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INSECTICIDAL EFFECTS OF POWDERED PARTS OF EIGHT NIGERIAN PLANT SPECIES AGAINST MAIZE WEEVIL *SITOPHILUS ZEAMAIS* MOTSCHULSKY (COLEOPTERA: CURCULIONIDAE)

BY

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ABSTRACT

Powders prepared from parts of 8 different plant species indigenous to Nigeria were tested under laboratory conditions at 30 °C, 65% r.h and 12h: 12h light: dark regimes for their insecticidal activity against *Sitophilus zeamais* Motschulsky (Maize weevil). Results show that at 2% concentration, the eight plant powders increased mortality and reduced adult emergence of the weevils. The powders of *Piper guineense* and *Capsicum frutescens* had the highest percentage mortality (79.8 and 75.1) respectively, when compared with the other treatments. Adult emergence was least (6.00) in maize seeds treated with *P. guineense*. The powders significantly (P> 0.05) reduced adult emergence, grain damage and weight loss in the various treatments. It is suggested that the plants are suitable for possible exploitation in insect pest control.

Key words: *Sitophilus zeamais,* plant powders, mortality, adult emergence, weight loss, damage.

INTRODUCTION:

Maize is a very important cereal grain in Africa where it is widely cultivated and consumed (Rouanet, 1987). It serves as a source of dietary carbohydrate for humans (Onwueme and Sinha, 1999). Post harvest storage of maize is greatly constrained by the pest, *Sitophilus zeamais* Motschulsky. Initial infestations of maize grain occur in the field just before harvest and the insects are carried into the store where the population builds up rapidly (Appert, 1987; Adedire and Lajide 2003). The huge post harvest losses and quality deterioration caused by this insect pest is a major obstacle to achieving food security in developing countries (Rouanet, 1987).

The control of storage insects like *S. zeamais* has centered mainly on the use of synthetic insecticides (Menn, 1983; Redlinger *et al.*, 1988). However, the use of these chemicals is hampered by many attendant problems such as development of insect resistant strains, their toxic residues getting into food of animals and man, workers safety and high cost of procurement (Sighamony *et al.*, 1990). These problems have necessitated research on the use of alternative eco-friendly cheaper insect pest control methods amongst which are the use of powdered plant parts and their extracts (Cobbinah and Appiah-Kwarteng, 1989, Niber, 1994; Jembere *et al.*, 1995; Lajide *et al.*, 1998; Asawalam and Adesiyan, 2001). In this study, various parts of indigenous plant species reputed to have both medicinal and insecticidal properties in Nigeria were tested as possible insecticides against the maize weevil, *S. zeamais* Motschulsky.

MATERIALS AND METHODS

This study was conducted in the Crop Science Laboratory, of the College of Crop and Soil Sciences, of Michael Okpara

University of Agriculture Umudike, Umuahia Abia State, Nigeria.

Mass rearing of *Sitophilus zeamais*

Adult *S. zeamais* was cultured in the laboratory at 27 ±2°C, 60-65% r.h and 12h: 12h light: dark regime. *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 Halstead (1963) and Stenley and Wilbur (1966), were introduced into I-litre glass jar containing 400g weevil susceptible maize grains (bende white). 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. Prior to the experiments, the grains were disinfested in the oven at 40°C for 4 hours (Santhoy and Rejesus, 1975; Jembere *et al.*, 1995) and kept in the laboratory to avoid re infestation before use.

Plant materials collection

Plant materials used in this investigation were collected from Umudike, Nigeria and authenticated by the herbarium department of Michael Okpara University of Agriculture, Umudike, Nigeria. The plant materials were air- dried in a well ventilated area in the laboratory for one week, before milling into fine powder using a Thomas milling machine (model Ed. 5). The powder was stored in polyethylene bags. The plant materials are listed in Table 1.

Table 1 Plants to be evaluated for insecticidal properties

Scientific Name	Common Name/Local name	Family	Part to be used
Vernonia amygdalina Del	Bitter leaf	Compositae	Leaves
Ocimum grattissimum L.	African curry, nchanwu (Ibo)	Labiatae	Leaves
Piper guineense Shum and Thonn	Black pepper (Uziza) (Ibo)	piperaceae	Seeds
Xylopia aetiopica (Dunal) A. Rich	Uda (Ibo)	Annonaceae	Seeds
Chromolaena odorata L.	Siam weed	Asteraceae	Leaves
Afromomum melegueta Shum	Alligator pepper	Zingiberaceae	Seeds
Nicotiana tabacum L.	Tobacco	Solanaceae	Leaves
Capsicum frutescens L.	Chilli Pepper	Solanaceae	Fruits

Mortality, Progeny and damage assessment assays:

The treatments consisted of powders of the eight plant materials indicated above.

Twenty grams (20 g) of clean and uninfested weevil susceptible maize grains variety used for the study were weighed into eight sterilized plastic vials. To each of the plastic vials 0.4g of each powder was added. A control experiment was set up with no plant material powder added. Five pairs of five-day old *S. zeamais* adults were introduced into treated and untreated maize grains. The lids of the plastic vials were perforated. Muslin cloths were used to secure the mouths of the plastic vials to ensure aeration and avoid entry or exit of insects. The contents of the plastic vials were then shaken vigorously for proper admixture. Each treatment was replicated four times. The experiment was arranged in completely randomized design. The number of dead insects in each vial was counted after 33 days to estimate maize weevil mortality. Maize weevil mortality was assessed as:

100 (Number of dead insects) / (Total number of insect)

Data on percentage adult weevil mortality were corrected using Abbott's (1925) formula thus:

$P_T = (P_o \ P_c) / (100 - P_c)$ Where P_T = Corrected mortality (%), P_O = Observed mortality (%), PC = Control mortality (%). Insects subsequently emerging were counted to estimate F_1 progeny production. Counting was stopped after 33 days to avoid overlapping of generation.

Damage assessment was carried out on treated and untreated grains. Weevil perforation index (WPI) was adopted for the analysis of damage (Fatope *et al.*, 1995).

The weevil perforation index is defined as follows:

Weevil Perforation Index (WPI) = (% treated maize grains perforated) x 100 / (% control maize grains perforated) WPI > 50 = negative protectant of plant material tested (i.e. enhancement of infestation by the weevil). WPI < 50 = positive protectant (i.e. prevention of infestation by the weevil)

Weight loss was measured by re-weighing the grains to determine percentage weight loss. Percentage weight loss was calculated following the method of FAO (1985) as.

Percentage weight loss = [UaN (U + D)] x 100 / UaN

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.

Statistical Analysis:
Data obtained were subjected to analysis of variance (ANOVA) using a general linear model procedure (SAS, 2000) and significant difference (P>0.05), means were separated by using Student Newman-Keuls (SNK) test.

RESULTS AND DISCUSSION

Mortality

Figure 1 compares the maize weevil mortality in the nine treatments. All the plant powders had above 50% mortality when compared with the control, which recorded no mortality. However *P. guineense, C. frutescens, N. tabacum* and *X. aetiopica* powders had the highest percentage mortality when compared with the other treatments, as they caused 79, 75, 71 and 70% mortality respectively. Their effect was significantly better than the other treatments.

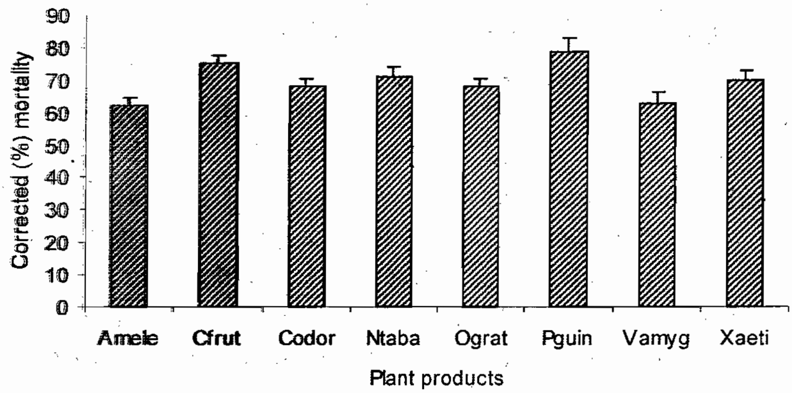

Fig. 1.]

Adult emergence

The effect of the plant powders on adult emergence is shown in Figure 2. The various plant powders used in the study significantly suppressed the emergence of adult *S. zeamais* when compared with the control. Adult emergence of *S. zeamais* was least in maize seeds treated with *P. guineense* while the control significantly had the highest adult emergence (64), followed by treatments that received *A. melegueta*. Adult emergence of *S. zeamais* was similar in *C. frutescens*, *O. grattissimum* and *V. Amygdalina.*

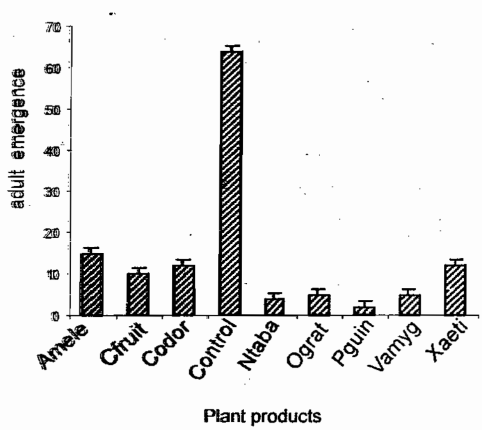

Fig. 2. Effect of plant products on adult emergence of *S. zeamais*

Weight loss

Percentage weight loss of maize seeds treated with the various plant powders followed a similar trend as percentage mortality and the weevil perforation index. Percentage weight loss of maize grains treated with *P. guineense* was significantly lower than the other treatments (see Figure 3).

This is followed by *C. frutescens* (2.27). Weight loss in maize treated with other plant materials was minimal ranging from 3.95 to 21.97.3

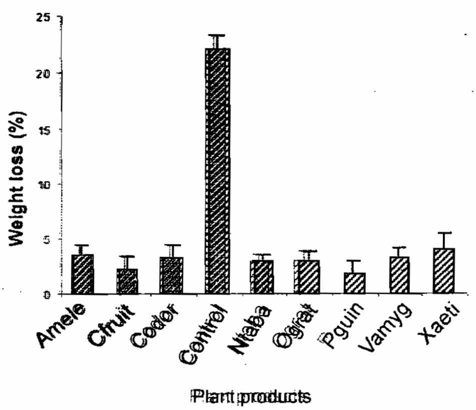

Fig.3. Weight loss (%) of maize grains treated with different plant powders

Damage assessment

The damage inflicted on maize grains by *S. zeamais* after four months of storage is presented in Figure 4. The level of damage was more in the control treatment whereas in the treatment with *P. guineense,* few maize grains were damaged with a weevil perforation index (WPI) of 5 followed by *C. frutescens,* which had 7 WPI. Results suggest that the weevils would prefer to avoid maize grains treated with any plant powder.

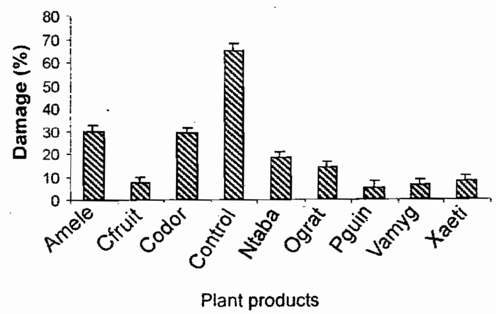

Fig. 4. Percent damage by *S. zeamais* in maize grains treated with different plant powders

The result showed that all the plant materials had varying degree of insecticidal activities. The ability of these plant powders to cause mortality of *S. zeamais* adults on maize grains can be attributed to contact toxicity of the powders on the weevil. Lajide *et al* (1998) also reported the effectiveness of some of these plant powders in controlling *S. zeamais* by causing adult mortality of the insect.

The treatment with *P. guineense* powder had the highest percentage mortality as well as reduced the number of adult emergence than any of the plant materials. The least percentage weight loss and weevil perforation was also recorded here.

The plant family Piperaceae to which *P. guineense* belongs, has been reported to possess some forms of insecticidal properties against eggs of cowpea storage bruchid (Adedire and Lajide, 1999) which are capable of suppressing various developmental instars of *Callosobruchus maculatus*. Fasakin and Aberejo (2002) have reported that pulverized plant material from *P. guineense* inhibited egg hatchability and adult emergence of *Dermestes maculatus* Degeer in smoked catfish *(Clarias gariepipus)* during storage.

Similar effects of plant materials as insect protectants have been observed in the treatment of cowpea and maize weevils (Ofuya and Dawodu, 2002; Adedire and Ajayi, 1996).

Insecticidal property of any plant material would depend on the active constituents of the plant material. Okonkwo and Okoye (1996) reported that *P. guineense* contains piperine and chavicine, which are insecticidal while Lale (1995), included piperidine and alkaloids as the major active components in *P. guineense* seeds. The reduction in adult emergence and seed perforation of the treatment with *P. guineense* powder and *C. frutescens* powder suggest that *S. zeamais* development was adversely affected on grains treated with these powders than the control.

The loss of weight of maize grains (52.5%) infested with *S. zeamais* could be a good index for assessing damage and waste during storage. *Ocimum* species are known to be important sources of toxicants against major insect pests. Hassanali *et al.,* (1990) reported that the active constituent eugenol, extracted from *Ocimum* suave is an effective repellent against *S. zeamais*. The active constituent in these plant materials appears to be responsible for their insecticidal properties against the maize weevil. *Nicotiana tabacum* is reported to possess contact, stomach and respiratory poisoning properties attributed to the active constituent nicotine (Stoll, 1988).

CONCLUSION AND RECOMMENDATION

Results obtained from this study demonstrate attractive potentials of these plant products as botanical insecticides against maize weevil in Nigeria. The effectiveness of *P. guineense* in reducing damage and controlling *S. zeamais* infestation in maize grains during storage could be encouraging and a possible means of ensuring a steady supply of good quality maize grains. *P. guineense* has the added advantage of being a proven edible spice whose use in storage is unlikely to lead to food poisoning in man.

Although the Chemical composition of *P. guineense* has been reported (Okonkwo and Okoye, 1996). The isolation of its active ingredient/s and relevant biological evaluation are yet to be determined.

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