



**EVALUATION OF INSECTICID ACTIVITY OF *LANTANA CAMARA* ON  
RED FLOUR BEETLE (*TRIBOLIUM CASTANIUM*) CAUSING DAMAGE ON  
WHEAT IN THE STORAGE**

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**ABSTRACT**

Laboratory experiment was carried out to determine the insecticidal activity of leaves and root powder of *Lantana camara* and optimum concentration for the management of Red Flour Beetle (*Tribolium castanum*). Actellic dust was used as positive control while untreated wheat seeds serving as negative control. The consisted of three rates of Leaf powder (1.5 g, 3.5 g and 5.5 g), three rates of root powder (1.5 g 3.5 g and 5.5 g), Actellic dust and a control These were applied to 100 g uninfested wheat seedslaid out in a Completely Randomized Design (CRD) andrepeated three times. Contact activity of the plant products were evaluated and data collected were subjected to analysis of variance (ANOVA) and means were separated using NDMRT at 1% and 5% probability level. Five pairs of laboratory reared F<sub>2</sub> generation of the *T. castanum* was introduced into the treated and untreated wheat The open end of the plastic containers was covered with a fine muslin cloth and tied firmly with rubber band and kept at room temperature (29 – 32°C) in the laboratory. Observation on insect mortality was recorded at 24, 48and 72 hours after exposure to the treatment for three days. The results showed thatapplication of 5.5 g/100g leaves powders significantly ( $P \leq 0.05$ ) caused highest mortality of adult *T. castanum* at 24 (3.00), 48 (2.67), 72 (2.00) and 96 (2.00) hours by contact toxicity compare to other treatments. Similarly, wheat seeds treated with 5.5 g /100 g of the leaves and root powder significantly ( $P \leq 0.05$ ) decreased Oviposition (0.00), Adult emergence (0.00), Percentage grain damage (4.33%), Number of exit holes (0.00) and Weight loss (0.00%). Germination of the treated seeds was not affected negatively. The 5.5 g and 3.5 of leave of *L. camara* could be recommended as an alternative to chemical insecticides to be used as contact protectants against *T. castanum* on stored wheat seeds.

**Keywords:** Actellic dust, *Lantana camara*, leaves, Roots, *Tribolium castanum*, Wheat

**INTRODUCTION**

Globally, stored wheat faces substantial post-harvest losses estimated at 10–20% annually, with insect pests accounting for a major share of these losses (Stored Product Insects, 2018). Among these, *Tribolium castaneum* is the most important. The red flour beetle, is considered a principal secondary pest capable of infesting processed wheat products, flour, and bran, leading to both quantitative weight loss and qualitative degradation through contamination and mycotoxin spread (Stored Product Insects, 2018). Numerous cases of food poisoning, environmental hazards and insufficient financial resources of African farmers have drawn attention to safe means of pest control. The control of insect pest of stored products (such as *C. maculatus*, *S. zeamais*, *Tribolium castaneum* and *Rhizopertha dominica*) was based on the use of fumigants like (methyl bromide and phosphine). However, their increasing use in recent years has created a range of ecological problems such as bio-magnification, resurgence and the development of insecticide tolerant strains of pest species (Radha and Susheela, 2014).

*Lantana* species, especially *L. camara*, contain pentacyclic triterpenoids that cause hepatotoxicity and photosensitivity when ingested by grazing animals such as sheep, goats, bovines, and horses (Sanders, 2012). This has led to widespread livestock loss in the United States, South



Africa, India, Mexico, and Australia. Plants have long time been used as an alternative to chemical insecticides because of their non-cytotoxicity, easy of biodegradable, more environmentally friendly (Alade *et al.*, 2017). Various plant parts have shown antifeedant, ovicidal, repellent, and toxic effects against insects pest (Devi *et al.*, 2011) Essential oils and their individual constitute have been known to play an important role in protection of stored grains and proved to have repellent and insecticidal properties (Yao *et al.*, 2008).

Phytochemical screenings report total phenolic content of 120–150 mg GAE/g and flavonoid content up to 80 mg QE/g in leaf extracts, while roots contain complementary compounds such as steroids and tannins (Melanie *et al.*, 2020; Kumar *et al.*, 2023). Leaf and flower essential oils of *L. camara* have shown both contact and fumigant toxicity against various storage pests, with LC<sub>50</sub> values against *T. castaneum* ranging from 178 to 250 µL/L air in fumigant assays and LD<sub>50</sub> of 0.20 mg/cm<sup>2</sup> in contact assays (Rajashekar *et al.*, 2014; Lashari *et al.*, 2014). Methanolic and ethanolic leaf extracts produce significant adult mortality (>80% at 2 mg/mL) and oviposition inhibition in *Sitophilus oryzae* and *T. castaneum* (Rajashekar *et al.*, 2014; Aisha *et al.*, 2024). While leaf extracts have been extensively studied, few investigations have targeted root extracts, which may harbor unique compounds with synergistic insecticidal activity. Comparative phytochemical profiling of *L. camara* leaf and root extracts can reveal variations in compound classes and concentrations that underpin differential bioactivities. For example, leaves often exhibit higher concentrations of volatile terpenoids, whereas roots may accumulate non-volatile alkaloids and phenolic glycosides (Jayanna *et al.*, 2022). There is increase in demand and experience in the use of these natural products which could be used as an alternative to synthetic chemicals for management stored grain. This includes the development of nonchemical technologies which may eliminate the use of synthetic chemical insecticides and have economic and health benefits for applicators, consumers, and the environment. The present study was carried out to investigation the insecticidal activity leave and roots powder of *Lantana camara* for the management of *T. castanum* on stored maize grain.

## **MATERIALS AND METHODS**

### **Study Area**

The study was conducted at the Zoology Laboratory, Faculty of Science, Abubakar Tafawa Balewa University, Bauchi. The experiment was carried out under ambient temperatures ranging from 28°C to 32°C and relative humidity between 55% and 75% over a period of three months. Bauchi is located at approximately 10° 74'E longitude and 9° 47'N latitude, situated at 690.3 meters above sea level in the savannah zone of Nigeria.

### **Collection and Preparation of *Lantana camara***

Leaves and stems of *Lantana camara* were collected from plants growing around Botanical Garden in the University of Maiduguri, Borno metropolis. The collected plant materials were air-dried under shade for two weeks to preserve their phytochemical integrity. After drying, the leaves and root were ground separately using a pestle and mortar to obtain fine powders. The powdered samples were kept in airtight polythene bags until further use.

### **Disinfestation of Wheat Seeds**

Wheat seeds were manually sorted to remove damaged seeds, seeds with holes, and other contaminants. The seeds were then sieved to eliminate insects and remaining debris. To control any existing infestation, the seeds were fumigated with aluminum phosphide (Phostoxin tablets) at a dosage of 0.2 g/kg for 72 hours under airtight conditions, following the method described by Abdullahi (2011). The seeds were spread out on a clean polythene mat and covered with a baft cloth for 48 hours to allow the dissipation of any residual fumigant and prevent re-infestation.

### **Source and Rearing of Experimental Insects**

A sample of *Tribolium castaneum* (commonly known as Red flour beetle) was collected from previously infested stored Wheat seeds purchased from the Railway Market in Bauchi Local Government Area, Bauchi State, Nigeria. The insects were transported to the laboratory and maintained at room temperature (28 ± 2°C) and relative humidity (70 ± 5%).



10 kg of sound, uninfested Wheat grains were weighed and transferred into an earthen clay pot. Adult *Tribolium castaneum* were introduced into the earthen pot to establish a breeding culture. The pot was covered with white muslin cloth, secured tightly with a rubber band, and the insects were allowed to oviposit under crowded conditions for two weeks. After this period, all live and dead parental insects were sieved out, leaving the eggs and larvae to develop until the emergence of the F<sub>1</sub> generation. The same procedure was repeated with the F<sub>1</sub> generation to obtain the F<sub>2</sub> generation, ensuring a pure, laboratory-maintained culture for use in the experiments.

#### **Treatment and Experimental Design**

The treatments consisted of three (3) rates of *Lantana camara* Leaf powder (1.5 g, 3.5 g, and 5.5 g), three (3) rates of Root powder (1.5 g, 3.5 g, and 5.5 g), Pirimiphos-methyl (Actellic dust) as the positive control and Untreated Wheat seeds as the negative control. Each treatment was applied to 100 g of uninfested wheat seeds and was replicated three times. The experiment was arranged in a Completely Randomized Design (CRD). Treatment means were separated using the New Duncan Multiple Range Test (NDMRT).

#### **Determination of the Bioactivity of Test Materials on Red flour beetle by Mode of Action**

##### **Contact toxicity**

Five pairs of laboratory-reared F<sub>2</sub> generation red flour beetles (*T. castaneum*) were introduced into plastic jars (4 x 6 x 8 cm) containing treated and untreated wheat seeds. The open ends of the jars were covered securely with fine muslin cloth and fastened with rubber bands to prevent insect escape while allowing ventilation. The jars were maintained at room temperature (29–32°C) in the laboratory. Insect mortality was recorded at 24, 48, and 72 hours post-exposure for three consecutive days, following the methodology of Liu and Ho (1999).

##### **Evaluation of Oviposition**

Five infested wheat seeds were randomly selected from both treated and untreated batches. The number of eggs laid on each seed was counted with the aid of magnifying hand lens. Eggs were identified by the characteristic dot-like marks on the seed surface, which indicate larval entry holes that have been sealed by the weevil. The percentage of oviposition deterrence was evaluated using the formula:

$$\% \text{Deterrence} = \frac{C_s - C_t}{C_s} \times 100$$

Where C<sub>s</sub> = number of eggs laid on control (untreated) seeds, and C<sub>t</sub> = number of eggs laid on treated seeds, as described by Vanmathi *et al.* (2010).

##### **Evaluation of Adult Emergence**

All treated and untreated Wheat seeds were incubated at room temperature in complete darkness for eight weeks to monitor the emergence of adult *Tribolium castaneum* weevils from the seeds. The number of adult weevils that emerged was recorded weekly. The percentage of adult emergence deterrence was calculated using the following formula, as described by Vanmathi *et al.* (2010):

$$\% \text{Deterrence} = \frac{A_c - A_t}{A_c} \times 100$$

Where:

A<sub>c</sub> = Number of adults emerged from the control (untreated seeds)

A<sub>t</sub> = Number of adults emerged from treated seeds

##### **Evaluation of Percentage Seed Damage**

Ten seeds were randomly selected from each treatment, and the number of exit holes on each seed was examined. Seeds containing three or more holes were classified as damaged. The number of damaged and undamaged seeds was counted and recorded for each replicate. The percentage seed damage was calculated using the formula:

$$\% \text{Seed Damage} = \frac{G_1}{G_2} \times 100$$

Where:

G<sub>1</sub> = Number of damaged seeds (seeds with three or more holes)

G<sub>2</sub> = Number of undamaged seeds (seeds with fewer than three holes)



### **Evaluation of Weight Loss**

At the conclusion of the experiment, the Wheat seeds were sieved to remove dead insects and powder residues. The cleaned seeds were then weighed to determine the weight loss. The percentage weight loss was calculated using the formula:

$$\% \text{Loss} = \frac{\text{initial weight} - \text{final weight}}{\text{initial weight}} \times 100$$

This method follows the procedure described by Awoke *et al.* (2014).

### **Evaluation of Seed Viability**

Ten seeds were randomly selected from each treatment group to assess their germination potential. The seeds were evenly placed on moistened filter paper within Petri dishes and incubated under controlled conditions for a period of seven days. During this time, regular observations were made to monitor seed germination. At the end of the seven-day period, the number of germinated seeds in each Petri dish was counted and recorded.

The germination percentage (GP) was calculated using the following formula as described by Awoke *et al.* (2014):

$$\text{Germination percentage (GP)} = \frac{\text{number of seed germinated}}{\text{Total number of seed planted}} \times 100$$

### **Data Collection and Analysis**

Data were collected on the following parameters: adult mortality of *Tribolium castaneum*, number of seeds with holes, number of eggs laid, number of emerging weevils, number of germinated seeds, weight loss, and percentage grain damage.

All data collected were subjected to analysis of variance (ANOVA) using SPSS software version 23. Where significant differences detected among treatment means, New Duncan's Multiple Range Test (NDMRT) was adopted to separate and compare the means at a 5% significance level.

## **RESULTS AND DISCUSSION**

### **Adult Mortality**

Result of the effects of *L. camara* on adult mortality of *tribolium castanum* at various hours after exposure to treatment are presented in Table 1. The results revealed that, wheat seeds treated with 5.5 g/100g leaves and root powder significantly caused highest (3.00) mortality of adult *T. castanum*. This could be compared with Actellic dust (chemical insecticide) that recorded (3.00). Adult mortality of *T. castanum* increases with the increase in concentration at various hours after exposure to treatment. The result of this is in conformity with the of report of Adane, (2020); Bouda *et al.* (2001) who reported that *L. camara* oil had the potential to control *S. zeamais* and a morality rate of 100% was recorded for the highest concentration of 0.5% v/w. Similarly a report by Fang *et al.*, (2010) affirmed that, after 24 h treatment with *Nepeta cataria* leaf oil, the mortality was 24%, 36%, 46%, 52%, 76%, and 94% with concentration of 3, 8, 16, 31, 63, and 126 L L<sub>1</sub>, respectively. Crude extract of *L. camara* has fumigant toxicity against rice weevils (*S. oryzae*) (Alghamdi, 2018). The mortality of *S. oryzae* was up to 74% with 10% w/w concentration and long exposure time. In the present study, seeds treated with leaf powder of *L. camara* produces best results in causing mortality and this could be as a result of high phyto compounds than in the roots. The fumigant toxicity of *L. camara* oil could also be attributed to the presence of major and active biological components present such as phytol, octadecanoic acid, Fumaric acid, diproparylylester etc. The insecticidal toxicity of oil extract and their chemical constituents induced toxic action quickly due to their fast penetration into insects which inhibited



**Table 1:** Effects of *Lantana camara* Leaf and Stem Powder on Adults Mortality of *Tribolium castanum* on Stored Wheat

Treatment	Conc.(g/100g seed)	Mean mortality (Hours)					
		24	48	72	96	120	336
Leaves	1.5	1 <sup>c</sup>	0.67 <sup>b</sup>	1.00 <sup>bc</sup>	1.00 <sup>b</sup>	0.67 <sup>bc</sup>	1.00
	3.5	2 <sup>b</sup>	1.67 <sup>b</sup>	1.33 <sup>b</sup>	1.00 <sup>b</sup>	1.00	0.00
	5.5	3 <sup>a</sup>	2.67 <sup>a</sup>	2.00 <sup>a</sup>	2.00 <sup>a</sup>	2.00 <sup>a</sup>	0.00
Root	1.5	1 <sup>c</sup>	1.33 <sup>b</sup>	1.00 <sup>bc</sup>	1.00 <sup>b</sup>	1.00 <sup>b</sup>	0.67
	3.5	1 <sup>c</sup>	2.0 <sup>ab</sup>	2.00 <sup>a</sup>	2.00 <sup>a</sup>	1.67 <sup>b</sup>	0.00
	5.5	2 <sup>b</sup>	2.67 <sup>a</sup>	2.00 <sup>a</sup>	2.00 <sup>a</sup>	2.00 <sup>a</sup>	0.00
Actellic dust	0.04%	3 <sup>a</sup>	2.67 <sup>a</sup>	2.00 <sup>a</sup>	2.00 <sup>a</sup>	2.00 <sup>a</sup>	0.00
Control (untreated)		0.00 <sup>d</sup>	0.00 <sup>c</sup>	0.67 <sup>c</sup>	0.33 <sup>c</sup>	0.33 <sup>c</sup>	0.33
LS		**	**	**	**	**	**
SE(±)		0.00	0.26	0.16	0.12	1.18	0.18

Means followed by the same letter are not significantly different ( $P \leq 0.01$ ) from each other, using New Duncan's Multiple Range Test (NDMRT), LS = level of Significance, \*\*Significant at 1%, and \* at 5%, SE = Standard Error

### Oviposition

Table 2 presented results of the effect of leaf and root power of *Lantana camara* on oviposition of adult *T. castanum*. The result revealed that, wheat seeds treated with high concentration of leaf and root (5.5 g/100g) powder significantly reduced oviposition (0.00), furthermore the application of 3.5 g /100g reduced the oviposition of adult *T. castanum*. This agrees with thereport of Mohammed and Buba, (2015) who reported that all the three application rates (1, 2 and 3g) of the plant products and synthetic treatments were significantly ( $P=0.05$ ) better than the control treatment in causing mortality of adult weevils, reduced number of eggs laid and decreased number of holes made on the grains.

**Table 2:** Effect of *Lantana camara* leaf and Root Powder on Number of Eggs and Percentage Oviposition Deterrence of *Tribolium castanum* on Stored Wheat

Treatments	Conc. (g/100g seed)	Oviposition	% Deterrence
Root	1.5	3.33 <sup>b</sup>	69.72
	3.5	1.00 <sup>d</sup>	90.00
	5.5	0.00 <sup>c</sup>	100.00
Leaves	1.5	2.33 <sup>c</sup>	78.18
	3.5	0.00 <sup>c</sup>	100.00
	5.5	0.00 <sup>d</sup>	100.00
Actellic	0.04	0.00 <sup>c</sup>	100.00
Control (untreated)		11.00 <sup>a</sup>	0.00
LS		**	
SE±		0.27	

Means followed by the same letter are not significantly different ( $P \leq 0.01$ ) from each other, using New Duncan's Multiple Range Test (NDMRT), \*\*Significant at 1%, LS = level of Significance, SE = Standard Error

### Adult Emergence

Table 3 revealed the resultof efficacy of leaf and root powder of *L. camara* on adult emergence of *T. castanum*. Adult emergence was lower on treatment with high concentration of both leaves and root powder. This could be as result of phyto-compound in the treated seeds which interfere with reproductive capability and hinder eggs from hatching. The fumigant toxicity of *L. camara* could also be attributed to the presence of major and active biological components present. The insecticidal toxicity of powder and their chemical constituents were induced toxic action quickly due to their fast penetration into insects. Onunkun, (2013); Udebuani *et al.*, (2015); Ahad *et al.*, (2016) have reported high repellence with increasing concentrations of plants powders against insect pests



including stored product pests. Although several studies have reported the repellent activities of the leaf powder of *C. odorata* against stored product pests (Onunkun, 2013), but studies on the repellent activities of the root powder of this plant are still scarce.

**Table 3:** Effect of *Lantana camara* leaf and Root Powder on Adult Emergence of *Tribolium castanum* on Stored Wheat Seeds

Treatments	conc. (g/100g seed)	No: adult emerge	% Deterrence
Root	1.5	2.00 <sup>b</sup>	76.74
	3.5	1.00 <sup>bcd</sup>	86.17
	5.5	0.00 <sup>d</sup>	86.79
Leaves	1.5	1.33 <sup>bcd</sup>	77.98
	3.5	0.67 <sup>cd</sup>	79.87
	5.5	0.33 <sup>cd</sup>	93.08
Actellic	0.04%	0.00 <sup>d</sup>	93.72
Control (untreated)		8.67 <sup>a</sup>	0.00
LS		**	
SE(+)		1.97	

Means followed by the same letter are not significantly different ( $P \leq 0.01$ ) from each other, using New Duncan's Multiple Range Test (NDMRT), \*\*Significant at 1%, LS = level of Significance, SE = Standard Error

### Seed Perforation

Table 4 presented result of the effect of leaf and root powder of *lantana camera* on number of exit hole (10.33) and percentage grain damage (35.67) on wheat treated with various concentrations. Higher number of exit holes and percentage grain damage was recorded on untreated seed control. The higher number of exit holes and percentage grain damage could be as a result of absence of leaves and root powder of *lantana camara* that opportune to laid eggs and feed on the wheat seeds. This is inconformity with the result of Abubakar *et al.* (2020) who reported that maize seeds treated with 5 g /100 g of the leaf powder significantly ( $P \leq 0.05$ ) decreased Oviposition (3.33), Adult emergence (3.00), Percentage grain damage (3.67%), Number of exit holes (3.33) and Weight loss (1.63%).

Similarly, Adane, (2020) reported that, extract of *R. communis* at 0.5 mL per 20 g induced 76.67% adult mortality after one day, while *S. alata* extract achieved 86.67% mortality under the same conditions. Each plant's powders and extracts effectively inhibited egg-laying, progeny production, weight loss, and seed damage. Among the two, *S. alata* demonstrated superior efficacy in both powdered and extract forms.

**Table 4:** Effect of *Lantana camara* Lea and Root Powder on Percentage Grain Damage and Number of Exit Holes of *Tribolium castanum* on Stored Wheat Seed

Treatment	Conc.(g/100g seed)	% Grain damage	Number of Exit hole
Root	1.5	5.50 <sup>b</sup>	1.33 <sup>b</sup>
	3.5	2.83 <sup>b</sup>	0.67 <sup>bc</sup>
	5.5	4.33 <sup>b</sup>	0.00 <sup>c</sup>
Leaves	1.5	3.67 <sup>b</sup>	1.00 <sup>bc</sup>
	3.5	1.33 <sup>b</sup>	0.33 <sup>bc</sup>
	5.5	1.33 <sup>b</sup>	0.33 <sup>bc</sup>
Actellic	0.04%	1.33 <sup>b</sup>	0.00 <sup>c</sup>
Control		35.67 <sup>a</sup>	10.33 <sup>a</sup>
LS		5.35	**
S+		**	0.35

Means followed by the same letter are not significantly different ( $P \leq 0.01$ ) from each other, using New Duncan's Multiple Range Test (NDMRT), \*\*Significant at 1%, and \* at 5%, LS = level of Significance, SE = Standard Error

### Weight Loss and Germination Percentage

Results of the effects of leaf and root of *L. camara* on weight loss and germination percentage of stored wheat seed infested by *T. castanum* is presented in Table 5. The result indicated that, weight loss was lowest on seeds treated with high concentration of leaf and root powder of *Lantana camara*. This could be attributed to antifeedant properties present on the plant and this supports the findings of Wahedi *et al.* (2013) who found that seeds treated with Neem seed extract significantly prevented emergence of F<sub>1</sub> adults of *C. maculatus* and subsequent weight loss done due to pest. Germination was not affected and this implies that seeds treated with *L. camara* have no negative effect against germination of the wheat seeds. This agrees the findings of Taye *et al.* (2014) reported that the lowest percentage of seed damage (5%) was recorded from seeds treated with mixture of lantana leaf and flower while the highest (13.3%) was recorded from lantana leaf. In the present study the percentage of seed weight loss is to some extent directly related to the percentage of grain damage. This indicated that cereal grains like maize, millet and wheat the percentage of weight loss is directly related to the percentage of damage grain but not constantly related.

**Table 5:** Effect of *Lantana camara* leaf and Root Powder on Percentage Weight Loss and Germination after Exposure to the Treatments

Treatment	Conc. (g/100g seed)	% Grain weight loss	% Seed germination
Root	1.5	3.67 <sup>b</sup>	95.33 <sup>c</sup>
	3.5	2.00 <sup>b</sup>	97.67 <sup>b</sup>
	5.5	2.00 <sup>b</sup>	100.00 <sup>a</sup>
Leaves	1.5	4.00 <sup>b</sup>	94.67 <sup>c</sup>
	3.5	2.00 <sup>b</sup>	98.00 <sup>b</sup>
	5.5	0.33 <sup>b</sup>	100.00 <sup>a</sup>
Actellic	0.04%	0.33 <sup>b</sup>	100.00 <sup>a</sup>
Control (untreated)		50.67 <sup>a</sup>	93.33 <sup>d</sup>
LS		**	**
SE <sub>+</sub>		1.27	0.24

Means followed by the same letter are not significantly different ( $P \leq 0.01$ ) from each other, using New Duncan's Multiple Range Test (NDMRT), \*\*Significant at 1%, and \* at 5%, LS = level of Significance, SE = Standard Error

### CONCLUSION AND RECOMMENDATION

Based on the results of this investigation, both leaf and root powder possessed insecticidal properties, anti-feeding, adult emergence and ovipositional deterrent effect against the most economically important wheat storage pests. Sustainable use of botanical insecticides will improve the food security in the environment where investments in synthetic pest control are uneconomical. The 5.5 and 3.5 of leaf and or root powder of *L. camara* could be recommended as an alternative to chemical insecticides to be used as contact protectants against *T. castanum* on stored wheat seeds.

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