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COMPARATIVE EFFICACY OF *Piper guineense* (SCHUM AND THONN) AND PIRIMIPHOS METHYL ON *Sitophilus zeamais* (MOTSCH.)

[EFICACIA COMPARATIVA DE *Piper guineense* (SCHUM AND THONN) Y PIRIMIPHOS METHYL SOBRE *Sitophilus zeamais* (MOTSCH.)]

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SUMMARY

Powdered seeds of black pepper *Piper guineense* Schum and Thonn applied at 0.1, 0.2, 0.3, and 0.4g/50g of maize grains were evaluated for maize weevil, *Sitophilus zeamais* control. An insecticide treatment (1g pirimiphos methyl/50g grain) and an untreated control were included. The effect of particle sizes of the seed powder from *P. guineense* was also evaluated. Percentage weevil mortality was recorded at 3, 5, 7, 14 and 21 days after infestation. At 5 days post-treatment, all rates of seed powder caused significantly higher mortality than the control while the synthetic insecticide recorded 100% mortality. The finer particle sizes (1mm, 600µm) of the pepper seed powder compared favourably with pirimiphos methyl in the control of *S. zeamais*. Grains treated with the powder showed significant reduction in the number of progeny derived from surviving *S. zeamais*. There was no observable feeding damage on grains treated with the higher concentrations and finer particle sizes. The results provide a scientific rationale for the use of *P. guineense* in post-harvest protection.

Key words: *Piper guineense*, Pirimiphos methyl, *Sitophilus zeamais*, maize, concentration, particle size.

RESUMEN

Se evaluó el uso de semillas pulverizadas de *Piper guineense* Schum y Thonn aplicadas a 0.1, 0.2, 0.3, y 0.4g/50g de grano de maíz para el control de *Sitophilus zeamais*. Se empleó un tratamiento con insecticida (1g pirimiphos methyl /50g grano) y un testigo sin tramiento como controles. Se evaluó igualmente el efecto del tamaño de partícula del polvo de *P. guineense.* Se registró la mortalidad a los 3, 5, 7, 14 y 21 d post infestación. A los 5 d post tratamiento, todos los nivel de aplicación de *P. guineense* registraron una mortalidad superior al testigo, mientras que con el tratamiento con insecticida se obtuvo 100% de mortalidad. Las partículas más finas (1mm, 600µm) se compararon favorablemente con pirimiphos methyl en el control de *S. zeamais*. Adicionalmente el tramiento de granos con *P. guineense* indujo una reducción en la progenie derivada de los *S. zeamais* sobrevivientes. Los resultados proveen la base para el uso de *P. guineense* en la protección post cosecha.

Palabras clave: *Piper guineense*, Pirimiphos methyl, *Sitophilus zeamais*, maíz, concentración, tamaño de partícula.

INTRODUCTION

The maize weevil, *Sitophilus zeamais* (Motsch.) (Coleoptera: Curculionidae) is a serious pest of stored maize grain in Africa, although it is capable of developing on all cereal grains and cereal products (Tipping *et al*., 1987; Walgenbach and Burkholder, 1986). Efficient 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 has 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 as aromatic in the drink industry and medicinally, (Burkhill 1984; Rehn and Espig, 1991). The fruits contain the pungent Piperine, resin and essential oils. The pungency of the pepper is due to the presence in the fruits of various resins particularly Chavicine and a yellow alkaloid, piperine that contains 5-8% of the weight of black pepper (Rehn and Espig, 1991; Lale, 1992). This study was initiated with the objective of evaluating the efficacy of *Piper guineense* powder as protectants of maize grains against infestation by *S. zeamais.*

MATERIAL AND METHODS

Sitophilus zeamais culture

Adult *S. zeamais* was obtained from stocks maintained at Crop Science Laboratory, Michael Okpara University of Agriculture Umudike. The food media used was whole maize grains. Fifty pairs of *S. zeamais*, sexed following the methods of Bekele and Hassanali (2001) were introduced into I litre glass jars containing 400 g weevil susceptible maize grains (Bende white). The mouths of the jars were then covered with nylon mesh held in place with rubber bands. Freshly emerged adults of *S. zeamais* were then used for the experiments. Maize grains used for the study were purchased from Umuahia main market, Abia State, Nigeria and disinfested in the oven at 40^0C during 4 hours (Santhoy and Rejesus, 1975; Jembere *et al.*, 1995).

Plant Material

Ripe dried seeds of *P. guineense* were purchased from a local market at Umudike, Abia state, 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

Treatments consisted of four rates of *P. guineense* seed powder (0.1, 0.2, 0.3, and 0.4g /50 g of maize grains) and 1.0g of pirimiphos methyl /50 g grains. The seed powders and pirimiphos methyl were separately admixed with 50g 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. The design of the experiment was completely randomized design (CRD) with four replications. The treatments were kept on a laboratory room temperature.

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 from each particle size was admixed with 50g of maize grains in plastic vials before infesting with five pairs of 5-day-old weevils. Treatments were replicated four times. A control treatment was set up in which there was no plant powder.

Weevil mortality was documented at 3, 5, 7, 14 and 21 days after treatment. 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' (1925) formula. F_1 Progeny were counted through to 33 days post-infestation to avoid overlapping of generation.

Weevil damage was assessed using the Weevil Perforation Index (WPI) Fatope *et al*., (1995). Grains were re-weighed after sieving and percentage weight loss calculated by method of FAO (1985) as

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

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 seeds per treatment. The seeds 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 germinated seeds were counted and converted to percentage of plated seeds.

Statistical analysis

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

RESULTS

Mortality

Mortality to *S. zeamais* exposed to different rates of *P. guineense* is shown in Fig. 1. Mortality to *S. zeamais* adult increased with increase in rate of seed powder and with increase in exposure period and also with the concentration of the plant powder (Fig. 1). At 5 days post-treatment, all rates of seed powder caused 50% mortality, but 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 treatment to less than 2.6 in other treatments.

Grain Damage

The damaged maize grains in treatments that had various concentrations of *P. guineense* seed powder varied from 0.00 to 7.3% (Table 1). All treatments proved superior to control with pirimiphos-methyl and 0.4g rate of seed powder outstanding. The 0.1 g seed powder rate was significantly less effective than the other rates. Weevil perforation index increased significantly with decreasing application rate (Table 1). The loss in weight of maize grains due to damage by *S. zeamais* varied from 0.3 % to 16.2% (control). The 0.3 g and 0.4 g seed powder rates were statistically comparable with pirimiphos methyl but significantly better than the other treatments in minimizing weight loss (Table 1).

Effect on Germination:

The highest germination percentage (78.05%) was observed in the grains treated with 0.4 g seed powder concentration apart from that of pirimiphos methyl (89.19%) (Table 1). This was then followed by 0.3 g, 0.2 g and 0.1 g, which achieved 72.77, 68.00 and 65.84 percent germination respectively.

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

Results obtained from this study indicated that the percentage mortality was zero in the untreated maize grains from 7 days after treatment (DAT) (Fig. 2) to 21 days after treatment. However the mean percentage mortality for control was not significantly different (P > 0.05) from that of 2 mm particle size at seven days after treatment (DAT) but became significantly different (P < 0.05) at 14 DAT. At 7 DAT, the effect of 1 mm and 600µm particle size was not significantly different with regards to mean percentage mortality but was significantly different from the pirimiphos methyl, which had the highest percentage mortality at 7 DAT. However, there was no significant difference in mortality among the 1mm, 600µm particle sizes and pirimiphos methyl at 14 DAT.

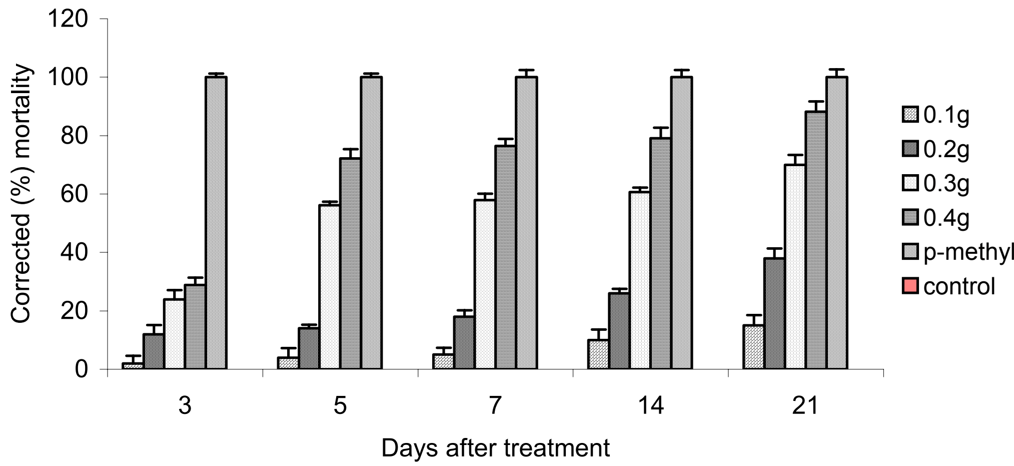

Figure 1. Percent mortality of adult *S. zeamais* on maize grains treated with different concentrations of *P. guineense*

Table 1: Effect of different concentrations of *P. guineense* powder and pirimiphos methyl on *S. zeamais* and grain damage

Treatments Conc. (%) (W/W)	No. of emerged adults	Grain damage (%)	Weight loss (%)	Seed germination (%)
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
0.4g	1.0 ± 1.5	0 ± 0	0.3 ± 0.9	78.1 ± 1.5
Pirimiphos-methyl	1.0 ± 1.2	0 ± 0	0.3 ± 0.8	89.2 ± 1.8
Untreated	9.2 ± 1.9	42.5 ± 3.7	16.2 ± 2.4	43.2 ± 2.1

S.E ± = Standard error of the mean

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

Results in this study showed that efficacy of *P. guineense* seed powder increased with decreasing particle sizes used as shown by greatly reduced grain damage, weight loss and loss of viability. Weight losses in 600µm and I 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 seeds treated with pirimiphos-methyl was higher (74.3%), it was not significantly different from 600µm treatment.

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 ($P < 0.05$) oviposition and adult emergence of *Callosobruchus maculatus*. The finer particle sizes of *P. guinense* seed powder compared favourably with Pirimiphos methyl in the control of *S. zeamais*. Fine particle size enables the material to be more uniformly coated on the seeds thus enhancing contact with the target pest. This result indicates the superiority of the finer particle sizes (1 mm and 600µm) over the larger particle size (2 mm) in preventing *S. zeamais* infestation.

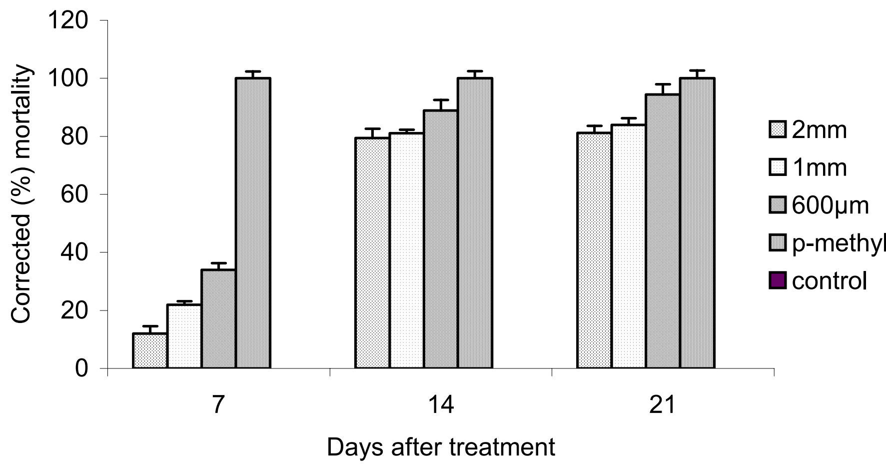

Figure 2. Effect of different particle sizes of *P. guineense* powder on mortality of *S. zeamais*

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

Treatments (Particle sizes)	No. of emerged adults	Grain damage (%)	Weight loss (%)	Seed germination (%)
2mm	3.4 ± 0.7	19.5 ± 2.6	9.4 ± 1.6	61.1 ± 3.7
1mm	2.3 ± 0.3	8.7 ± 1.5	1.1 ± 0.6	62.9 ± 3.1
600µm	1.5 ± 1.7	1.2 ± 0.8	1.0 ± 0.4	67.2 ± 2.6
Pirimiphos-methyl	1.3 ± 0.6	1.1 ± 0.2	1.1 ± 0.3	74.3 ± 1.5
Untreated	9.9 ± 3.2	58.4 ± 2.6	16.87 ± 1.8	44.2 ± 2.9

S.E ± = Standard error of the mean

This result agrees with report of Ogunwolu and Idowu (1994) who studied the particle size effects on insecticidal activity of *Zanthoxylum zanthoxyloides* root bark and *Azadirachta indica* seed powder against *C. maculatus* in Makurdi Nigeria. They observed that the powders were more effective when applied as finely ground particles (300µm) than when applied as coarse particles (2 mm). It can be deduced from this study that particle size affects dispersion, and the finer the particles, the more uniformly the powders will coat treated seeds and storage container thus enhancing contact with the target insect. Results in this study confirm the insecticidal potency of *P. guineense* seed products against stored product coleopterans reported by Lale (1995). He observed that *P. guineense* seed products demonstrated insecticidal, ovicidal and behaviour–modifying properties against the species of Coleoptera studied. The results provide a scientific rationale for the use of *P. guineense* in post-harvest protection.

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