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*Full Length Research Paper*

# Costs analysis and toxicity of *Jatropha curcas* L. on maize weevil, *Sitophilus zeamais* Motsch.

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**The toxicity of *Jatropha* seed oil to maize weevil, *Sitophilus zeamais* Motsch. in stored grains was tested in the laboratory. The cost analysis of seed oil extraction was estimated. The rates of seed oil treatment at 0.2, 0.5 and 1.0 ml and the untreated control for storage of 100 g grains were replicated four times. Each experimental unit contained five pairs of freshly emerged adult *S. zeamais*. Results showed disproportionate increase in adult mortality with increase in rate of treatment. There was significant difference (P<0.05) in the treatments compared to the oil-free control. At the end of four months storage period, the weevil perforation index (WPI) ranges between 17.91 and 26.315% in the treatments compared to the control. Application of the seed oil to the grains was simple and the results determined the possibility of including the seed oil in pest management programme.**

**Key words:** *Jatropha curcas, Sitophilus zeamais,* costs analysis, toxicity.

## INTRODUCTION

*Jatropha curcas* Linnaeus is a multi-purpose bush/small tree belonging to the family of Euphorbiaceae. It is a native of tropical America, but now thrives in many parts of the tropics and sub-tropics in Africa/Asia (Gubitz et al., 1999; Kumar and Sharma, 2008; Openshaw, 2000; Martinez-Herrera et al., 2006). *Jatropha* plant produces seeds containing 27 to 40% oil. It is a perennial plant which does not require much care and produces well for 30 to 40 years after establishment. It is among several other plants which exist with very high nutritive value and yet remain unexploited for human and animal benefits. Thus, they deserve more attention as they can receive worldwide attention so that as many people and animal as possible can benefit from their various advantages.

The seed from this plant can be used as seed cake after extracting the oil either mechanically or chemically using ethanol to remove the polar oil or petroleum ether to remove both the polar and non – polar oil. The seed cake to be used in this experiment has been shown by previous researchers (Makker et al., 1998) to contain vital nutrients like crude protein (57 to 64%) with 90% true protein, the amino acid except lysine is also higher than FAO reference protein required for animal wellbeing and growth. However, *J. curcas* contains some toxins and anti-nutritive compounds which had been identified as curcin, tannins, phytates, flavonoids, saponins, vitexine, cyanide and trypsin inhibitor (Makker and Becker, 1999). Various methods like heat, chemical and biological treatments had been found to inactivate the toxins except phorbol esters.

Due to the environmental concern and expensive/ synthetic insecticides, the demand for alternative source(s) of insect pest control has increased. Also, the pervasive use of these insecticides in granaries of small-scale farmers has led to a number of problems, such as killing of non-target species, user hazards, found residues, evolution of resistance to the chemicals, high cost of the chemicals and the destruction of the balance of the ecosystem (Boateng and Kusi, 2008). One way of reducing the continual dependence on imported

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**Table 1.** Costs analysis of seed oil production.

| Input | Quantity | Unit cost (USD) | Costs (USD) |
|---|---|---|---|
| Raw seeds | 0.4kg | 1.65/kg | 0.66 |
| Labour: Shelling (manual) | 0.4 man-day | 3.20/man-day | 1.32 |
| Milling | - | 0.66/kg | 0.26 |
| Petroleum spirit | 35 ml | 6.60/L | 0.23 |
| Total | | | 2.47 |

insecticides is to use the widely available but under-utilized plant products including *J. curcas*. Whatever the intended end–use, candidate plants for pest control would need to be perennial, easy to grow and economical in terms of space, labour, water and fertilizer application. They should not show any potential to become weeds or host for pathogens, and if possible, they should offer complementary economic uses (Dales, 1996).

Vegetable oil-based products hold great potential for stimulating rural economic development because farmers would benefit from increased demand for vegetable oils (Akbar et al., 2009). The control of insect pests with *Jatropha* is poorly documented. Researchers do not have adequate information base about the potential and economics of this plant to make decisions. This study therefore examines the toxicity of *Jatropha* seed oil on maize weevil, *Sitophilus zeamais* Motsch. in stored maize grains and the costs analysis of its production.

## MATERIALS AND METHODS

### Insect culture

Newly emerged adult *S. zeamais* from existing stock culture were used for the experiment. The culture was maintained in an insectary at 32± 3°C and 60 to 65% relative humidity.

### Preparation of grain sample

Seeds of SUWAN-1 maize variety obtained from Nigerian Stored Products Research Institute, Ilorin, Nigeria were disinfested by storing in a deep freezer at 5°C for 7 days. The maize grains were dried, prior to use, to a constant moisture content of 12% in an oven at 110°C for 4 h.

### Preparation of plant material

Seeds of *J. curcas* were collected from different parts of Ilorin, Nigeria between 7 and 14th June, 2009, and then milled after air-drying for 7 days in a well-ventilated area under shade.

### Seed oil extraction

A Soxhlet extractor was used to extract oil from *Jatropha* seeds. Petroleum spirit was used as the solvent. The extraction process was carried out for 6 h until required quantity of the seed oil was obtained. For this experiment, 40 g of *Jatropha* seed produced the oil used.

### Cost of seed oil production

To determine the cost of producing seed oil, total cost of the variable inputs namely raw *Jatropha* seeds, labour on shelling, milling and solvent used were estimated.

### Experimental design

Three rates of the seed oil, 0.2, 0.5 and 1.0 ml were measured into jars (14 cm in diameter) containing 100 g maize grains and untreated control containing the maize seeds only. Each jar was thoroughly mixed and the oil was allowed to settle for 1 h before introducing 5 pairs of newly emerged adult weevils. Each treatment and the control were replicated four times and arranged in Completely Randomized Design (CRD) on a laboratory table. The jars were covered with perforated lid placed over muslin material to allow aeration and avoid suffocation or entry/exit of insects. Adult mortality was counted and recorded on daily basis for 4 days. Damage by the weevil was examined by the number of grains perforated and percentage seed damage determined while percentage weight loss was computed as:

(Weight of grains consumed / Weight of grains supplied) x 100

In the weevil bioassay with *Jatropha* seed oil, the experimental set up was similar to the above. After 4 months, the number of grains perforated in the treated and control jars were counted for the determination of the WPI following the procedure of Stoll (2000).

WPI = (% of treated grains perforated / % of control grains perforated) X 100 + Percentage of treated grains perforated

### Statistical analysis

Relevant data were subjected to analysis of variance and significantly different means were separated using Least Significant Difference (LSD) at 5% level of probability.

## RESULTS AND DISCUSSION

Table 1 shows the cost of seed oil used in the study. A total cost of USD 2.47 was used for producing136 ml of seed oil. The estimate could be lower under large scale production of the oil.

Table 2 shows that *Jatropha* seed oil applied at 0.2, 0.5 and 1.0 ml/100 g maize grains caused significantly higher ($P<0.05$) adult mortality compared to control. At 24 h after

**Table 2.** Effect of *J. curcas* seed oil on adult mortality of *S. zeamais* in stored grains.

| Rate of treatment (ml) | Time intervals (h) | | | |
|---|---|---|---|---|
| | **24** | **48** | **72** | **96** |
| 0.0 | 0.0 | 0.25 | 2.5 | 3.5 |
| 0.2 | 1.0 | 4.75 | 7.5 | 9.5 |
| 0.5 | 6.0 | 9.25 | 9.75 | 10.0 |
| 1.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| SE | 0.41 | 0.82 | 0.67 | 0.57 |
| LSD | 0.93 | 1.88 | 1.53 | 1.32 |

**Table 3.** Percentage weight loss caused by *S. zeamais* on maize grains treated with Jatropha seed oil.

| Rate of treatment | Weight loss (%) |
|---|---|
| 0.0 | 65.0 |
| 0.2 | 65.0 |
| 0.5 | 12.0 |
| 1.0 | 0.0 |
| SE | 0.20 |
| LSD | 0.46 |

**Table 4.** Weevil perforation index and seed damage by *S. zeamais* on maize grains treated with *Jatropha* seed oil.

| Rate of treatment | Total No. of grains | No. of grains damaged | No. of undamaged grains | seed damage (%) | WPI |
|---|---|---|---|---|---|
| 0.0 | 414 | 50 | 364 | 12.08 | 100.0 |
| 0.2 | 414 | 12 | 402 | 2.89 | 26.31 |
| 0.5 | 414 | 11 | 403 | 2.66 | 24.68 |
| 1.0 | 414 | 8 | 406 | 1.93 | 17.91 |

treatment, all insects died at 1.0 ml/100 g grains showing that petroleum spirit extract of *Jatropha* seed afforded contact toxicity to *S. zeamais* while the effectiveness of other rates of treatment increased with increase in period of exposure. There was no significant difference (P>0.05) in the number of adult insects killed at 0.5 and 1.0 ml/100 g grains 72 and 96 h after treatment. The results showed that inedible vegetable oils, mostly produced by seed-bearing trees and shrubs can provide an alternative to the use of insecticides (Akbar et al., 2009). With no competing food uses, this characteristic turns attention to *J. curcas* which grows in tropical and sub-tropical climates across the developing world (Openshaw, 2000). The toxic effect of the seed oil may be attributed to the toxic phorbol esters present in the seed and in the oil. There is therefore the need to detoxify the seed and oil before use for nutritional purposes. The Jatropha seed oil had been used to control *Callosobruchus maculatus* (Jadhav and Jadhav, 1984).

Table 3 shows percentage weight loss caused by *S. zeamais* on stored seeds treated with *Jatropha* seed oil 4 months after infestation. There was significant difference between different rates of treatment compared to the control. It was observed that applying the oil was better than no application at all. An important observation was made during the study that weevil damage was less severe with increase in rate of treatment (Table 4). Fatope et al. (1995) reported that the weevil bioassay tool can be used to identify storage pest-controlling plants irrespective of their mode of action. A WPI value < 50 indicates positive grain protectant effect or reduction of weevil infestation.

## CONCLUSION AND RECOMMENDATION

Jatropha seed oil extract seems quite appropriate as a component of insect pest management approach on grains. The cost of extraction could further be reduced under large scale production and for bulk storage.

However, there is the need to make further researches into cost effective post - harvest processes. Appropriate and affordable technology should be developed for the extraction of *Jatropha* seed oil.

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