# LABORATORY EVALUATION OF WEST AFRICAN BLACK PEPPER (*PIPER GUINEENSE*) SEED POWDER AGAINST MAIZE WEEVIL (*SITOPHILUS ZEAMAIS* MOTS.)

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ABSTRACT: The seed powder of West African black pepper (*Piper guineense*) was evaluated in the laboratory against the maize weevil (*Sitophilus zeamais* Mots.) to assess for repellency, progeny development and adult mortality. The powder was applied as direct admixture at 0, 5, 10 and 20 g per 40g of maize grains. Results obtained showed significant ($P<0.05$) of 49.50% to 100% compared with the control. Adult mortality significantly ($P<0.05$) increased with increase in concentration and 100% mortality was achieved after 96 hours of exposure of insects to treatment. Progeny development was also significantly inhibited as fewer adults emerged from treated grains compared with the control. The potential of using the seed powder of *P. guineense* as grain protectant against infestation of stored maize by *S. zeamais* is discussed.

KEY WORDS: Black pepper, weevil, progeny, repellency, stored maize.

The overall goal of storage is to ensure food security and ensure that agricultural commodities are preserved for the attainment of prize stabilization, national and domestic food security, provision of raw materials for industry and international trade, provision for a country's strategic stock, enhancement of a nation's international status and provision of seeds for planting (Lale, 2002).

The economic situation in a developing country like Nigeria has been adversely affected mostly by post harvest losses of agricultural products which are usually encountered especially during storage and could be caused by pests and other spoilage agents (Arannilewa et al., 2002). Severe attack by insects is one of the major constraints in profitable production and efficient storage of cereal grains.

The maize weevil (*Sitophilus zeamais* Mots.) is one of the most destructive pests of stored maize in the world (Bekele, 2002). This insect has a wide host range with a high capacity to penetrate gain mass and can infest grains in field as well as in storage and accounts for about 50% of loss in stored maize.

Control of storage pests is imperative in the successful production and storage of cereal grains. In an attempt to control this insect pest, farmers in Akwa Ibom State of Nigeria commonly hang harvested maize cobs over cooking fire to prevent damage by this insect. However, this method is not very effective as losses encountered are still high. Presently, farmers rely heavily on the use of synthetic insecticides to control *S. zeamais* and other insect pests of stored products.

The negative environmental impacts of the use of synthetic insecticides including harm on non-target species, development of resistance in insect species, high and prohibitive cost of application, high mammalian toxicity, health hazards to grain handlers and erratic supply in developing countries due to foreign exchange constraints have necessitated research interest on the use of alternative

control measures and attention has been turned to botanical insecticides because they are eco-friendly, safe and biodegradable.

Plants are known to produce secondary metabolites many of which act as natural defense against insects, herbivores and disease causing micro-organisms (Potenza et al., 2004). More than 100,000 secondary metabolites from about 200,000 plant species which may possess insecticidal properties have been identified and include alkaloids, terpenoids, flavonoids, etc. (Vendramim & Castiglioni, 2000; Schmutterer, 1990; Potenza et al., 2004). Some plants in the Piperaceae family such as black pepper (*Piper nigrum*), West African black pepper (*Piper guineense*) and Betel pepper (*Piper betel*) produce alkaloids like piperine, piperidine and chavicine as secondary metabolites that help plants defend themselves against phytophagus insects, fungi and other pests (Tsao et al., 2002). The present study evaluated the bioactivity of *Piper guineense* seed powder for insecticidal properties against *S. zeamais* on stored maize.

## MATERIALS AND METHODS

### Culturing of insects

Adult *S. zeamais* were obtained from infested stock of maize at Uyo main market, Akwa Ibom State, Nigeria. The insects were reared on whole maize and were transferred to a glass jar containing 300g of grains which were sterilized in a freezer for 14 days. After one week of oviposition, all insects were removed and discarded by freezing to enable the emergence of same age progeny that were used to establish the main culture.

### Preparation of seed powder

*P. guineense* seeds were purchased from Uyo main market, Akwa Ibom State, Nigeria and 600 g of the dry seeds were ground into fine powder using manual hand grinder. The powder was stored in polyethylene bags prior to application.

### Repellency bioassay

The repellent action of *P. guineense* seed powder against *S. zeamais* was assessed using food preference method as described by Inyang (2004). Five maize grains were coated in slurry of the seed powder at different concentrations of 1, 5 and 10 g, respectively and left to dry while the control was treated with distilled water only. The treated and untreated grains were placed adjacent to each other with a space between them on a filter paper in a Petri-dish (11 cm diameter). Ten adult S. zeamais were introduced into the middle of the Petri-dish (Udo, 2000). Each treatment was replicated four times and the number of insects present on control ($N_c$) and treated ($N_t$) grains were recorded after 1, 6, 24 and 48 hours of exposure. Percent repellency (PR) was computed using the formula according to Inyang (2004):

$$PR = \frac{Nc - Nt}{Nc + Nt} \times \frac{100}{1}$$

### Weevil mortality

Mortality test was carried out by placing 40g of maize in 9cm white plastic cups and the seed powder of *P. guineense* was added as direct admixture at concentration level of 5, 10 and 20 g while the control had no seed powder added. Twenty adult *S. zeamais* of mixed sex were introduced into each cup and replicated four times. The cups were covered with white muslin cloth held in place with rubber bands. The number of dead insects in each treatment was counted after 24 hours and up to 96 hours. Insects were considered dead on failure to respond to three probing with a blunt probe.

**Progeny development**

One hundred adult *S. zeamais* were introduced into 600g of uninfested maize in a glass jar and left for seven days to allow for oviposition. One day after adult removal, *P. guineense* seed powder was applied at 5, 10 and 20g to 40g of grains and the treatments were repeated after 7 days, 14 and 21 days after adult removal. Each treatment was replicated four times while the control had no seed powder added.

**Data analysis**

The data obtained were subjected to analysis of variance (ANOVA) for complete randomized design (CRD) while means were separated using least significant difference (LSD).

## RESULTS

**Repellency**

Result of the repellent effect of *P. guineense* against *S. zeamais* is shown in Table 1. There was a significant repellency of 80 – 100% being observed at all treatment levels. The 1 g treatment level was able to evoke about 50% repellent effect on the beetles one hour after treatment and within 48 hours after treatment recorded a repellent effect of 99%. This is noteworthy as the insects could be repelled from stored grains even at such low treatment concentration.

**Insect mortality**

The effect of *P. guineense* seed powder on mortality of *S. zeamais* is presented in Table 2. Adult mortality significantly ($P<0.05$) increased with increase in concentration and hours exposure. One hundred percent mortality was observed in the 10 g treatment level after 96 hours of exposure.

**Progeny development**

The effect of *P. guineense* seed powder treatment on the progeny of *S. zeamais* is summarized in Table 3. The number of adults that emerged decreased with increase in treatment level. There was no significant difference amongst the treatments over the control after 21 days of adult removal. However, the powder significantly affected progeny development within 1 day to 14 days after adult removal.

## DISCUSSION

The repellent properties exhibited by *P. guineense* against *S. zeamais* explains the fact that *P. guineense* has broad spectrum of activity as it is reputed to contain alkaloids like *piperine, chavicine* and *piperidine* (Lale & Alaga, 2000). The alkaloids therefore may be involved in offering protection against attack of maize grains by the weevil. The seed powder evoked a strong repellent action of 80 – 100% against adult weevils and this agrees with the result from other researchers (Udo, 2000; Pessu and Williams, 1998). This suggests its incorporation into traditional storage systems with periodic applications as repellent against the weevils from attacking stored maize. The seed powder caused significant insect mortality which could be attributed to the presence of highly pungent alkaloidic secondary metabolites. The extremely pepperish nature of *P. guineense* may have exerted toxic effect on the weevils thereby resulting in death. Dead insects were observed to have their metathoracic wings unfolded which suggest that death was as a result of the toxic action of the West African black pepper (Adedire & Ajayi, 1996). *Piperidine* being one of the secondary metabolites present in *P. guineense* is known to be an axonic poison and this may be another reason for the toxic action of the powder against the adult weevil (Ivbijare & Agbaje, 1986; Udo,

2005). The significant inhibition of the progeny of *S. zeamais* by the seed powder of *P. guineense* could probably be attributed to the fact that some edible spices possesses appreciable vapour pressure so that toxic quantities could be picked up by insects via the vapour phase (Lale, 2002). The pungent vapour of *P. guineense* seed powder could had been absorbed by the larval stages of *S. zeamais* developing within the grains thus leading to reduced progeny emergence. It has also been observed that *P. guineense* seed powder caused adult, larval and egg mortality as well as impaired oviposition and reduced adult emergence in *C. maculatus*, *S. zeamais* and *T. castaneum* (Lale, 2002). The present study has confirmed that *P. guineense* seed powder possess insecticidal properties that can be exploited for successful storage of maize grains. The use of plant products in the form of powders in the management of stored product insect pests is perhaps the most convenient among resource-poor farmers because the powders are easy to apply and commodities remain clean compared to those treated with fixed plant oils. Because of *P. guineense* abundance in the study area and also relatively are cheaper to procure, resource poor farmers could incorporate them into traditional storage systems.

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Table 1. Percent repellency of *Piper guineense* to *S. zeamais* adults at different hours after treatment.

| Treatment level (g) | Mean percent repellency Hours after treatment | | | |
|---|---|---|---|---|
| | 1 | 6 | 24 | 48 |
| 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1 | 49.50 | 55.00 | 84.50 | 99.25 |
| 5 | 80.00 | 89.25 | 98.25 | 100.00 |
| 10 | 83.00 | 98.25 | 100.00 | 100.00 |
| LSD (P<0.05) | 10.10 | 5.72 | 6.14 | ns |

Table 2. Effect of *Piper guineense* seed powder on adult mortality of *S. zeamais*.

| Treatment level (g) | Mean percent mortality Hours after treatment | | | |
|---|---|---|---|---|
| | 24 | 48 | 72 | 96 |
| 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5 | 15.00 | 52.50 | 85.00 | 95.00 |
| 10 | 35.00 | 75.50 | 97.50 | 100.00 |
| 20 | 75.00 | 90.00 | 100.00 | 100.00 |
| LSD (P<0.05) | 0.80 | 1.53 | 0.93 | 0.49 |

Table 3. Effect of *P. guineense* seed powder on progeny development of *S. zeamais*.

| Treatment level (g) | Mean percent $F_1$ emergence Days after adult removal | | | |
|---|---|---|---|---|
| | 1 | 7 | 14 | 21 |
| 0 | 145.00 | 146.00 | 74.00 | 73.00 |
| 5 | 63.75 | 85.75 | 118.50 | 61.75 |
| 10 | 37.75 | 52.70 | 79.00 | 48.75 |
| 20 | 24.00 | 29.50 | 52.75 | 28.25 |
| LSD (P<0.05) | 73.49 | 73.49 | 66.58 | ns |