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COMPLIMENTARY EFFECT OF *ZINGIBER OFFICINALE* AND *PIPER GUINEENSE* POWDERS AGAINST *SITOPHILUS ZEAMAIS* ON STORED MAIZE

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ABSTRACT: *A laboratory study was carried out to evaluate the effect of powders of Zingiber officinale and Piper guineense as direct admixtures at different ratios (Z_{100}:P_0, Z_0:P_{100}, Z_{25}:P_{75}, Z_{75}:P_{25}, Z_{50}:P_{50}) against maize weevil Sitophilus zeamais to determine insect mortality and grain damage as well as progeny production on treated and untreated grains. The experiment was fitted into complete randomized design and replicated four times while significant means were compared using least significant difference at 5% probability. Results obtained showed significant insect mortality between treatment ratios and exposure time. P. guineense alone and in combination in a ratio of P_{75}:Z_{25} gave significant mortality with a reduction in grain damage and reduced progeny production. The incorporation of botanicals into traditional grain storage system is hereby advocated.*

KEYWORDS: Piper Guineense, Mortality, Progeny, Weight Loss, Maize Weevil

INTRODUCTION

Maize is an important staple food in the tropics, where it is consumed by human and used as feed for animals. After harvesting, farmers usually store their maize products for short to long term periods to ensure food security, attain price stabilization and provide raw materials for industries, provision of seeds for planting and enhancement of a nation's strategic stock (Adedire et al., 2011). Post-harvest losses as high as 30 – 100% have been recorded in the tropics as a result of poor storage systems, inclement weather conditions and the incidence of pest infestation constituting major constraints to efficient storage (Demissie et al., 2008; Udo, 2008). Insects attack of stored cereals and legumes has been identified as a major constraint to profitable production and storage of such products (Asmanizar and Idris, 2008). Amongst the storage insect pests of maize, *Sitophilus zeamais* has been observed to be most destructive and can infest grains in the field before storage (Ukeh et al., 2009).

Attempts at control of the maize weevil by farmers have over the years relied on the use of synthetic chemicals with attendant consequences being well reported (Umoetok et al., 2004; Akobi and Ewete, 2007). The negative consequences of the use of synthetic insecticides have over the years, stimulated research interest in botanicals because they are safe, easily degradable and environmentally friendly. Plants produce secondary metabolites such as alkaloids, terpenoids, flavonoids, phenols, etc. which act as a natural defense against phytophagous pests and disease-causing organisms (Potenza et. al., 2004, Vendramim and Castiglioni, 2000; Udo, 2013).

Evidently plants have long been used for their spicy nature in foods and in protecting harvested food crops from pest infestation. The aim of this study was to evaluate the effect of *Zingiber* *officinale* (Zingiberaceae) and *Piper guineense* (Piperaceae) against *S. zeamais* on stored maize.

MATERIALS AND METHODS

Culturing of Insects

Adult *S. zeamais* were obtained from the infested stock of maize at Uyo main market, Akwa Ibom State, Nigeria and cultured in the laboratory after the methods of Inyang (2004). Adult *S. zeamais* were introduced into pre-equilibrated grains in glass jars and kept for seven days to allow for oviposition. After the seven days, the adult weevils were sieved out using an impact test sieve and kept for 21 days to allow for the emergence of same age progeny that were used for the various bioassays.

Plant Materials Preparation

Z. officinale rhizomes and *P. guineense* seeds were purchased from Ikpe Annang market in Akwa Ibom State, Nigeria. The plant materials were air dried in the laboratory for one week and ground into powder using Thomas (model ED-5) milling machine after which they were sieved respectively using 80 um laboratory sieves. The powders were stored in black polythene bags and kept away in laboratory cupboards until use.

Mortality Assessment

One hundred grams of maize were placed in white plastic cups and the powders of the mixed botanicals added at different concentrations (Z_{100}:P_0, Z_0:P_{100}, Z_{25}:P_{75}, Z_{75}:P_{25}, Z_{50}:P_{50}) as direct admixtures before twenty adult S. zeamais of mixed sexes were introduced into the cups. The cups were covered with white muslin cloths and held in place with rubber bands. The control treatment had no plant powder added and each treatment was replicated four times. Insect mortality was recorded after 24 hours of treatment and up to 96 hours. Insects were assumed dead on failure to respond to three probing with a blunt dissecting probe (Udo, 2008).

Progeny Production

Grains treated with mixed powder of plant materials were assessed for the emergence of the first filial generation. Maize grains which had been kept in the freezer for two weeks to prevent hidden infestation were used for the experiment. Twenty adult insects were introduced into treated and untreated grains with cups covered with white muslin cloth and left to stand undisturbed for five weeks while the number of insects emerging from each treatment was counted for one week.

Damage Assessment

One hundred grams of grains previously kept in the deep freezer for two weeks to avoid hidden infestation were used for the experiment. Plant powders at different concentrations (Z_{100}:P_0, Z_0:P_{100}, Z_{25}:P_{75}, Z_{75}:P_{25}, Z_{50}:P_{50}) were added to the grains and ten pairs of insect pest introduced into treated and untreated grains. The experiment was left to stand for four weeks with each treatment replicated four times. Samples of 100 grains were taken from each cup and number of damaged grains (grains with characteristic holes) and undamaged grains were counted and weighed. Percent damage was computed using the method of FAO (1985).

RESULTS

Insect Mortality

Significant ($P<0.05$) mortality was observed against the insect at all treatment levels compared with the control (Table 1). There was an increase in mortality after 24 hours of application of treatment with some treatments recording a mortality of 100% after 96 hours of treatment. Mortality was observed to increase with an increase in the duration of exposure time.

Progeny Production

The mixed powders significantly ($p < 0.05$) reduced the progeny of *S. zeamais* (Table 2) compared with the control. The mixed plant powders were observed to lead to a decrease of the progeny according to the various combination ratios of the treatment.

Damage Assessment

Grains treated with mixed powdered plant materials showed significant difference ($p < 0.05$) in the reduction of damage caused by *S. zeamais* (Table 2). Some of the treatment levels offered complete protection of maize compared with untreated control.

DISCUSSION

Mixed powders of *Z. officinale* and *P. guineense* were toxic to *S. zeamais* exposed to treatment and this phenomenon suggests the presence of pungent secondary metabolites in the plant. Some constituent secondary metabolite identified in the two botanicals include piperine, chavicine and piperidine reputed for insecticidal activity (Anyaele and Amusan, 2003). Some secondary plant metabolites may act both as insecticides and antifeedants thus influencing insect locomotion, oviposition, feeding behavior, developmental and physiological processes as well as behavioural patterns. The mixed plant powders tested at different concentrations, reduced damage caused by the insect species thus indicating the presence of antifeedant and oviposition deterrent properties in the plant (Gemuchie et al., 2013). This is further evidenced by the reproduction inhibition observed against the insect and confirms the reported reproduction suppression properties of *D. tripetala* against *C. maculatus* on stored cowpea (Ukeh et al., 2011). The effective utilization of *Z. officinale* and *P. guineense* as botanical pesticides could minimize the use of hazardous chemicals in stored product pest control. In the traditional post-harvest system in Africa, resource poor farmers could prepare the powders and use them locally and at cheaper cost. Therefore, botanical pesticides represent an important component of integrated pest management systems in traditional grain storage as they are broad spectrum in action, based on local materials and potentially less expensive while many are safe to the environment and pose no danger to man and other mammals.

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APPENDIX

Table 1: Mean Percentage Mortality of *S. Zeamais*

Treatment	Percent Mortality at Different Hours after Treatment			
	24	48	72	96
Control	0.00 ± 0.00^{c}	0.00 ± 0.00^{e}	0.00 ± 0.00^{c}	0.00 ± 0.00^{c}
Z_{100}:P_{0}	13.33 ± 1.07^{b}	16.66 ± 1.77^{d}	26.66 ± 5.27^{b}	33.33 ± 2.18^{b}
Z_{0}:P_{100}	26.67 ± 5.71^{a}	70.00 ± 1.32^{a}	90.00 ± 5.77^{a}	100 ± 0.00^{a}
Z_{25}:P_{75}	0.00 ± 0.00^{c}	36.00 ± 1.58^{b}	85.00 ± 10.00^{a}	100 ± 0.00^{a}
Z_{50}:P_{50}	16.66 ± 1.54^{b}	26.66 ± 5.77^{c}	80.00 ± 10.00^{a}	100 ± 0.00^{a}
Z_{75}:P_{25}	0.00 ± 0.00^{c}	26.66 ± 5.77^{c}	80.00 ± 10.00^{a}	96.66 ± 5.77^{a}

Means in the same column followed by the same letter are not significant (P<0.05)
(Z_{100}:P_{0} = Zingiber officinale 100%: Piper guineense 0%, Z_{0}:P_{100} = Zingiber officinale 0%: Piper guineense 100%, Z_{25}:P_{75} = Zingiber officinale 25%: Piper guineense 75%, Z_{75}:P_{25} = Zingiber officinale 75%: Piper guineense 25%, Z_{50}:P_{50} = Zingiber officinale 50%: Piper guineense 50%)

Table 2: Percentage Progeny Emergence of *S. Zeamais* and Weight Loss Caused by *S. Zeamais* to Treated and Untreated Grains.

Treatment	Percent Progeny Emergence	Percent Weight Loss
Control	85	37
Z_{100}:P_{0}	50	15
Z_{0}:P_{100}	42	10
Z_{25}:P_{75}	25	8
Z_{50}:P_{50}	28	5
Z_{75}:P_{25}	20	5
LSD (P<0.05)	7.00	3.25

(Z_{100}:P_{0} = *Zingiber officinale* 100%: *Piper guineense* 0%, Z_{0}:P_{100} = *Zingiber officinale* 0%: *Piper guineense* 100%, Z_{25}:P_{75} = *Zingiber officinale* 25%: *Piper guineense* 75%, Z_{75}:P_{25} = *Zingiber officinale* 75%: *Piper guineense* 25%, Z_{50}:P_{50} = *Zingiber officinale* 50%: *Piper guineense* 50%)