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Insecticidal properties of Leaf extract of *Lamium purpureum* (Lamiaceae) against Maize weevils *Sitophilus zeamais* (Coleoptera: Curculionidae).

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Abstract

Insecticidal activity of Leaf extracts of *Lamium purpureum* was evaluated as; contact toxicants, fumigant and F1 progeny production inhibitors to Maize weevil *Sitophilus zeamais*. The leaves of *L. purpureum* were collected around Sharada area Kano by hand picking and identified at herbarium of the Department of Biological sciences, Bayero University Kano. They were washed with clean water, dried under shade, grounded into fine powder using pestle and mortar. The extracts were obtained by cold percolation using ethanol as a solvent and four extract concentrations were prepared using 50% Dimethyl Sulfoxide (DMSO) solution. *S. zeamais* were obtained from infested Maize grains at Abubakar Rimi Market Kano, identified by its morphological appearances and reared under ambient conditions (32±0.64^{0}C, 68±3% R.H and 12L: 12D photoperiods) in the laboratory. All bioassays were carried out in small transparent plastic containers (4cm height and 6cm diameter) in triplicates. Data generated were subjected to Analysis of Variance using SPSS (version 20) means were separated at 5% level by Turkeys tests. Results obtained indicate that leaf extract of *L. purpureum* were effective as contact toxicant, fumigant and inhibitor to First Filial (F1) progeny generation of S. *zeamais.* Hence leaf extracts of *L. purpureum* has potential to be use as control agent of Maize weevil *S. zeamais* infesting stored food products. The findings of this study reveal the usefulness of *L. purpureum* as biopesticide, as such its incorporation into traditional storage pest management system is recommended.

Keywords: Leaf extract, *Lamium purpureum,* toxicity, *Sitophilu szeamais,* progeny.

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Introduction

Sitophilus zeamais is the major storage pest of maize; the third most important cereal crop in the world (FAO, 2002). This insect causes reduced quality and quantity of stored maize in only few months of infestation, consuming up to 15% of the

stored maize grain (Bergvinson, 2004). Poor post-harvest storage has accounted for up to 40% lost in cultivated maize (Gerald, 2008). To combat this effect caused by S. *zeamais* and other pests associated with stored maize grains, control measures are employed. Stored-Product pest management in most part of the world has relied on the use of chemical insecticides; however, chemical control methods are restricted because of the development of pest resistance, health hazards and risk of environmental contamination (Isman, 2006). Therefore, there is urgent need to develop safer, environmental friendly and efficient alternatives that have potential to replace synthetic chemical insecticides and convenient to use.

Plant extracts and their components possess potential for development as insecticides and may have advantages over conventional insecticides in terms of low mammalian toxicity, rapid degradation and local availability (Shayya *et al*, 1997; Li and Zou, 2001). Extracts derived from more than 75 plant species have been evaluated for fumigant toxicity against stored product insect pests (Rajendran *et al*., 2008) Plant extract have insecticidal (Shayya *et al*., 1997) antifungal (Kordali *et al*., 2008) nematicidal (Oka *et al*., 2000) virucidal (Schumacher *et al*., 2008) antibacterial (Kotan *et al*.,2008) effect. Hence in the present study insecticidal activity of leaves extract of *L. purpureum* was evaluated as contact toxicant, fumigant and inhibitors of progeny generations against Maize weevil *S. zeamais.*

Materials and Methods

Culturing of insects

Maize weevil *S. zeamais* were collected from infested stock of maize grains at A. Rimi market Kano. *S. zeamais* was identified as described by Donald and Richard (1970).Twenty (20) pairs of *S. zeamais* were used to infest fresh preserved 1000g of maize grains contained in a label transparent bucket (35cm height and 30cm diameter) The bucket was capped with piece of net 10mesh/cm which allowed for ventilation but preclude the entry or exit of the insects. The set were maintain under ambient conditions of temperature, relative humidity and photoperiods (32 ± 0.64^0C, 68±3% and 12L: 12D) (Olaifa *et al.*, 1997) in the Laboratory for two weeks to ensure oviposition. The parent stocks were sieve out and maintained undisturbed until adult emergence. The First Filial (F1) adults emerging over 24hrs period were collected, preserved in another container and used for subsequent experiments (Magaji *et al.*, 2009).

Collection of Plant materials and Extract preparation

Purple dead nettle (*L. purpureum*) Leaves were collected around Sharada phase II industrial area Kano by direct hand picking, and identified at herbarium of the Department of Biological Science Bayero University Kano. They were washed with clean water and dried under shade at room temperature of about 30^0C for five days. Shade dried Leaves of *L. purpureum* were grounded into fine powder using mortar and pestle as describe by Lale (2002). Of the grounded powder 100g were added into 500ml of ethanol (95%) contained in a glass jar. The mixture was shaken thoroughly and vigorously for about 10minutes daily for one week and then filtered. The filtrate was allowed to stand at room temperature for 120hrs during which the solvent was vaporized yielding crude extract. The process was repeated until desired extract quantity was obtained. From the crude extract 20g was added into 20ml of 50% DMSO solution to obtain 1.00g/ml extract concentration and three other concentrations 0.50, 0.25, and 0.125g/ml prepared by serial dilution.

Contact toxicity Experiment

One micro liter of each extract concentration prepared (1.00, 0.50, 0.25, 0.125 g/ml) were applied to the dorsal surface of the thorax of 10 sets of adult (0-5 days old) *S. zeamais*, using micro syringe individually. For the control treatment 50% DMSO was used. Treated sets were quickly transferred into small transparent plastic containers (4cm height and 6cm diameter) containing 10g of

Maize grains, which was then closed with perforated cap to aid ventilation but preclude entry or exist of the insects. Each set was replicated two times making 3 replicates and insect mortality was recorded after 48hrs post-treatment intervals for one week (Udo, 2011).

Fumigant effect Experiment

Four different concentrations of each plants extract (1.00, 0.50, 0.25 and 0.125g/ml) were applied onto a small Whatman's No.1 filter paper disc (2cm diameter) separately and the solvent was allowed to evaporate for 10minute. Each filter paper disc was attached to the under surface of the cap of small transparent plastic containers (4cm height and 6cm diameter), containing 10 adults (0-5 days old) of *S. zeamais*, in 10g of maize grains. The caps were used to close each container thus exposing the insects to fumigants and precluding the entry or exist of the insects while in the control treatment 50% DMSO was used. Each set was replicated two more times and insect mortality was recorded every 48hrs post treatment intervals for one week. (Radha and Susheeta, 2014)

In contact toxicity and fumigant effect assays, insect was considered dead only if they fail three probing blunt tests. Abbott's formula (Abbott, 1925) was used to correct observed mortalities were control mortalities exceed 20%.

Correct Mortality =

$$\frac{\%\text{Test Mortality} - \%\text{Control Mortality}}{100 - \%\text{Control Mortality}} \times 100$$

Progeny production

Twenty (20) adults (0-5 day old) of *S. zeamais* were introduced into small transparent plastic container (4cm height and 6cm diameter) containing 20g of maize grains and then closed with perforated cap to aid ventilation but preclude the entry or exits of the insects. They were kept undisturbed for two weeks to ensure oviposition, then the parent stock was sieved out and the set were treated with 1.00g/ml of extract, with controls treated with 50% DMSO only. Each set was replicated two more time and they were maintained for another five weeks. The number of insects emerged from each treatment were counted and recorded daily for one week. (Udo, 2011)

Data analysis

All data generated from the work were subjected to analysis of variance (ANOVA) using SPSS (version 20) for windows, means were separated ($p<0.05$) using Turkey's multiple comparison tests.

Results

Contact toxicity

Toxicity of leaves extracts of *L. purpureum* applied topically to *S. zeamais* is summarized in Table1.00. The result shows that there was increase in (%) mortality of *S. zeamais* with increased concentration of extracts and exposure times. There was significant difference ($p<0.05$) among the treatments with 0.50 and 1.00g/ml conc. Inducing highest percentage mortality (100%) each at 96hrs and 144hrs after treatment respectively.

Fumigant effect

Fumigant effect of leaves *L. purpureum* was presented in Table2.00. Percentage mortality varies with dosage levels and exposure times. There was significant differences ($p<0.05$) among the treatments.

Progeny production

Leaves extract of *L. purpureum* significantly ($p<0.05$) reduced the progeny productions of *S. zeamais* (Figure 1)

Table 1: **Toxicity of leaves extract of *L. purpureum* applied topically to *S. zeamais.***

Mean Percentage mortality at different exposure times (hrs)			
Treatment (g/ml)	48	96	144
Control.	0.0e±0.0.	11.4d±1.2.	14.2c±1.0
0.125.	41.2d±0.7.	73.2c±0.6.	92.6b±0.8
0.25.	55.1c±0.5.	85.4b±0.6.	100.0a±0.0
0.50.	73.8b±0.6.	100.0a±0.0.	100.0a±0.0
1.00.	82.4a±0.6.	100.0a±0.0.	100.0a±0.0

Mean (±SE) represents three replicates of 10 insects each. Mean in the same column followed by different letter(s) are significantly different by Turkey's tests.

Table 2: Fumigant effects of leaves extract of *L. purpureum* against *S. zeamais.*

	Mean Percentage mortality at different exposure times (hrs)		
Treatment(g/ml)	48	96	144
Control.	0.0 ± 0.0.e	10.2 ± 1.2.e	20.1 ± 1.0d
0.125.	22.2 ± 1.0.d	42.1 ± 0.7.d	52.2 ± 0.5c
0.25.	36.1 ± 0.5.c	64.8 ± 0.4.c	84.2 ± 0.6b
0.50.	54.3 ± 0.5b	83.1 ± 0.6.b	100.0 ± 0.0a
1.00.	63.5 ± 0.6.a	94.6 ± 0.8.a	100.0 ± 0.0a

Mean (±SE) represents three replicates of 10 insects each. Mean in the same column followed by different letter(s) are significantly different by Turkey's tests.

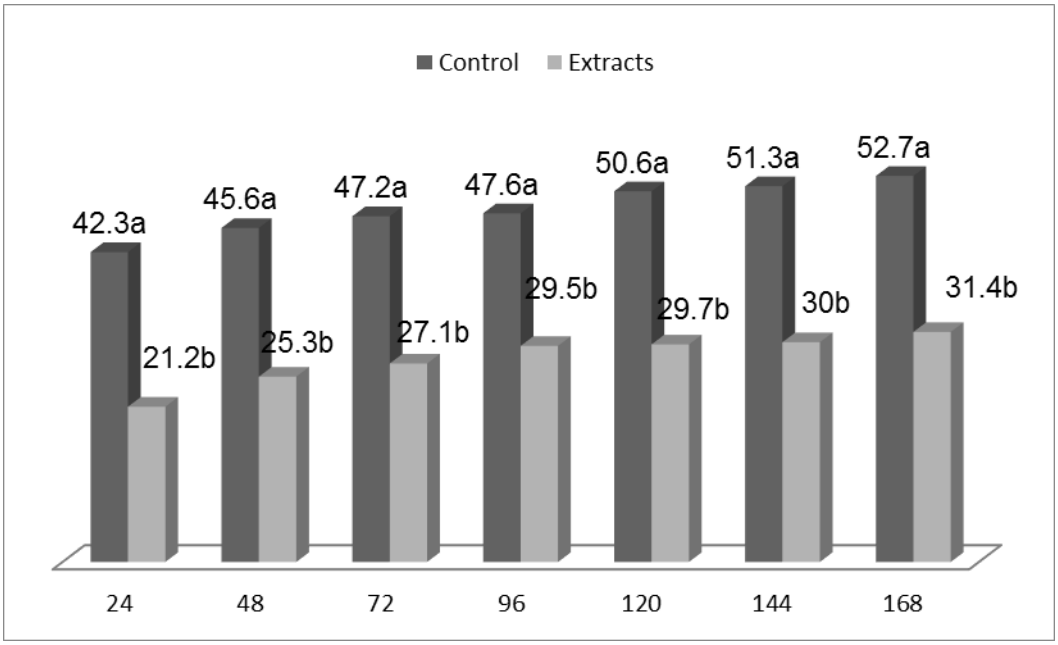

Figure 1. Effects of leaves extracts of *L. purpureum* on the number of F1 progeny produced by *S. zeamais*

Discussion

Leaves extracts of *L. purpureum* were toxic to adults *S. zeamais,* thus killing significant percentage of adults *S. zeamais*exposed to treatments as contact toxicant, fumigant and inhibitors to F1 progeny production, this phenomenon suggest the presence of highly pungent secondary metabolites (Udo, 2011). Alkaloids, Terpenoids, Tannin, Saponin and phenolic compounds were identified in the leaves extracts of *L. purpureum* and these compounds have been reported to possess anti-insect activities (FAO, 1999). They can affect insects in several different ways such as disruption of metabolic pathways, interference with cuticular developments, acts as attractant, deterrent, phagostimulant and antifeedants (Bell *et al.,* 1990).

The extracts were more effective as contact toxicant as highest percentage mortality was recorded in contact toxicity assay, 100% mortality was recorded in 0.50 and 1.00g/ml conc. at 96h post-treatment. This could be due to the direct contacts of extracts with insect thorax hence synergism of several mechanisms such as contact poisoning, blockage of spiracles and interference with cuticular developments (Abdullahi *et al.,* 2011). Active compounds such as alkaloids, Tannin, Saponin and phenolic compounds present in the *L. purpureum* leaves extracts caused rapid death of *S. zeamais.* Similarly *L. purpureum* leaves extracts as fumigant significantly ($p<0.05$) caused mortalities of adults *S. zeamais* with highest percentage mortality observed in 0.50 and 1.00g/ml concentrations 144hrs after treatments, the mortalities of *S. zeamais* caused by fumigant effects of leaves extract could be attributed directly to interferences with insect respiratory system by the active compounds such as alkaloids, terpenoids, tannins, saponnins and phenolic compounds present in *L. purpureum* leaves extract which leads to suffocations and death. Also leaves extract of *L. purpureum* significantly ($p<0.05$) reduced F1 progeny production of *S. zeamais* as is evident when comparing with control sets (Fig1.00). This could be due to effects of one or more or synergism of the active compounds in the *L. purpureum* leaves, causing exterminations or inhibiting development of eggs, larvae or pupae (Radha and Susheela, 2014), preventing molting of larvae, poisoning of eggs, larvae or pupae and inhibiting of the formation of chitin which is the substance essential for insect to form an exoskeleton.

The results of this study confirmed the findings of many other previous works on the use of plants extracts in controlling insect pest of stored products. Khoshnoud and Khayamy (2008) evaluated the insecticidal and progeny production effects of ethanol extracts of *Verbascum cheiranthifolium* against *Sitophilus oryzae* and *Tribolium castaneum* and observed significant mortality and suppression of progeny production. Also the essential oils from *Myristica fragrans* and *Illicium verum* were tested for their biological activity against *Sitophilus oryzae* and *Tribolium castaneum* by Shukla *et al,* (2008) and observed that it inhibited oviposition and toxic to growing larvae. Yankanchi and Gadache (2010) also reported that plants extracts from *Cleodendro neinerma, Withaniasomnifera, Gliricidia sepia, Cassia tora*and *Eupatorium odoratum* were effective in suppressing progeny generation (F1) and eliminating adults of rice weevils *Sitophilus oryzae*. Furthermore, Popoola (2013) also reported that powder and whole forms of *Allium sativum, Allium cepa* and *Capsicum annum* causes' significant mortality and reduction in F1 adults' emergence of *Oryzae philussurinamensis* infesting Date fruits.

Conclusion

The leaves extracts of *Lamium purpureum* act as contact toxicant, fumigant and inhibitor to *Tribolium castaneum* F1 progeny production. Hence leaves extracts of *Lamium purpureum* has potential to be use as control agents of stored food products against Maize weevils *S. zeamais* Infestations. Plants materials have advantages over broad-spectrum conventional pesticides as they affect only target pest, closely related organisms, and are equally effective in very small quantities, decomposed quickly, provide

residue free food and are safe to environments.

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