

SHORT COMMUNICATION

Comparative Efficacy Of *Piper guineense* (Schum and Thonn) Powder and Pirimiphos-methyl Dust Against *Sitophilus zeamais* (Motsch.) (Coleoptera: Curculionidae) In Stored MaizeASAWALAM, E. F. and EMOSAIRUE, S. O.²¹ Plant Health Management Department, Michael Okpara University of Agriculture, Umudike, P.M.B.7267 Umuahia, Abia State, Nigeria.

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ABSTRACT. Powdered seeds of black pepper, *Piper guineense* (Schum and Thonn) applied at 0.1g, 0.2g, 0.3g, and 0.4g/50g of maize grains evaluated for maize weevil, *Sitophilus zeamais* Motsch, control. An insecticide treatment (1g pirimiphos-methyl /50g) and an untreated control were included. The effect of particle size of the seed powder on maize weevil control was also evaluated. The experiments were laid in completely randomized design with four replications. Percentage weevil mortality was recorded at 3, 5, 7, 14 and 21 days after infestation. At 5 days post-treatment, all rates of the seed powder caused significantly higher mortality than the level in control; the synthetic insecticide caused 100% mortality. The finer particle sizes (1mm, 600µm) of the pepper seed powder compared favourably with pirimiphos-methyl in controlling *S. zeamais*. In addition, grains treated with the seed powder showed significant reduction in the number of progeny derived from surviving *S. zeamais*. The powder reduced weight loss and induced high germination percentage. There was no observable feeding damage on grains treated with the higher rates and finer particle sizes. The results provide scientific rationale for the use of *P. guineense* in post-harvest protection.

INTRODUCTION

The maize weevil, *Sitophilus zeamais* (Motsch.) (Coleoptera: Curculionidae), is a serious pest of stored maize grain in Africa, and it is capable of developing on all cereal grains and cereal products (Tipping *et al.*, 1987; Walgenbach and Burkholder, 1986). Effective control of this insect pest relies heavily on the use of synthetic insecticides but the increasing cost of application and their hazardous effects in the environment have become a source of concern. For these reasons, alternative chemicals for pest control are being sourced from plants (Berger, 1994).

Black pepper, *Piper guineense* (Schum and Thonn), is a plant that has been reported to possess high potential for use in insect pest control (Ivbijaro and Agbaje, 1986; Olaifa *et al.*, 1987). Already, the plant provides oil used medicinally, and as aromatic ingredient in the drink industry (Burkhill 1984; Rehn and Espig, 1991). The fruits contain the pungent piperine, resin and essential oils. The various resins, particularly chavicine and a yellow alkaloid, piperine, account for 5-8% of the weight of black pepper fruit (Lale, 1992, Rehn and Espig, 1991). This study was initiated with the objective of evaluating the efficacy of *P. guineense* seed powder as protectants of maize grains against infestation by *S. zeamais*.

MATERIALS AND METHODS***Sitophilus zeamais* culture**

Adult *S. zeamais* was obtained from stocks maintained on whole maize grains at the Crop

Science Laboratory, Michael Okpara University of Agriculture, Umudike. Fifty pairs of *S. zeamais*, sexed following the methods of Bekele and Hassanali (2001) were introduced into 1 litre glass jars containing 400g weevil-susceptible maize grains (Bende white). The mouths of the jars were then covered with nylon mesh held in place with rubber bands. The maize grains used for the study were purchased from Umuahia main market, Abia State, and disinfested in the oven at 40°C for 4 hr (Jembere *et al.*, 1995; Santhoy and Rejesus, 1975).

Plant Material

Ripe dried seeds of *P. guineense* were also purchased from a local market at Umudike and milled into fine powder after air-drying for 7 days in a well-ventilated area under shade. The powder was stored in polyethylene bags until needed.

Assessments

The treatments consisted of four rates of *P. guineense* seed powder (0.1g, 0.2g, 0.3g, and 0.4g /50 g of maize grains) and 1g of pirimiphos-methyl /50 g grains. The seed powders and pirimiphos-methyl were separately admixed with the disinfested grains in 3-litre containers. A control treatment was also set up. Five pairs of 5-day old *S. zeamais* adults were introduced into treated and untreated maize grains and confined by perforated lids placed over muslin cloth held in place by a rubber band. All treatments were replicated four times and arranged in completely randomized design on a table in the laboratory.

In another experiment, the seed powder of *P. guineense* was sieved into three particle sizes (600µm, 1.0mm and 2.0mm) with a standard sieve and 0.4g powder of each was admixed with 50g of

1 Corresponding Author, e-mail: elechiasw@yahoo.com

2 Present address: Agronomy Department, Delta State University (Asaba campus) Asaba, Delta State, Nigeria.

maize grains in plastic vials before infesting with five pairs of 5-day old weevils. The three treatments and an untreated control were replicated four times.

Weevil mortality was documented at 3, 5, 7, 14 and 21 days after treatment (DAT). Weevils were presumed dead if they remained immobile and did not respond to five probings with a blunt dissecting probe. Percentage weevil mortality was corrected for mortality in control using Abbott's (1925) formula. F₁ progenies were counted through to 33 days post-infestation to avoid overlapping generations. Weevil damage was assessed using the weevil perforation index of Fatope *et al.* (1995). Grains were re-weighed after sieving and percentage weight loss calculated by method of FAO (1985) as:

$$\% \text{ Weight loss} = \frac{[\text{UaN} - (\text{U} + \text{D})] \times 100}{\text{UaN} \times 1}$$

Where U = Weight of undamaged fraction in the sample

N = Total number of grains in the sample

Ua = Average weight of undamaged grains

D = Weight of damaged fraction in the sample

Tests for viability was conducted using a random sample of 20 grains per treatment. The grains were soaked and placed in Petri dishes lined with Whatman No. 1 filter paper and then covered. Each dish was moistened daily with distilled (de-ionized water) and after 4 days germination was recorded and converted to percentage of plated grains.

Statistical Analysis

Data were subjected to analysis of variance using a general linear model procedure (SAS, 2000) and significantly different (P≤0.05) means were separated by using Student Newman-Keuls (SNK) test.

RESULTS

Mortality

Mortality of *S. zeamais* exposed to different rates of *P. guineense* or to pirimiphos-methyl is shown in Fig. 1. Mortality increased with increase in rate of seed powder and with increase in exposure period. By 5 days post-treatment, the 3 g and 4 g rates of seed powder had caused >50% mortality; the synthetic insecticide had caused 100% mortality 2 days earlier.

Adult Emergence

The effect of pirimiphos-methyl and different concentrations of *P. guineense* powder on adult emergence is shown in Table 1. Emergence was significantly (P<0.05) reduced from 9.2 in the control to <2.6 in other treatments.

Grain Damage

Damage to maize grains treated with 0.1 – 0.4 g of *P. guineense* seed powder varied from 0.00 to 7.3% (Table 1), the weevil perforation index increased significantly as application decreased. The 0.1 g seed powder rate was significantly less effective than the other rates. The loss in grain weight varied from 0.3 % to 16.2%. The 0.3 g and 0.4 g seed powder rates were statistically comparable with pirimiphos-methyl but significantly better than the other treatments (Table 1).

Effect on Germination

The highest germination percentage (89.2%) was observed in the grains treated with pirimiphos-methyl followed by grains treated with 0.4 g seed powder (78.11%, Table 1). Lower rates of the seed powder, resulted to progressively decreasing percentage germination (Table 1)

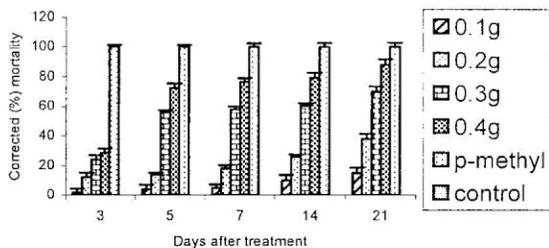


Fig. 1. Percent mortality of adult *S. zeamais* exposed to maize grains treated with different rates of *P. guineense* or with pirimiphos-methyl.

Table 1. Effect of treatment with different rates of *P. guineense* powder or pirimiphos-methyl on *S. zeamais* development and grain damage

Treatment	Treatment Rate	Mean ^a no of emerged adults	Weevil perforation index (%)	Mean % weight loss	Mean % seed germination
Black pepper seed powder	0.1g	2.6 ± 1.6	7.3 ± 2.6	5.7 ± 1.6	65.8 ± 1.7
	0.2g	2.4 ± 2.1	3.2 ± 1.5	4.8 ± 2.1	68.0 ± 3.1
	0.3g	1.0 ± 1.7	3.1 ± 0.9	0.3 ± 0.6	72.8 ± 2.2
	0.4	1.0 ± 1.5	0 ± 0	0.3 ± 0.9	78.1 ± 1.5
Pirimiphos-methyl	g1 g	1.0 ± 1.2	0 ± 0	0.3 ± 0.8	89.2 ± 1.8
Control	-	9.2 ± 1.9	42.5 ± 3.7	16.2 ± 2.4	43.2 ± 2.1

^a Mean of four replications; treatment means within each column followed by the same letter are not significantly different at the P= 0.05 according to Student –Newman – Keuls (SNK) test.

Table 2. Effect of different particle sizes of *P. guineense* seed powder on *S. zeamais* development and damage

Treatments	Mean no of emerged adults	Mean % grain damage	Weevil perforation index (%)	Mean % seed germination
2mm-particle seed powder	3.4 ± 0.7	19.5 ± 2.6	9.4 ± 1.6	61.1 ± 3.7
1mm-particle seed powder	2.3 ± 0.3	8.7 ± 1.5	1.1 ± 0.6	62.9 ± 3.1
600µm-pesticide seed powder	1.5 ± 1.7	1.2 ± 0.8	1.0 ± 0.4	67.2 ± 2.6
Pirimiphos-methyl Untreated	1.3 ± 0.6	1.1 ± 0.2	1.1 ± 0.3	74.3 ± 1.5
Control	9.9 ± 3.2	58.4 ± 2.6	16.87 ± 1.8	44.2 ± 2.9

^a Mean of four replications; Treatment means within each column followed by the same letter are not significantly different at the P= 0.05 according to Student –Newman – Keuls (SNK) test.

Effects of particle size on efficacy of *P. guineense*

There was no mortality in the untreated maize grains from 7 – 21 DAT. Mortality in grains treated with seed powder of 2 mm particle size was not significantly higher than that of control at 7 DAT but by 14 DAT the difference became significant (P< 0.05). Mortalities in grains treated with seed powder of particle sizes of 1 mm and 600 um were statistically comparable but each was significantly lower than mortality in grains treated with pirimiphos-methyl only at 7 DAT. From 14 DAT, differences among all treatments were due to random variation.

The result obtained on the effect of the particle size on adult emergence, grain damage, weight loss and germination (Table 2) indicated that the 1mm and 600µm particle sizes and pirimiphos-methyl treatments generally gave the best protection to the maize grains.

Efficacy of *P. guineense* seed powder increased as particle size decreased as seen from the greatly reduced grain damage, weight loss and loss of viability. Weight losses in 600µm and 1 mm particle sizes, respectively 1.0 and 1.1%, were statistically comparable with that from pirimiphos-methyl treatment (1.0%). Data on seed germination showed slightly better results with 600µm particle size (67.2%) than with 1 mm particle size (62.9%) or 2mm (61.1%). Though germination in grains treated with pirimiphos-methyl was higher (74.3%), it was not significantly different from 600µm treatment.

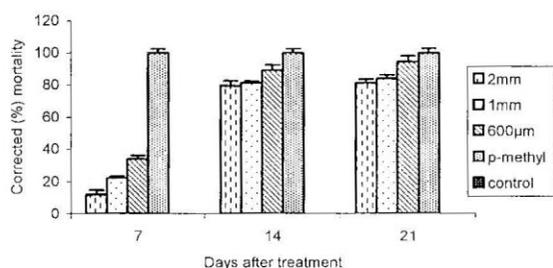


Fig. 2 Effect of different particle sizes of *P. guineense* powder on mortality of *S. zeamais*

DISCUSSION

It was observed that with 0.1 g of *P. guineense* powder/50 g of maize grain, significant reduction in adult emergence was achieved. Ofuya and Dawodu (2002) had earlier observed that when *P. guineense* powder was applied at five rates (0.1, 0.2, 0.3, 0.4 and 0.5 g/20 g of cowpea seeds), it significantly reduced ($P < 0.05$) reduced oviposition and adult emergence of *Callosobruchus maculatus* (F.). The finer particle sizes of *P. guineense* seed powder compared favourably with pirimiphos-methyl in controlling *S. zeamais*. Fine particle size enables the treated grains to be more uniformly coated thus enhancing contact with the target pest. Ogunwolu and Idowu (1994) had similarly reported more effective control of *C. maculatus* with finely ground particles of *Zanthoxylum zanthoxyloides* Waterm. root bark and *Azadirachta indica* A. Juss than when applied as coarse particles (2 mm). Results obtained in this study confirm the insecticidal potency of *P. guineense* seed products against stored product coleopterans. *P. guineense* seed products have been shown to have insecticidal, ovicidal and behaviour-modifying properties against stored product coleopterans (Ivbijaro and Agbaje, 1986; Lale, 1995; Ofuya and Dawodu, 2002) hence the justification for their usage in post-harvest protection.

REFERENCES

- Abbott, W. S. 1925. A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology* 18: 265 – 267.
- Bekele, A.J. and Hassanali, A. 2001. Blend effects in the toxicity of the essential oil constituents of *Ocimum kilmandscharicum* and *Ocimum kenyense* (Labiatae) on two post-harvest insect pests. *Phytochemistry* 57: 385-391.
- Berger, M. 1994. Using natural pesticides: Current and future perspectives: Swedish University of Agricultural Sciences, Uppsala: pp. 6-9
- Burkhill, H. M. 1984. The Useful Plants of West Tropical Africa, 2nd ed., Vol. I Families A-D Royal Botanic Gardens, Kew, UK. 686 pp.
- FAO. 1985. Prevention of post harvest food losses. Food and Agricultural Organization, Training Series No.10, Rome. Italy.
- Fatope, M. O., Nuhu A. M., Mann, A., and Takeda, Y. 1995. Cowpea weevil bioassay. A simple prescreen for plant with grain protectants. *International Journal of Pest Management* 41: 84 – 86.
- Ivbijaro, M. F. and Agbaje, M. 1986. Insecticidal activities of *Piper guineense* Schum and Thonn and *Capsicum* species on the cowpea bruchid, *Callosobruchus maculatus*. *Insect Science and Its Applications* 7 (4): 521-524
- Jembere, B., Obeng- Ofori, D., and Hassanali, A. 1995. Products derived from the leaves of *Ocimum kilmandscharicum* (Labiatae) as post harvest grain protectants against the infestation of three major stored insect product pests. *Bulletin of Entomological Research* 85: 361-367.
- Lale, N. E. S. 1992. A laboratory study of the comparative toxicity of products from three species to the maize weevil. *Post Harvest Biology and Technology* 2: 61–64.
- Lale, N. E. S. 1995. An overview of the use of plant products in the management of stored product Coleoptera in the tropics. *Post Harvest News and Information* 6: 69N – 75N.
- Ofuya, T. I. and Dawodu, E. O. 2002. Aspects of insecticidal action of *Piper guineense* Schum and Thonn fruit powders against *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae). *Nigerian Journal of Entomology* 19: 40 – 50.
- Ogunwolu, O. and Idowu O. 1994. Potential of powdered *Zanthoxylum zanthoxyloides* (Rutaceae) root bark and *Azadirachta indica* (Meliaceae) seed for control of the cowpea seed bruchid *Callosobruchus maculatus* (Bruchidae), in Nigeria. *Journal of African Zoology* 108, (6): 521 – 528.
- Olaifa, J. I., Erhum, W. O., and Akingbohunbe, A. E. 1987. Insecticidal activity of some Nigerian plants. *Insect Science and Its Applications* 8: 221-224.
- Rehn, S. and Espig, G. 1991. The Cultivated Plants of the Tropics and Subtropics. Cultivation, Economic Value, Utilization. Verlag Josef Margraf Scientific Books, CTA, 522 pp.
- Santhoy, G. and Rejesus, B. M. 1975. The development rate, body weight and reproduction capacity of *Sitophilus zeamais* (Motschulsky) reared on three natural hosts. *Phillipines Entomology* 2: 311-321
- SAS 2000. Statistical Analytical Systems SAS/STAT User's Guide Version 8 (2) SAS Institute Inc., Cary, North Carolina, USA.
- Tipping, P., Mikalajczak, W., Rudringuez, J.G., Poneleit, C.G., and Legg, D.E. 1987 Effects of whole corn kernels and extracts on the behavior of maize weevil (Coleoptera: Curculionidae). *Annals of Entomological Society of America* 85: 1010 -1013.
- Walgenbach, C. A and Burkholder W. E. 1986. Factors affecting the response of maize weevil, *Sitophilus zeamais* Coleoptera:Curculionidae), to its aggregation pheromone. *Environmental Entomology* 15: 733-738.