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Research Article

Effect of Pawpaw plant extracts against *Sitophilus zeamais* (Mots) (Coleoptera: Curculionidae) on maize seeds

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Abstract: The effect of Pawpaw plant part extracts (leaf, stem bark, root and flower) at different dosages (0.5, 1.0, 1.5, 2.0 and 2.5g) against *Sitophilus zeamais* infesting stored maize grains were assessed at the Biology Laboratory of the Southwestern University, Okun-Owa. Treatments were admixed with 30g of maize grains, infested with ten adults of *S. zeamais* and stored in 3.0 mm petri dishes. The experiment was laid out in completely randomized design (CRD) and replicated four times each. Data were collected on adult mortality, oviposition and percentage weight loss of the grain in each of the replicate. Data collected were analyzed using analysis of variance, while sample means were separated with the aid of least significant difference (LSD) at 5%. There were significant differences in adult mortality of *S. zeamais* treated with different dosages of the plant parts powder. The flower powder of the plant recorded the highest means adult mortality (10) compared to the lowest adult mortality of 0.1 obtained at the control experiment. The flower part powder also revealed the lowest mean eggs laid (oviposition) (7.1) and the lowest grain damage loss (1.4 %) when compared with the values of 18.7 and 40.0 obtained for mean eggs laid and percentage weight loss obtained when stem bark and control treatments respectively. This clearly showed that the powder of the flower of *C. papaya* showed good potential as bio-insecticide for protecting stored maize grains.

Keywords: Mortality, *Sitophilus zeamais*, toxicity, storage, oviposition, eclosion.

INTRODUCTION

Maize (*Zea mays* (L.)) is an annual monocotyledonous plant belonging to the family of Poaceae. It originated from Mexico and it is one of the most important cereal crops cultivated in the world (Romain, 2001). Maize constitutes one of the major diets of millions of people. In Africa, maize is mainly grown by small-scale farmers for utilization as both human food and animal feed (Edelduck *et al*., 2015). Maize is produced in Africa on over 20 million hectares, which is 16 % of the total world area under which the crop is produced. The total annual production is about 25 million tons, which represents 6% of the total world production (Romain, 2001). Maize could be grilled, boiled, roasted or made into various products for human consumption (Polazek and Khan, 1998).

The important constituents of maize are carbohydrates, protein, fat and oil and minerals. The protein quantity in maize is relatively low and ranges between 8 and 15%, but has relatively high percentage of Sulphur-containing amino acids, methionine and cysteine (Romain, 2001). However, the availability of maize is often hindered by infestation of insect pests which constitute a major problem in its production and storage. The most important storage pest of maize is *Sitophilus zeamais* (Mots.) (Edelduok *et al*., 2015).

According to Adesina (2013), *Sitophilus zeamais* is the most widespread and destructive major insect pest of stored cereals throughout the world. It is a cosmopolitan field-to-store pest of maize in tropical and subtropical regions. Damages caused by this insect become noticeable when the adult insect bore holes that reach approximately 1.0 mm in size in the grain and deposit its egg within the hole (Edelduok, 2015). The developmental stages of the insect is within the grain after which the adult weevil bores its way out, leaving a characteristic emergence hole in the grain (Rees, 2004; Hill, 1983). *S. zeamais* damage reduces the availability of maize production by farmers who use stored grains as seeds for planting. Insect infestation of maize grain leads to a reduction in both quality and quantity of harvested crops and in most cases predispose the stored grains to secondary phyto-pathogenic infection (Evans, 1987).

Different methods have been adopted to manage the level of infestation by this pest to the barest minimum. The use of synthetic chemicals in pest control is eliciting much concern owing to the undesirable effects emanating from their use (Torignan *et al*., 2001). Residual effects of some of the pesticides sometimes pose problems to the environment. Emphasis in recent times has been laid on non-chemical strategies to protect agricultural crops and human environment. This is rekindling a renewed interest in the use of natural products from higher plants and plant products in the pest management scheme (Salako, 2002).

Carica papaya belongs to the family Caricaceae, which originated from America. It is a latex producing tree. The latex contains papain which could be used to protect the seeds against insects infestation. Several researchers have reported the efficacy of the insecticidal properties of some local plants to storage pests as alternative to the conventional pesticides application. Adedire and Ajayi (1996) reported that plant powder, extracts and oils are cheaper, safer and eco-friendly in controlling storage pests, while Adenekan and Shosanya (2006) reported the efficacy of *Plumeria rubra* products for the control of *Callosobruchus maculatus*. The toxicity of *Piper guineense* has also been reported to be very high on the cowpea beetle (Ivbijaro and Agbaje, 1986).

According to Ulcih *et al*., 2008), plant powders are cheap, easily bio-degradable and readily available and will not contaminate food produce in acting as protectant in small scale storage system. Thus, this study assessed the toxicity of *Carica papaya* powders against *Sitophilus zeamais* (Mots.) on maize seeds during storage.

MATERIALS AND METHODS

The experiment was carried out at the Biology Laboratory of the Southwestern University, Okun-Owa, Ijebu-Ode, Ogun State. Nigeria. 30g of weevil-infested maize grains was purchased from Apata market in Ibadan. 10 adults male and female beetles were carefully identified and introduced into Kilner jar containing un-infested maize grains. After 14 days, the adult insects were removed from the culture and used for the experiment. The plant products tested for insecticidal activities were collected from growing stand of *Carica papaya* in Moor Plantation, Ibadan, a month before the commencement of the study. The leaves, stem bark, root and flowers of the plant were separately collected and air-dried before grinding to powdery form.

The untreated maize seeds used for this trial was obtained from the seed store of the Institute of Agricultural Research and Training (IAR&T), Ibadan. 20g of maize grains were measured into empty glass petri dishes. Powder of each *Carica papaya* products was applied at the rate of 0.5, 1.0, 1.5 and 2.0 g, while the last sets containing only maize seed served as the control experiment. The petri dishes were then vigorously shaken for optimum coverage of the grain with the plant powder. Five males and females of tenera adults of *S. zeamais* were introduced into each of the treatments and control. Each treatment was carefully labelled and arranged in completely randomized design (CRD) and set aside in the laboratory for 24 hours before data recording started.

After every 24hrs mortality of adult *S. zeamais* in treated and untreated maize grains was observed and recorded. This was done by touching the insects with a pair of forceps. Insects that did not move when touched was considered dead. This continued for 30 days when all the insects in the treated grains were dead before the emergence of the F_1 generation.

25 days after infestation (DAI), the grains were each examined in gentian violet to reveal the number of eggs laid on the seeds. These were carefully counted and recorded (Goosens, 1949). Similarly, the percentage weight loss was calculated for each of the treatments using the method of Babarinde *et al*., (2010) as presented below:

$$\text{Percentage weight loss} = \frac{W_C - W_t}{W_c} \times 100\,\%$$

W_c = Initial weight of grain before infestation
W_t = Final weight of grain after infestation

Data collected from each treatment were subjected to one-way analysis of variance, while treatment means were separated using the Least Significant Difference (LSD) at five percent (5%) level of significance ($P \leq 0.05$).

RESULTS

The results of the toxicity of *Carica papaya* powder on mortality of *Sitophilus zeamais* on maize grains are presented in Table 1. The mortality of *S. zeamais* increased with increasing dosage application. The mean mortality of 2.2 obtained when 0.5 g of the leaf powder of *C. papaya* was significantly different from the mean value of 6.4 obtained when flower powder was applied, but was not significantly different from the values of 2.6 and 1.4 obtained when the root and the stem bark were respectively applied.

Table 1: Toxicity of *C. papaya* plant parts powder on the mean adult mortality of *S. zeamais on maize seeds.*

Test plant powder	Concentration of *Carica papaya* on mean mortality of *S. zeamais* on maize seeds (g)					
	0.5	1.0	1.5	2.0	2.5	0.0
Leaf	2.2	2.1	3.5	3.5	4.1	0.0
Stem bark	1.4	2.5	2.8	4.5	6.4	1.0
Flower	6.4	6.8	7.4	8.2	10	1.2
Root	2.6	2.8	3.5	4.6	5.2	0.1
LSD $_{(0.05)}$	1.64	1.32	2.1	3.4	3.1	0.1

n = 10 insects

Total mortality of *S. zeamais* was obtained at 2.5g of *C. papaya* flower powder per 30g of maize grains, while 8.2 mean mortality was obtained when the flower powder of the tested plant was applied at 2.0g. However, the flower powder of *C. papaya* significantly increased the mean mortality of the weevil at different dosages when compared to the control experiment when only 1.2 mortality was obtained after 48 hrs. of infestation (Figure 1).

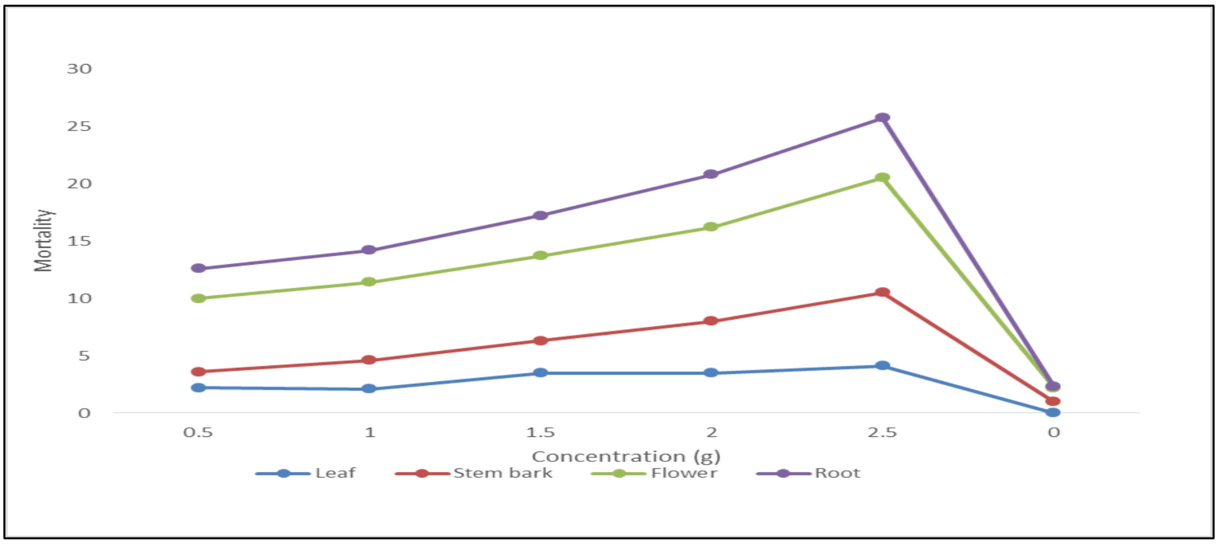

Figure 1: Effects of *C. papaya* plant parts powder on the mean mortality of *S. zeamais* on maize seeds

Females of *S. zeamais* were able to lay eggs at all the treatment dosages, but the lowest of 2.4 was obtained when 2.5 g of flower powder was applied and was significantly different from the values of 8.1, 7.1 and 4.3 eggs laid obtained on maize grains when the stem, root and leaf powders were applied respectively (Table 2). The highest mean number of eggs (29.3) was obtained at the control experiment, while the lowest egg of 2.4 was obtained on grains treated with 2.5 g of the flower powder of *C. papaya (*Figure 2). The results of this study revealed clearly that flower powder of *C. papaya* significantly decreased the oviposition and population of *S. zeamais* on stored maize grains

Table 2: Effects of *C. papaya* plant parts powder on the mean oviposition (eggs laid) by *S. zeamais on maize seeds*

Test plant powder	Concentration of *Carica papaya* on mean oviposition of *S. zeamais* on maize seeds (30g)					
	0.5	1.0	1.5	2.0	2.5	0.0
Leaf	15.3	12.4	6.5	4.4	4.3	25.2
Stem bark	18.7	16.2	14.3	10.1	8.1	27.1
Flower	12.3	6.1	6	4.2	2.4	24.1
Root	11.3	9.5	8.6	8.1	7.1	29.3
LSD $_{(0.05)}$	2.7	3.1	4.3	2.1	4.0	12.4

n = 10 insects

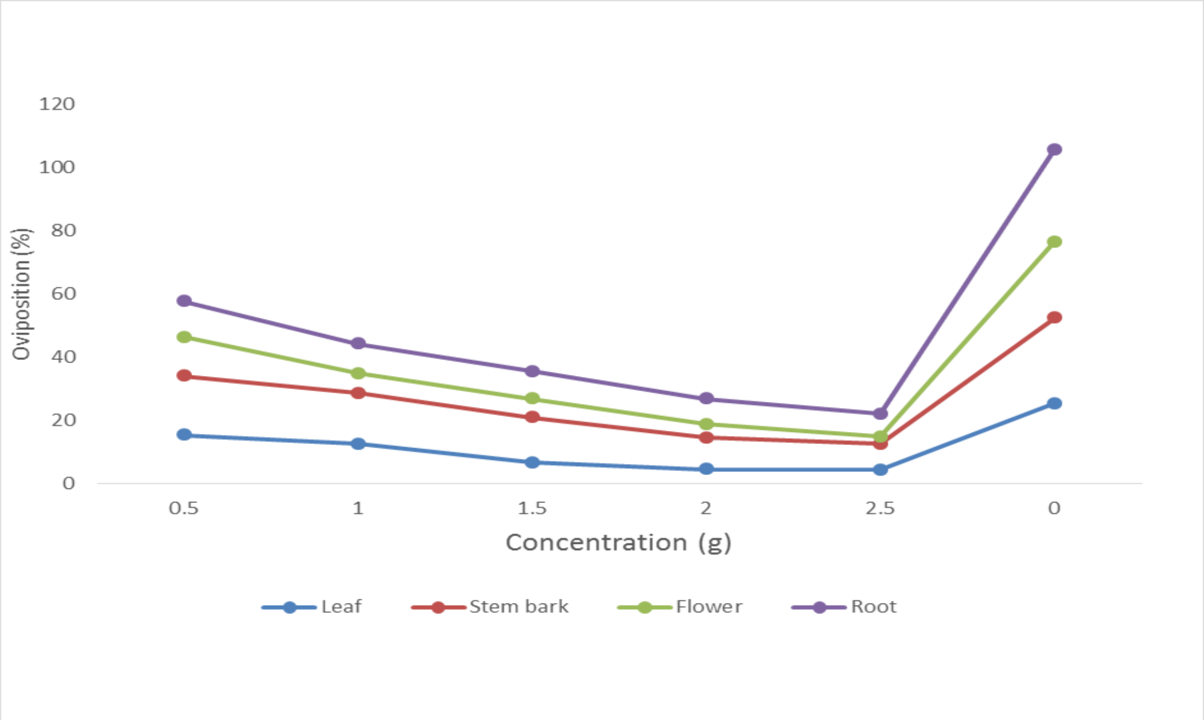

Figure 2: Influence of *C. papaya* plant parts powder on the mean oviposition (eggs laid) by *S. zeamais* on maize seeds

Percentage weight loss of maize grains treated with different plant powders of *C. papaya* are summarized in Table 3. The results showed reduction in weight loss on the seed grains treated with different concentrations of the tested plant parts powder when compared to the control. Results of weight loss obtained when 2.0 and 2.4g of the flower powder of *C. papaya* plant was applied revealed the lowest weight loss of 2.0 and 1.4% respectively which was significantly different when compared to the values of 40.0 and 39.8% recorded from the control experiment where no plant part powder was applied (Table 3). There were no significant differences in the percentage weight loss of maize grain recorded in this study but the efficacies of the powders were in the order: flower > leaf > root > stem (Figure 3).

Table 3: Effects of *C. papaya* plant parts powder on the percentage mean weight loss of maize seeds infested with *S. zeamais*

Test plant powder	**Concentration of *Carica papaya* on mean weight loss of maize seeds (30g)**					
	0.5	**1.0**	**1.5**	**2.0**	**2.5**	**0.0**
Leaf	35.1	37.1	26.1	20.1	10.5	40.0
Stem bark	38.4	34.2	19.4	12.1	12	40.0
Flower	5.2	2.4	3.4	2.0	1.4	39.8
Root	22.4	22.1	16.4	10.1	8.4	39.8
LSD $_{(0.05)}$	3.4	3.9	3.7	4.3	2.4	4.3

n = 10 tenera insects

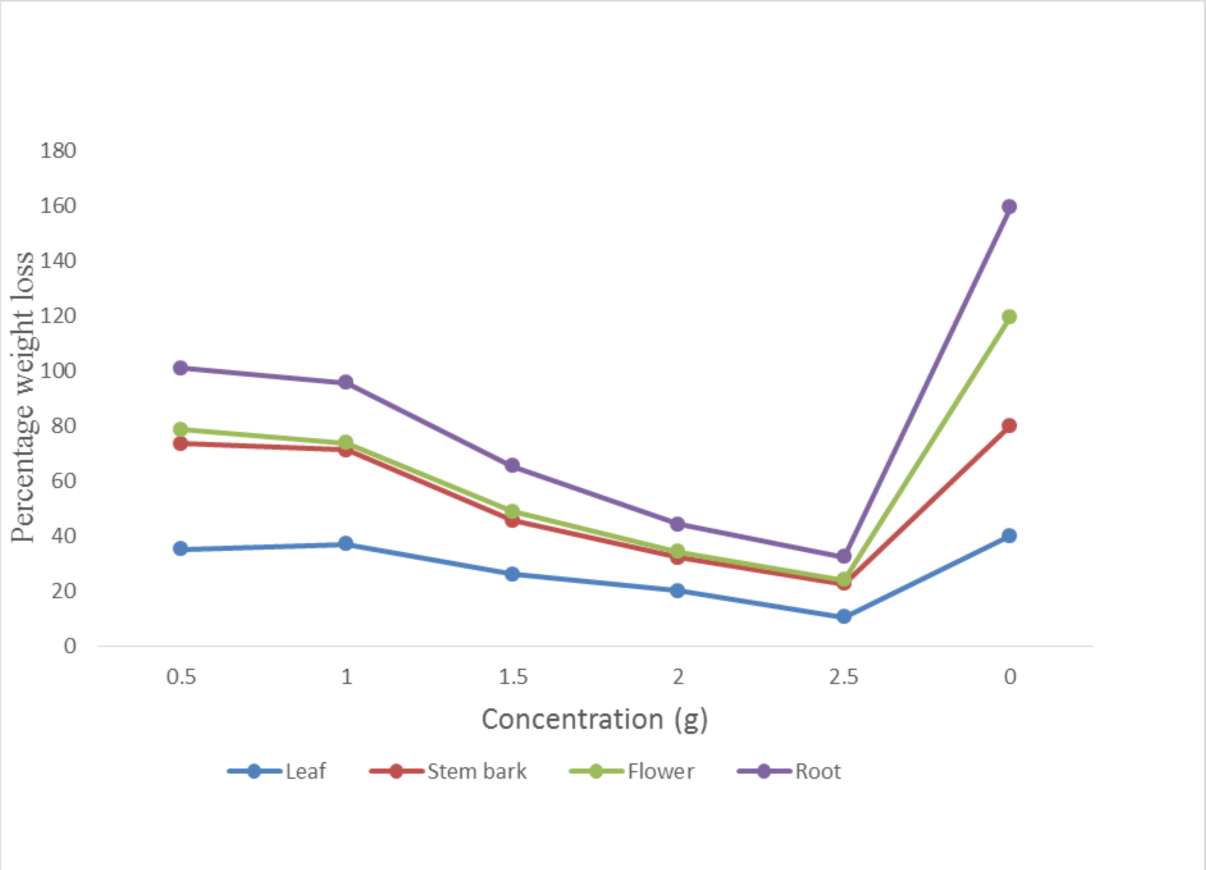

Figure 3: Influence of *C. papaya* plant parts powder on the percentage mean weigt loss of maize seeds infested with *S.zeamais*

DISCUSSION

This study investigated the toxicity of *C. papaya* plant powders against *S. zeamais* on maize seeds. Results of this study revealed that the flower powder of *C. papaya* possesses toxicity ingredients against *S. zeamais*. Several studies have consistently reported the insecticidal effects of *Imperata cylindrical*, *Sida acuta*, *Chromoleana odorata* and *Gmelina arborea* against *S. zeamais* (Ehisiaya and Ikpti, 2018). Adesina (2013) also reported the insecticidal potentials of *Mormordica charantia* leaves powder against maize weevils. The efficacy of seed oil, leaf, stem and seed extracts of *Jathropha curcas* against several insect pests of stored agricultural grains have been confirmed (Bashir and El-Shafi, 2013; Adebowale and Adedire, 2006; Abdoul *et al.*, 2014). Studies on the toxicity effects of *C. papaya* plant extracts on *S. zeamais* are scanty; however, in this study, the flower powder of the plant demonstrated excellent toxicity activity against *S. zeamais*. This result corroborated the findings of Adenekan *et al.*, (2007; 2013) where high mortalities of *Callosobruchus maculatus* at all tested concentrations of *C. papaya* and *Moringa oleifera* flower powders on cowpea seeds during storage were reported. At the highest concentration, the flower powder of *C. papaya* caused about 100 % mortality of *S. zeamais*, while the lowest concentration caused about 64 % mortality after 200hrs. of infestation. This is in agreement with the report of Opuba *et al.*, (2018) who stated that the mortality of *C. maculatus* depended on the duration while using *Jathropha curcas*.

The mean eggs laid by *S. zeamais* were significantly affected by the application of different dosages of *C. papaya* plant powders. The flower powder of the tested plant showed the lowest mean oviposition value of 2.4 which was significantly different from the mean value of 24.1 obtained at the control experiment where no plan powder was applied. This clearly indicates that the flower powder of this plant has an effect on oviposition of this insect pest. Studies on the toxicity effect of *C. papaya* plant parts powder on the percentage mean weight loss at various dosages revealed that the plant flower powder was effective in reducing maize grain damages caused by *S. zeamais*. At higher concentration of 2.5 g, the flower powder showed lowest weight loss of 1.4 % when compared with the value of 40.0 % recorded at the control experiment.

The result of this study unequivocally shows that the flower powder of *C. papaya* has higher potential in controlling *S. zeamais* in maize grain storage. The plant is readily available in the environment and can easily be obtained and processed for the protection of stored maize grains against insect pests, especially *S. zeamais*. It is therefore recommended that in order to reduce the adverse effects of synthetic insecticides to humans and the environment, *C. papaya* flower powder could be adopted by local farmers and small scale industries for the protection of maize grains against *S. zeamais.*

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