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Effects of *Piper guineense* seed and *Zingiber officinale* rhizome powder on *Callosobruchus maculatus* in cowpea

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ABSTRACT

Seeds of *Piper guineense* and rhizomes of *Zingiber officinale* were evaluated for their insecticidal properties against *Callosobruchus maculatus* in cowpea seeds. The mean number of eggs laid and mean number of bored sites were significantly reduced ($P< 0.05$) at all concentrations of *P. guineense* relative to control (untreated cowpea). The effect of *Zingiber officinale* was not significant ($P<0.005$) at all concentrations used. Seeds of *P. guineense* has commendable insecticidal property against *Callosobruchus maculatus*. The study provides scientific rationale for the use of *Piper guineense* in post-harvest protection of cowpea seeds.

INTRODUCTION

Cowpea (*Vigna unguiculata* (L) walp) is a dicotyledonous plant belonging to the family Fabaceae (Dutta, 2003). It is an important annual leguminous crop grown in the tropics and subtropics of Africa, Asia, Central and South America. The grains occupy a prominent place in the nutrition of Nigerian people because their edible seed form a cheap alternative source of protein (Ofuya, 1995). Animal protein sources are rarely affordable in adequate quantities by majority of the populace in developing countries, Cowpea therefore has been described as 'poor man's meat' (Ofuya and Credland, 1995). Cowpea is also used as food for livestock while the seeds are in addition source of calcium, iron, thiamins and riboflavin (Singh and Rachie, 1985).

In Nigeria, *Callosobruchus macutatus* (f) is a major pest of stored cowpea seeds. *C. maculatus* infestation starts with the females laying eggs on ripening cowpea pods in the field (Mbata, 1993). During exclusion, the larvae burrow through the chorion of the eggs directly into the pod wall, then into the seeds where they develop and pupate (Duke, 1990). Store infestation is frequently derived from harvested field – infested pods or seeds and hidden infestation in the store. *C. maculatus* infestation causes quantitative and qualitative losses to seeds in storage facilities (Mbata, 1993 and Shade *et al*., 1996). Post-harvest losses of cowpea due to *C. maculatus* constitute a major set-back in storage with a substantial loss of about 30-80% of total annual production (Ohiagu, 1985).

Effective control of this insect pest relies heavily on the use of synthetic insecticides but their increasing cost and hazardous effects in the environment have become a source of concern. For these reasons alternative chemicals for pest control are being sourced from plants because of their reduced effect on non-target organisms and the environments (Singh, 1978).

Black pepper (*Piper guineense*), fresh and deodorized palm oil (*Elaeis guineensis*); powdered dry chilli pepper fruits (*Capsicum frutescens*), Ginger (*Zingiber officinale*), root and bark of soursop (*Annona senegalensis*) L. (Echazona, 2006); Onion scale leaves (*Alluim cepa*) (Ofuya, 1986), citrus peels (*Citrus pardisi*) (Okwu, 2001) and powdered tobacco (*Nicotiama tabacum*) L. (Ofuya, 1995) have been reported to offer protection against post-harvest losses in cowpea due to *Callosobruchus maculatus*.

Ginger (*Zingiber officinale*), a member of Zingiberaceae) is mostly used for seasoning and flavouring in other to enhance the taste of foods, beverages and drugs (Dziezak, 1989). Ginger owes its properties to the presence of varying types of essential oils.

Black pepper (*Piper guineense*) is a plant that has been reported to have high pesticidal potential (Okwute, 1992). The plant provides oil used medicinally and as aromatic ingredient in Breweries (Achinewu *et al*., 1995). The fruit contains 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; Ravindran, 2002).

In view of the economic importance of cowpea, the severity of damage caused and the problems associated with the use of synthetic insecticides (Bellow, 1982), there is need to intensify the search for more natural methods in the control of *Callosobruchus maculatus* during storage.

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This study was therefore initiated with the objective of evaluating the efficacy of black pepper seeds and ginger rhizomes for their pesticidal effects against *C. maculatus* in cowpea.

MATERIALS AND METHODS

Adult stock of *Callosobruchus maculatus* (derived from harvested field-infested pods) was maintained in a susceptible cowpea (Ife Brown) variety in a 500ml conical flask. The conical flask was tightly covered with a muslin cloth of 1mm mesh size held in place with two rubber bands. The stock was maintained in the laboratory at 30°C to 35°C and 45% to 55°C relative humidity

Plant materials

The rhizomes of *Z. officinale* and *P. guineense* seeds (500g of each) were purchased from Marian Market in Calabar Municipality, Cross River State, dried in the oven at 65°C for 12 hours. Each dried sample was milled using electric blender MX 795N into fine powder and stored in sealed dry desiccator until when needed.

Assessments

The treatments consisted of three concentrations each of ginger rhizome powder and black pepper seed powder (1.0g, 2.0g and $3.0g/100g$ of cowpea seeds). The spice powders were separately mixed with disinfested (storing in freezer for 24 hours) cowpea seeds in 200ml conical flask. A control treatment (per 100g of cowpea seed) with no spice added was also set-up. Each flask was covered with perforated muslin cloth of 1mm mesh size held in place by rubber band to ensure adequate ventilations. The content of each flask was shaken thoroughly to ensure even distribution of materials among the seeds. These were kept for 2 hours before introduction of the 2 day old insects (Echezona, 2006).

Five pairs of 2-day-old *Callosobruchus maculatus* adults were introduced to treated and untreated cowpea seeds. All treatments were replicated five times and arranged in a randomized complete block design on a table in the laboratory at prevailing temperature. Data were collected weekly on number of dead weevils, number of surviving adults, number of bored sites and number of eggs laid on ten randomly selected seeds.

The data were subjected to analysis of variance (ANOVA) using 5% level of probability and means were separated using least significant difference (LSD) (Seigel and Morgan, 1996).

Table 1. Effect of different concentrations of *Zingiber officinale* rhizome powder and *Piper guineense* seed powder on *Callosobruchus maculatus*

Treatment g/100g cowpea seed weight	Number			
	Dead weevils	Surviving weevils	Eggs laid	Bored site
Ginger rhizome powder				
1	3.40 ±0.4	12.13^{C} ±3.03	6.53^{cde} ±2.41	8.75^{C} ± 4.0
2	3.33 ± 0.62	12.41^{C} ± 0.62	3.93^{abc} ± 1.81	7.78^{C} ± 3.86
3	4.15 ± 0.82	12.55^{C} ± 2.70	4.63^{bcd} ± 1.85	7.41^{C} ± 3.82
Black pepper seed powder				
1	3.81 ± 0.65	10.91^{abc} ± 2.0	1.51^{ab} ± 0.65	4.16^{b} ± 2.32
2	4.20 ± 0.58	9.53^{ab} ± 1.44	1.08^{a} ± 0.41	2.00^{a} ± 1.07
3	4.86 ± 0.59	8.81^{a} ± 1.20	0.75^{a} ± 0.35	0.95^{a} ± 0.55
Control	3.85 ± 0.73	12.46^{C} ± 2.97	9.71^{e} ± 3.50	11.35^{d} ± 5.33
LSD		2.6	3.49	2.13
Probability	P > 0.05	P < 0.05	P < 0.01	P < 0.01

Values are presented as $\bar{x}$ ± SEM. Values down the table with similar superscript are not significantly different based on ANOVA

RESULTS AND DISCUSSION

Significant difference ($P < 0.01$) was observed in the mean number of bored sites between control and treatment groups for cowpea seeds treated with black pepper seed powder (BPSP) and ginger rhizome powder (GRP) with 3g BPSP having the lowest means (0.95). The control treatment had the highest number of laid eggs with a mean of 9.71 which differed significantly ($P < 0.01$) from those of all the other treatments (Table 1). BPSP treatments gave the lowest number of laid eggs which differed from those treated with GRP. Significant difference ($P< 0.05$) was observed for number of surviving weevils between BPSP and all others treatments with 3.0g BPSP having the mean number (8.81). No significant difference ($P > 0.05$) was however observed between control and the treatment groups for number of dead weevil. Week 6 recorded the highest number of eggs laid in all treatments (Table 2). An average of 10.15 eggs were laid, this significantly differed ($P < 0.01$) from week 1 – 4. Significant difference ($P < 0.05$) was observed in number of dead per week with weeks 4, 5 and 6 differing significantly ($P < 0.01$) from weeks 1 – 3. Week 1 recorded significantly lower number of dead weevils (mean of 1.97) than other weeks (Table 2). The number of surviving weevils recorded per week was significantly different ($P < 0.01$) with weeks 4, 5 and 6 having higher mean values than weeks 1 – 3. Bored sites were observed from weeks 4 – 6 with week 6 having the highest significantly different ($P < 0.01$) mean value (1.63).

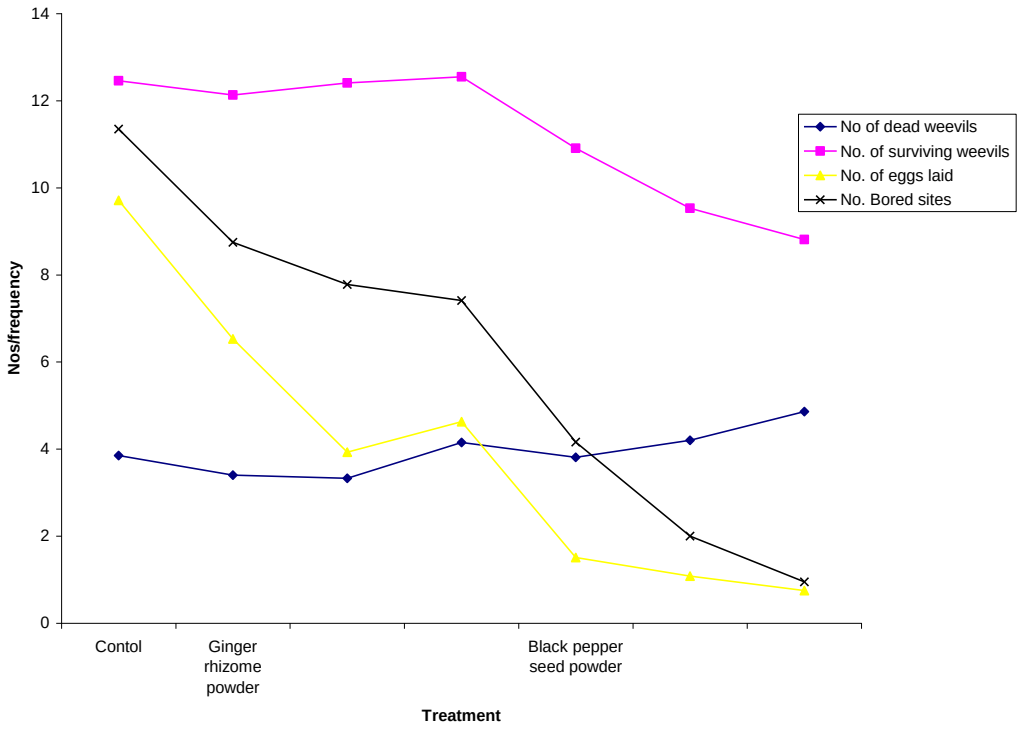

Fig. 1. Effect of different concentrations of *Zingiber officinale* rhizome powder and *Piper guineense* seed powder on *Callosobruchus maculatus*

Table 2. Mean weekly effect of different concentration of *Zingiber officinale* rhizome powder and *Piper guineense* seed powder on *Callosobruchus maculatus*

		Concentration g/100g cowpea weight									
Week	Parameters	*Z. officinale*				*P. guineense*					
1		1.00	2.00	3.00	Control	1.00	2.00	3.00	Control	Weekly toatl	Mean
	DW	2.5	1.0	1.5	2.0	2.0	2.3	2.5	2.0	13.8	2.0
	SW	7.5	8.0	7.5	7.0	7.5	8.0	7.0	7.0	52.5	7.2
	EL	0.8	0.6	1	1	0	1	0	1	4	0.57
	BS	0	0.0	0	0	0	0	0	0	0	0.0
2	DW	3.0	2.5	3.0	2.2	2.3	4.5	3.8	2.2	21.3	3.4
	SW	6.5	7.6	7.5	7.5	6.0	7.6	7.5	7.5	50.2	7.2
	EL	2.2	0	1	4.4	1	1	1	4.4	9.6	7.4
	BS	0	0	0	0	0	0	0	0	0	0
3	DW	1.9	3.5	2.8	3.0	3.0	3.0	5.0	3.0	22.2	3.2
	SW	4.5	6.0	5.3	5.4	6.5	5.2	5.3	5.4	38.2	5.5
	EL	4.4	1.6	2.2	5.0	0.6	0	0	5.0	13.8	1.98
	BS	0	0	0	0	0	0	0	0	0	0
4	DW	5.0	3.0	6.0	4.0	4.8	4.0	6.0	4.0	35.6	5.2
	SW	12.5	13.5	16.0	14.2	12.5	9.5	8.3	14.2	86.5	12.4
	EL	4.8	2.4	3.5	7.8	1.0	1.0	0	7.8	20.5	2.9
	BS	12.5	9.2	6.5	15.6	2.2	2.0	1.0	15.6	49.7	2.1
5	DW	4.5	5.0	5.0	6.5	4.6	4.0	6.0	6.5	35.6	5.1
	SW	18.5	15.6	17.5	16.2	17.5	11.6	12.5	16.2	8.9	15.6
	EL	10.5	8.5	9.0	16.5	2.0	2.0	1.5	16.5	15.0	7.1
	BS	18.8	15.3	17.5	24.5	10.5	3.5	1.2	24.5	91.3	13.3
6	DW	3.5	5.0	5.8	50.4	6.0	5.2	5.2	50.4	36.6	5.2
	SW	23.3	23.8	21.5	24.5	16.0	15.3	12.3	24.5	136.7	19.5
	EL	16.5	10.5	11.5	23.6	4.5	2.5	2.0	23.6	71.0	10.2
	BS	21.2	22.2	20.5	28.0	12.3	6.5	3.5	28.0	114.2	16.3

DW = dead weevils
SW = Surviving weevils
EL = Egg laid
BS = Bored sites

A number of plant materials has been tried as remedies and found effective against *Callosobruchus maculates*, an important pest of stored cowpea seeds (Olaifa and Erhun, 1988). Treatments of cowpea seed with various concentrations of BPSP and GRP gave slight effect on number of dead and surviving weevils on cowpea seeds.

BPSP significantly reduced egg laying capacity of adult weevils and the number of bored sites (Lale, 1995). The higher ovicidal effects observed in BPSP treated cowpea seed agrees with the findings of Lale, (1995). Though all concentrations of BPSP and GRP reduced oviposiiton, BPSP was more ovovicidal.

The effect of BPSP was dependent upon its concentrations as, 3g was more effective in reducing mean number of egg laid. GRP did not however give this dose dependent effect. This indicates the potential of Black pepper in the control of *C. maculatus*. *Piper guineense* thus seems to be more efficacious as an insecticide.

The number of bored sites which is an index of grain damage was reduced at all concentration of BPSP but not so with all concentration GRP. This shows clearly that *P. guineense* material is more effective than ginger in this aspect. Emerging adult weevils are responsible for bored sites found on cowpea seeds in storage. The lower adults survivals are in cowpea seeds treated with *P. guineense* material relative to control is attributable to its cidal effects on eggs and larval stages of development rather than an adult weevil. This is in line with the reports by Ofuga and Credland, (1995), that the cheapest and in the most effective methods of protecting cowpea seed against *Callosobruchus maculatus* in storage is the use of plant materials whose seeds could reduce oviposition or significantly delay insect developments and would offer farmers an economically and ecologically acceptable means of controlling bruchids in tropical storage.

Therefore *Piper guineense* seeds has great potential in the control of *C. maculatus* on stored cowpea seed.

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