as direct admixture at 5g, 10g and 15g while the seed oil was applied at 5ml and 10ml to 100g each of Maize and Cowpea grains respectively, while the control was without insecticide application to test for insect mortality., progeny development and damage caused on stored maize and cowpea (*Sitophilus zeamais* and *Callosobruchus maculatus*). The experiment was laid out in a Completely Randomized Design (CRD) and results obtained were subjected to analysis of variance (ANOVA) while means were separated using the Least Significant Difference (LSD). The result showed significantly (P<0.05) progeny reduction of adult *Sitophilus zeamais* and *Callosobruchus maculatus* using *Moringa oleifera* leaf powder at different concentration 0, 5g (23.90, 28.62), 10g and 15g respectively. Control (0) recorded the highest number 68.51 in *Callosobruchus maculatus*, and 56.85 in *Sitophilus zeamais*. Mortality test result showed that moringa leaf powder significantly(P<0.05) increased the mortality of adult *S. zeamais* and *C. maculatus* with increase in concentration after 96 hours of exposure while moringa seed oil offered 100% mortality after 24 hours of exposure. Germination of maize and cowpea was not affected after treatment with moringa leaf powder and seed oil. Contact toxicity result showed significant adult mortality of *S. zeamais* and *C. maculatus* on filter paper with 15% mortality in *C. maculatus* and 10% in *S. zeamais*. Damage was significantly reduced in treated grains compared with the untreated control. Moringa seed oil was more toxic to *S. zeamais* and *C. maculatus* compared to moringa leaf powder and the untreated control. The protective effect of moringa seed oil against *S. zeamais* and *C. maculatus* comes principally through oviposition suppression and reduced or complete inhibition of adult emergence, consequently reducing or eradicating infestation risk, damage and loss of maize and cowpea grains in storage. While the use of plant essential oils against storage insect pest is being advocated, the availability, affordability and the tendency of tainting protected grains should be considered.

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KEYWORDS: *Moringa oleifera*, *Sitophilus zeamais*, *Callosobruchus maculatus*, Stored grains.

INTRODUCTION

Cowpea, *Vigna unguiculata* (L) Walp, is an important dietary component in Africa where *Callosobruchus maculatus* (F) has become a major storage insect pest of the seeds. The magnitude of competition between *C. maculatus* and human beings for this important crop has contributed to food shortage and affected food sufficiency (Musa, *et al.*, 2009). A total of 2,663.390 tonnes of cowpea is produced from an estimated area of 9,441,562 ha (FAO, 2001).

Cowpea is a warm weather crop that is well adapted to drier regions of the tropics like Nigeria where other food legumes do not thrive well. It is one of the most economically and nutritionally important indigenous African legumes produced throughout the tropical and subtropical areas of the world. However, the production and storage of this important food crop, has faced so many constraints such as diseases and the limited use of fertilizers and irrigation inputs (Brigibe *et al.*, 2011) but insect pests is one of the major constraint. They infest cowpea before harvest and the higher the infestation levels before harvest, the greater the damage to seed in storage. This will result in higher weevil emergence causing a greater weight loss, larger number of holes and consequently

loss of economic value (Baidoo *et al.*, 2010). Infestation on stored grains may reach 50% within 3-4 months of storage (Dugje, *et al* 2009).

Maize, *Zea mays* L. on the other hand is a major food crop in Africa and it is usually stored to provide food reserve and also seed materials for planting (Akob and Ewete, 2007). It is an import crop in confectionery and pharmaceutical industries. Meanwhile, cowpea and maize production are threatened by heavy insect infestation (even in storage) resulting in colossal economic loss to both farmers and consumers. Stored seeds are severely damaged by insects and may be reduced to powdery form and rendered unfit for human consumption and other uses. Once infestation is naturally or artificially established, insect pests cause uninterrupted destruction as a result of their feeding activities leading to grain damage, gain weight loss, nutritional and physical loss of stored grains.

The economic situation in a developing country, like Nigeria, has been adversely affected mostly by the post-harvest losses of commodities which are usually encountered, especially during storage (Arannilewa *et al.*,2002).

Therefore, control of insect pests is necessary in the successful production and storage of these crops. Presently farmers rely solely on the use of synthetic insecticides to control *Sitophilus zeamais*, *Callosobruchus maculatus* and other insect pests of stored products. These insecticides poses negative impacts on the environment such as harm on non-target species, development of resistance, high cost of application, high mammalian toxicity, health hazard and erratic supply in developing countries due to foreign exchange. As a result of the negative impact of synthetic insecticides, alternative control measures like the use of botanical insecticides are being sought after. This gave impetus to this study which investigated the effects of *Moringa oleifera* leaf power and seed oil on *Sitophilus* zeamais and *Callosobrchus maculatus* being insect pests of stored maize and cowpea, respectively.

MATERIALS AND METHODS

Culturing of Insects

Adults *Sitophilus zeamais* and *Callobrochus maculatus* were obtained from infested stock of maize and cowpea at Itam market (a popular market) in Uyo, Akwa Ibom State, Nigeria.

The insects were reared on whole maize and cowpea grains and later transferred to 500l glass jar (Udo 2000), containing 400g of grains which were sterilized in a freezer for 14 days. After 1 week of oviposition, all insects were removed and discarded to enable the emergence of same age progeny that was used to establish the main culture.

Plant Material Preparation

Moringa oleifera leaves were collected from a mature Moringa shrub at Akpa Ube Street, uyo, Nigeria. The leaves were air dried for one week in the screen house of the Department of Crop Science, University of Uyo. 3000g of the dried leaves was ground into fine powder using manual grinder, and the powder stored in a black polyethylene bag and kept in the laboratory for the different bioassays.

Moringa Seed Oil

100ml of Moringa seed oil was purchased from International Institution of (IITA), Ibadan, Oyo State, Nigeria and used for the experiment.

Mortality Bioassay

The mortality test was conducted on 100g of maize and cowpea each in 9cm plastic cup. Moringa seed oil and leaf powder were added as direct admixture separately. The leaf powder was applied at concentration of 0, 5g, 10g, and 15g while the seed oil was applied at 0, 5ml, and 10ml. The control had neither seed oil nor leaf powder added. The Moringa leaf powder and oil were added a day before the introduction of insect in order for the treatment to get in contact with the surface of the grains. Twenty (20) *S. zeamais* and twenty (20) *C. maculatus* of mixed sexes were introduced into each of the cups with each treatment replicated four times. The plastic cups were covered using white muslin cloths held with rubber bands to allow adequate ventilation and to prevent the escape of the insects. The number of dead insects in each treatment was counted after 24 hours and up to 96 hours. Insects were considered dead on failure to respond to three probing with a blunt probe.

Contact Toxicity on Filter Paper

The two concentration (10µl and 20µl) plus a control of the moringa seed oil was applied on filter papers in the petri-dish and left for 30 minutes to dry while the control had no seed oil applied, ten(10) adult insects of *S. zeamais* and *C. maculatus* each of mixed sexes were introduced into the middle of the petri-dish (Udo, 2000). The petri-dish were covered with white muslin cloths and held in position with rubber band to allow adequate ventilation and prevent the escape of the insects. Each treatment was replicated four times. Mortality was recorded at interval l of 24 hours and up to 96 hours.

Progeny Development

One hundred grams each of maize and cowpea grains were weighed separately into the white plastic cups and the treatments (i.e Moringa, leaf powder and seed oil) were applied to each of the cups at the rate 0, 5g, 10g, and 0, 5ml, 10ml respectively after which

the cups with the treated grains were vigorously shaken to ensure adequate contact with the grain surface. The cups were covered with white muslin cloth held in place with rubber bands. The control treatment had no powder nor oil added and the experiment was replicated four times. Then, 20 *adult Sitophilus zeamais* and *Callosobruchus maculatus* were introduced separately into each of the cups. The experiments were left undisturbed in the laboratory for 30 days. Thereafter, the number of weevils alive were counted and recorded. This was done by observing and counting the total number of live weevils for five(5) days.

RESULTS

Insect Mortality

The effect of *Moringa oleifera* leaf powder on mortality of *Sitophilus zeamais* in stored maize is presented in **Table 1.** Adult insect mortality significantly ($p<0.05$) increased with increase in concentration from 0 to 15g respectively, and hours of exposure. Significant difference (50.00) was observed after 96 hours of exposure compared to untreated control.

The effect of *Moringa oleifera* leaf powder on *C. maculatus* in stored cowpea is presented in **Table 2.** The mortality increased significantly (25.00) with increase in concentration after 96 hour of exposure.

The effect of *Moringa oleifera* seed oil on *S. zeamais* on stored maize is presented in **Table 3.,** Moringa seed oil killed more insects with 100% mortality than the control after 24 hours of exposure.

This effect of *Moringa oleifera* seed oil on *C. maculatus* on stored cowpea is presented in **Table 4.** The Moringa seed oil achieved 100% insect mortality at 24 hours of exposure compared to the control.

Contact Toxicity On Filter Paper

The mortality of *S. zeamais* on contact with filter paper treated with Moringa seed oil is presented in **Table 5**. Mortality increased with increase in concentration and hours of exposure. There was significant mortality ($p<0.05$) at 72 and 92 hours compared with the untreated control.

Mortality of *C. maculatus* to Moringa seed oil on contact with filter paper is presented in **table 6.** 15% mortality was recorded in the concentration of 20ml at 96 hours of exposure.

Progeny Production

The effect of *Moringa oleifera* leaf powder on progeny production of *Sitophilus zeamais* and *Callosobruchus maculatus* is presented in **Table7**.

The number of adult insects that emerged decrease with increase in concentration level. The control recorded the highest progeny production. However, there was significant ($p<0.05$) differences in *Sitophilus zeamais* and *Callosobruchus maculatus* progenies.

Seed Germination

The percentage maize and cowpea seed germination after treatment with Moringa leaf powder is presented in **Table 8**: There was no significant difference ($p<0.05$) in treatment level in both maize and cowpea. 100% seed germination was observed in all the treatment levels respectively.

The percentage maize and cowpea seed germination after treatment with moringa seed oil is presented in **Table 9**: significant difference ($p<0.05$) was observed among the treatments. The control recorded the highest seed germination of 100% in both maize and cowpea followed by 5ml and 10ml had the lowest value. There was no significant difference in both maize and cowpea.

Damage Assessments

The percentage damage of maize and cowpea grain is presented in (Table 10).

The control recorded the highest percent damage in both maize and cowpea grains when compared to the different treatment levels. Damage in grains increase with decrease in treatment levels. Damage done by *C. Maculatus* is higher than the damage caused by *S. zeamais.*

DISCUSSION

Insect Mortality

The results in this study have shown that *Moringa oleifera* seed oil at concentration of 5ml and 10ml achieved 100% mortality on both *Sitophilus zeamais* and *Callosobruchus maculatus* compared to Moringa leaf powder which offered low mortality of *Sitophilus zeamais* and *Callosobruchus maculatus* at concentration of 5g, 10g, and 15g respectively.

This could be attributed to the presence of insecticidal properties and the repellent properties contained in the Moringa seed oil.

This has been confirmed by other researchers where over 95% mortality of *Sitophilus zeamais* and *Callosobruchus maculatus* induced by moringa seed oil was achieved (Udo, 2005; Lale, 1995).

Contact toxicity on filter paper

The effects of the Moringa seed oil to *S. zeamais* and *C. maculatus* on filter paper at concentration 10µl and 20µl showed the various bioactivity ranging from 2.5% - 15% at different hours of exposure. There was significant difference ($p<0.05$) in mortality of insects

among the treatments level. This confirmed the presence of contract action against the storage pests, thus making it an important component of pest management.

Progeny Production

Moringa leaf powder offered low mortality with high progeny production. This showed that Moringa seed oil offered complete or significant suppression and destruction of the eggs and larvae of both *Sitophilus zeamais* and *Callosobruchus maculatus* on storage. This therefore indicates that Moringa seed oil has some insecticidal properties that affects either the eggs or the larvae of the insect pests on storage.

Similar results were obtained by other researchers that Moringa seed oil caused eggs, larval and adults mortality, oviposition and reduced adult emergence in *Sitophilus zeamais* and *Callosobruschus maculatus*. The differences may depend on several factors such as chemical composition of Moringa, the insect species, susceptibility, and variation in insect behaviour.

Seed Germination

The germination percentages ranged from 98% - 100% in Moringa seed oil, while 100% seed germination was observed using Moringa leaf powder. Maize seeds had the highest percent seed germination indicating, highest percent seed germination indicating, high viability after exposure to Moringa seed oil. This might be attributed to the fact that the insect did not damage the seed embryo. The effect of plant powder and seed oil on the viability of treated grains shows that none of the leaf powder or seed oil adversely affected the viability of the maize and cowpea grains.

Damage Assessment

The seed treated with leaf powder showed significant difference in the reduction of weight and damage caused by *S. zeamais* and *C. maculatus* (Table 10). The highest damage of 61.26 and 72.97% were observed in control treatment which had neither Moringa leaf powder nor seed oil added. In the untreated grains, the percentage damage occurred as revealed by emergent holes of the weevils and beetles as a result of feeding activity of *S. zeamais* and *C. maculatus* adults and larvae on the grains. Mbailao *et al.,* (2006) made similar report that Moringa oleifera at higher concentration also reduced adults emergence of *S. zeamais*. Also reported the effect of *Moringa oleifera* longevity of *C. maculatus* adults on cowpea seeds.

CONCLUSION/RECOMMENDATION

This study has confirmed that Moringa seed oil and Moringa leaf powder have insecticidal properties that can be exploited for successful storage of maize and cowpea grains.

Moringa oleifera is very abundant in the study area and very cheap to procure making it possible for resource poor farmers to incorporate them into traditional storage systems. Moringa extracts are ecologically safe and leave no residual effects on the environment. Therefore, Moringa seed oil and Moringa leaf powder can be incorporated as a

Component of integrated pest management system for grain storage.

TABLE 1: Mortality of *Sitophilus zeamais* on Stored Maize at Different Hours after Treatment Using *Moringa oleifera* Leaf Powder

Percent Mortality at Different Hours after treatment				
Treatment level(g)	**24hrs**	**48hrs**	**72hrs**	**96hrs**
0	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00
10	12.50	12.50	25.00	37.50
15	25.00	25.00	25.00	50.00
LSD (p<0.05)	**0.002**	**0.002**	**NS**	**0.065**

Table 2: Mortality of *Callosobruchus maculatus* on stored Cowpea at Different Hours after Treatment Using *Moringa oleifera Leaf* Powder

Percent Mortality at Different Time after treatment				
Treatment Level (g)	**24hrs**	**48hrs**	**72hrs**	**96hrs**
0	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00

10	0.00	0.00	12.50	12.50
15	0.00	0.00	12.50	25.00
LSD (P<0.05)	**NS**	**NS**	**NS**	**0.002**

Table 3: Mortality of Sitophilus zeamais on stored Maize after Different Hours of Treatment Using *Moringa oleifera* Seed Oil.

Percentage Mortality at Different Time after treatment				
Treatment level(g)	**24hrs**	**48hrs**	**72hrs**	**96hrs**
0	0.00	0.00	0.00	0.00
5	100.00	100.00	100.00	100.00
10	100.00	100.00	100.00	100.00
LSD (P<0.05)	**NS**	**NS**	**NS**	**NS**

Table 4: Mortality of *Callosobruchus maculatus* on stored Cowpea after Different Hours of Treatment Using *Moringa oleifera* Seed Oil.

Percentage Mortality at Different Time after treatment				
Treatment level(g)	**24hrs**	**48hrs**	**72hrs**	**96hrs**
0	0.00	0.00	0.00	0.00
5	100.00	100.00	100.00	100.00
10	100.00	100.00	100.00	100.00
LSD (P<0.05)	**NS**	**NS**	**NS**	**NS**

Table 5: Contact toxicity of *Sitophilus zeamais* at different hours after treatment with Moringa (*Moringa oleifera*) Seed Oil

Percentage Mortality at different time after treatment				
Treatment level(ɳl)	**24hrs**	**48hrs**	**72hrs**	**96hrs**
0	0.00	0.00	0.00	0.00
10	0.00	12.50	25.00	37.50
20	0.00	12.50	37.50	50.00
LSD (P<0.05)	**NS**	**NS**	**0.08**	**0.02**

Table 6: Contact toxicity for *C. maculatus* at different hours after treatment wth *Moringa oleifera* Seed Oil.

Percentage Mortality at Different Time after treatment				
Treatment level(ɳl)	**24hrs**	**48hrs**	**72hrs**	**96hrs**
0	0.00	0.00	0.00	0.00
10	0.00	25.00	50.00	50.00
20	0.00	37.50	62.50	75.00
LSD (P<0.05)	NS	0.12	0.82	0.02

Table 7: Effect of *Moringa oleifera* Leaf Powder on Progeny Production

Treatment level(g)	***S. zeamais***	***C. maculatus***
0	56.85	68.51
5	23.90	28.62

10	23.60	16.24
15	21.60	12.18
LSD (p<0.05)	0.81	0.65

Table 8: Percent Seed Germination of Maize and Cowpea Treatment with Moringa Leaf Powder

Treatment Level (g)	% Maize seed germination	% Cowpea germination
0	100.00	100.00
5	100.00	100.00
10	100.00	100.00
15	100.00	100.00
LSD (p<0.05)	**NS**	**NS**

Table 9: Percent Seed Germination of Maize and Cowpea Treated with Moringa Seed Oil

Treatment Level (ml)	% Maize seed germination	% Cowpea germination
0	100.00	100.00
5	100.00	98.00
10	99.00	98.00
LSD (p<0.05)	**NS**	**NS**

Table 10: Percentage grain damage among treatment levels after 72 days of exposure to *S. zeamais* and *C. maculatus*

Treatment level (g)	Initial Weight % of grains	% Damage of Maize grains	% Damage of Cowpea grains
0	100	50.01	49.00
5	100	68.10	66.00
10	100	79.12	69.11
15	100	88.10	78.25
LSD (p<0.05)	NS	6.05	4.02

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