Management of stored maize against *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae) with the seed and root powders of *Jatropha curcas* (L.)

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ABSTRACT

Jatropha curcas seed and root powders were tested at four rates (0.00, 1.00, 2.00 and 3.00 g/100 g seed) in the Laboratory against the maize weevil, *Sitophilus zeamais*. The treatments were replicated three times including the control and laid out in a Completely Randomized Design. *J. curcas* seed powder at the highest rate (3.00 g) inflicted adult mortality (40.00 % and 70.0 %) after 48 hrs and 72 hrs of introduction, respectively. The seed powder also recorded the lowest adult emergence (0.67 - 2.67) and reduced seed damage with a weevil perforation index (WPI) of 15.34 %. Comparatively, however, the seed root powder, at the highest rate (3.00 g), recorded 0.00 % and 10.00 % mortality after 48 and 72 hrs of introduction, respectively. It also recorded more adult emergence and seed damage than the seed powder and had a WPI of 61.15%. Since WPI exceeding 50.0 % is regarded as negative protectant ability of a test material, the seed powder is to be preferred over the root powder in the management of stored maize against *S. zeamais* infestation. Both treatment materials had no significant adverse effect on the viability of stored maize seeds.

Keywords: *Jatropha curcas*, *Sitophilus zeamais*, plant extracts, mortality, emergence, weevil perforation index (WPI)

INTRODUCTION

Jatropha curcas L., the foremost 'diesel plant', has been used in traditional human medicine and for veterinary purposes for a long time (Duke, 1985). Oliver-Bever (1986) had reported that the root powder of the plant could be used as an aphrodisiac and is useful against asthma and rheumatism when mixed with milk. The bark, roots and leaves are acidic and pungent, and are taken to promote digestion. It has also been used as a molluscicide and rodenticide (Devappa *et al*., 2011)

Among the many *Jatropha* species, *J. curcas* is the most studied as the seeds are rich in oil and protein (Makkar and Becker, 1997). The protein quality of the cake or meal is high with the seed containing kernels and shells with an average ratio 62.20:37.70. The kernel has a higher crude protein (22–28 %) and oil contents (54–58 %) compared to the shell (4–6 % crude protein and 0.8−1.4 % oil) (Makkar *et al*., 1998).

The seed and root parts of *J. Curcas* have been variously reported (Chomnong, 1990); Ohazurike *et al*., 2003; Agu *et al*., 2013 and Ahuchaogu *et al*., 2014) to have cytotoxic, insecticidal and nematicidal activities on stored seeds and field crops. Various parts of the plant have also been reported to be used in soap making, as bio-diesel, as activated charcoal, as chewing-stick, in making ceiling boards, floor tiles as well as in dye and pigments production (Belewu, 2008).

Maize weevils, *Sitophilus zeamais*, are found in all warm and tropical parts of the world. The huge post-harvest losses and quality deterioration caused by this pest is a major obstacle to achieving food security in developing countries (Asawalam *et al.*, 2008).

Despite the research works on the efficacy of *J. curcas* plant parts, there is paucity of information on its bioactivity as a bio-insecticide in the control of *S. zeamais*. There is, therefore, a compelling need to carefully investigate the efficacy of the seed and root parts of the plant in the control of this major pest of stored maize grain.

MATERIALS AND METHODS

Laboratory Culture of *Sitophilus zeamais*

Adult *Sitophilus zeamais* were collected from infested maize seeds from Ihiagwa market in Owerri West area of Imo State, Nigeria. The insects were introduced into two breeding containers containing maize seeds and kept under ambient temperature of 28^0C $\pm$ 30^0C and relative humidity of 75 $\pm$ 5 %. These were used to establish a laboratory culture.

Collection and Preparation of Maize Seeds

Ten (10.0) kg of maize seeds procured from the Institute of Agricultural Research, Ahmadu Bello University, Zaria, Nigeria, were sorted to remove damaged seeds with holes and wrinkles. The sorted seeds were disinfested, air- dried and stored in an air-tight bin.

Preparation of Test Plant Powders

Seeds and roots of *J. curcas* were collected from Ihiagwa in Owerri West area of Imo State. The collected plant parts were chopped into small bits, shade-dried, ground, weighed and stored in air-tight 250 ml plastic containers.

Bioassay

One hundred grams of maize seeds were weighed out into 250 ml translucent plastic containers, which were covered with clean baft cloth to allow inflow of air. The ground plant materials (roots and seeds, respectively) were measured out in rates of 1.00 g, 2.00 g and 3.00 g and mixed with the100 g maize seeds in the 250 ml plastic containers.

Twenty four hours after the treatment, 50 seeds from each of the treated and untreated (control) maize seeds were placed in 100 ml plastic tubes. The treatments were replicated three times including the control. Five pairs of male and female *S. zeamais* were introduced into each of the treated tubes, which were covered with baft cloth tied firmly with rubber bands.

Data Collection

Mortality

Data were collected on the effect of the plant materials on the mortality of the adults, which was assessed 24 hr, 48 hr, 72 hr and seven days after treatment. At 24, 48 and 72 hours, the dead insects were discarded. Both the dead and living insects were discarded on the 7^{th} day.

Emergence and Damage Assessment

The effect of the experimental materials on emergence was checked on the first day of F_1 emergence. On this day, the insects, dead and living, were counted and discarded in order to distinguish them from those that would emerge later. This was repeated after 24 hr, 48 hr, 72 hr and 7 days.

Damage was assessed on the 7^{th} day by the distribution of holes per seed of sampled maize. The number of seeds with holes per sample of 10 randomly selected seeds of maize was recorded for damage assessment.

The weevil perforation index (WPI) (Fatope *et al*., 1995), was calculated thus:

$$WPI = \frac{\%\ \text{Treated maize grains perorated}}{\%\ \text{Control maize perforated}} \times \frac{100}{1}$$

Weevil perforation index exceeding 50 was regarded as enhancement of infestation by the weevil or negative protectant ability of the plant material or insecticide tested.

Viability Test

Thirty (30) maize seeds were selected from the reserve of untreated seeds. Ten seeds each were placed in three Petri-dishes whose bases were lined with Whatman's No.44 filter paper moistened with water. The experiment was left for seven days to ensure all the viable seeds germinated. Numbers of emerged seedlings per Petri- dish were recorded seven days after sowing.

Data Analysis

All data collected were analyzed using Analyses of Variance in a Completely Randomized Design and treatment means separated using Fisher's Least Significant Difference (F-LSD) at 5.00% probability levels.

RESULTS

The result on table 1 shows that maize seeds treated with the highest rate of *J. curcas* seed powder inflicted the highest mortality on the weevils (6.67 %) 24hours after introduction. This result, however, was not statistically different from seeds treated with the root powder and the control which recorded 0.00 % mortality. Similarly, 16.67, 23.33 and 40.00 % mortalities were recorded at the different rates with the seed powder 48hours after introduction which was significantly different from seeds treated with *J.* root powder.

Mortality of the weevil 72 hrs after introduction showed that maize seeds treated with the seed powder at the lowest, medium and highest rates recorded 53.33, 66.67 and 70.00 %, respectively. This result differed significantly from the root powder treatments which inflicted 13.33, 13.33 and 10.00 % mortalities respectively. The later, however, showed no statistical difference from the control which recorded 6.67 % mortality. This trend continued 7 days after introduction as 100.00 % mortality was recorded on seeds treated with the highest rate of the seed powder. This differed significantly from the root powder treated seeds with the highest mortality at 30.00 % only.

Table 1: Table 1: Effects of *J.* Curcas seed and root powders on the mortality of *Sitophilus zeamais.*

Treatment	Rate	24hrs	48hrs	72hrs	7days
JSP	1.00g	0.00	16.67	53.33	83.33
JSP	2.00g	3.33	23.33	66.67	90.00
JSP	3.00g	6.67	40.00	70.00	100.00
JRP	1.00g	0.00	0.00	13.33	26.67
JRP	2.00g	0.00	0.00	13.33	30.00
JRP	3.00g	0.00	0.00	10.00	23.33
Control	0.00g	0.00	0.00	6.67	23.33
$LSD_{0.05}$		NS	0.855	1.267	1.011

KEY:
JSP: *J. curcas* seed powder
JRP: *J. curcas* root powder
C: Control.

The first emergence of adult maize weevil was higher on seeds treated with *J. curcas* root powder which had 3.67-7.00 adults emerging. This was followed by seeds treated with the seed powder which recorded 0.33-1.00 adults (Table 2). Seeds treated with the root powder also recorded higher emergence than the seed powder at 48 hours. The former recorded 4.67-8.00, while the later, 0.67-2.67 adult emergence. The result also followed the same trend at 72 hours and 7 days.

Table 2: Effects of *J.* Curcas seed and root powders on the emergence of *sitophilus zeamais*

Treatment	Rate	First emergence	Emergence at 48hrs	Emergence at 72hrs	Emergence at 7days.
JSP	1.00g	1.00	2.67	0.00	0.00
JSP	2.00g	0.33	1.33	0.33	1.00
JSP	3.00g	0.00	0.67	0.33	1.00
JRP	1.00g	7.00	8.00	3.33	4.00
JRP	2.00g	4.67	5.00	5.33	9.67
JRP	3.00g	3.67	4.67	8.00	4.33
Control	0.00g	7.00	13.00	8.00	6.67
$LSD_{0.05}$		2.675	4.924	3.009	5.212

KEY:
JSP: *J. curcas* seed powder
JRP: *J. curcas* root powder
C: Control.

The control recorded the highest total number of emerged insects (24.00), followed by the root powder treatment which recorded between 22.00 – 24.00 total adult emergence (Fig. 1). The lowest total number of emerged insects was recorded by seeds treated with *J. curcas* seed powder which had 1.30 - 3.00 total adult emergence.

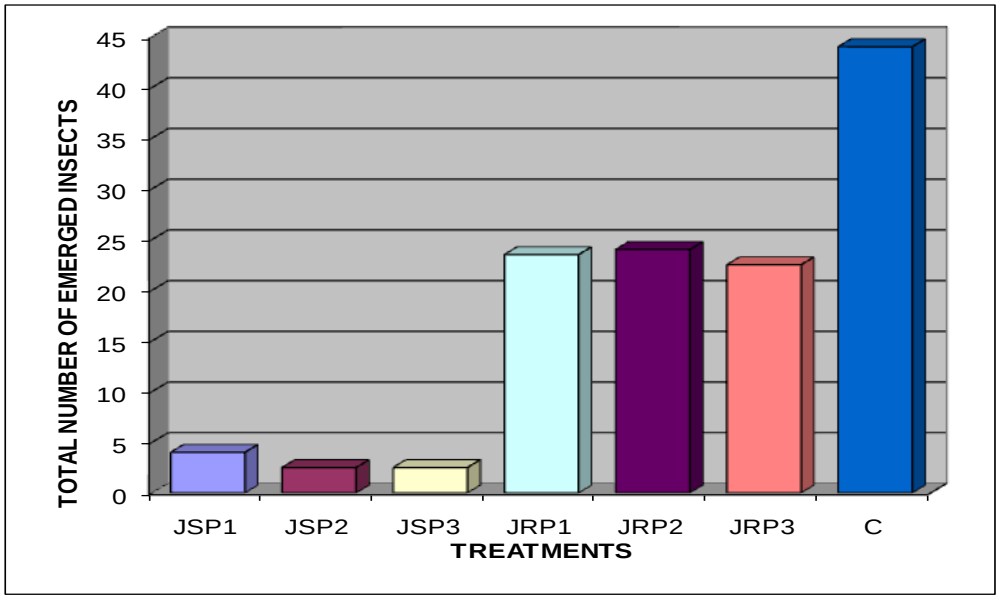

Figure 1: Effects of *J.* Curcas seed and root powders on total number of emerged insects.

KEY: JSP: *J. curcas* seed powder
JRP: *J. curcas* root powder
C: Control.

Seeds treated with *J. curcas* root powder (4.67-5.33) recorded the next higher number of damaged seeds after the control (Table 3). Contrarily, this significantly differed from the damage recorded on seeds treated with the seed powder (0.67-1.67). Both results were statistically different from untreated seeds which recorded the highest damage (8.67 seeds).

The assessment of the weevil perforation index (WPI) showed that seeds treated with the root

powder were most perforated (53.86 - 61.15 %) whereas the least perforated seeds were those treated with the seed powder (7.72 - 15.34%). Both results differed significantly from each other.

The seed and root powders of *J. curcas* had no significant effect on viability of maize seeds when compared with untreated seeds (Table 4).

Table 3: Effects of *J.* Curcas seed and root powders on seed damage and the weevil perforation index (WPI)

Treatment	Rate	No.of seeds with holes.	W.P.I (%)
JSP	1.00g	1.67	19.26
JSP	2.00g	1.33	15.34
JSP	3.00g	0.67	7.72
JRP	1.00g	4.67	53.86
JRP	2.00g	5.33	61.15
JRP	3.00g	5.33	61.15
Control	0.00g	8.67	
$LSD_{0.05}$		1.621	14.21

KEY:
JSP: *J. curcas* seed powder
JRP: *J. curcas* root powder
C: Control.

Table 4: Effects of *J.* Curcas seed and root powders on the germination of treated maize seeds

Treatment	Rate	Percentage germination (%)
JSP	1.00ml/100g	93.30
	2.00ml/100g	90.00
	3.00ml/100g	96.67
JSP	1.00ml/100g	90.00
	2.00ml/100g	90.00
	3.00ml/100g	90.00
$LSD_{0.05}$		11.46
Germination Test Before Treatment Application.		96.67

DISCUSSION

The different rates of root and seed powders of *J. curcas* caused various degrees of mortality of *S. zeamais*. The seed powder was the most effective of the treatment materials used in the control of the maize weevil. It caused the highest mortality of the storage insect pest, drastically reduced the emergence of the F_1 adults and also had the least number of damaged seeds when compared with those treated with the root powder. This could be as a result of the several tannins, saponins, phytates, curcins, diterpenes, sterols and terpenes contained in the seed of the plant which have been known to exhibit insecticidal property. Makkar *et al*. (1998) had reported that *J. curcas* seed extracts contains phorbol esters which exerted potential insecticidal effects against *Busseola fusca* and *Sesamia calamistis.*

The root powder of *J. curcas* did not significantly reduce the mortality rate of maize weevil when compared with untreated seeds and had more damaged seeds than those treated with the seed powder. The performance of the root powder of *J. curcas* could be due to the absence of curcin toxalbumin in the root as reported by Makkar and Becker, (2009). Fang *et al*. (2005) had earlier reported that the root contains a smaller amount of

phorbol esther (0.55 %) when compared with the seed (2.00-6.00 %).

The treatment materials used did not significantly affect the viability of maize seeds when compared with the control. This is in agreement with the findings of Ohazuruike (2003), Akikurolere, *et al*. (2006), Ojiako and Adesiyun (2008) and Ojiako and Kayode (2014) who reported that plant extracts had no negative effects on the viability of treated seeds.

Conclusion and Recommendation

Jatropha seed and root powders were able to control the major storage insect pest of maize (*Sitophilus zeamais*). However, the seed powder was more effective than the root powder. The plant powders were also found to have no effect on germinability of the maize seeds.

Farmers may, therefore use these bio-pesticides to control insect infestation on stored maize seeds. In Nigeria, this plant is readily available. They are cheap, easily bio-degradable, technologically and environmentally friendly and could provide valuable alternatives to the use of synthetic insecticide in the management of insect pests of stored maize.

Since Jatropha has been found to contain poisonous alkaloids, it is recommended these powders be used for seeds meant for planting only.

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