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Full Length Research Paper

An assessment of two plant product efficacy for the control of the maize weevil (*Sitophilus zeamais* Motschulsky) in stored maize

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Both *Chromolaena odorata* and *Citrus limon* are common in tropical areas as an important weed and fruit crop respectively. Dried and pulverized leaves of *C. odorata* and fruit peels of *C. limon* were evaluated at the rate of 15, 10 and 5 g per 100g of maize grain variety JZSR. *C. odorata* proved to be efficacious in the control of the maize weevil (*Sitophilus zeamais)* at the three concentrations with percentage mortalities of 75, 70 and 63.75, respectively, while *C. limon* was less effective providing insect mortalities of 60, 50 and 47.50%, respectively. Only *C. odorata* showed comparable results to that of *Actellic* dust (75.25%, used as a check) conferring with *C. odorata* leaf powder at 15 and 10 g, as the *Actellic* dust, a better protection against *S. zeamais*. Although the rest of treatments were not that protective, they achieved better protection than the untreated control. On progeny emergence, there were no significant differences among treatments. The overall attractiveness of stored grains was affected by the greenish brown colour of *C. odorata* leaf powder.

Key words: Plant product powder, maize weevil (*Sitophilus zeamais* Motschulsky), maize.

INTRODUCTION

Maize also known as corn is an important food crop in many tropical, subtropical and temperate countries where maize is grown. Klingman (1977) reported that maize seed contains approximately 76 – 88% carbohydrate, 6 - 15% protein, 4.5 - 7% fat and 1.3% minerals. The maize grain is used as food for human consumption in various forms. It forms an important part of the diet of most people, especially in northern Nigeria where it accounts for more than 30% of the calorie intake of the people (Campbell, 1987). According to Onwueme and Sinha (1991), total world production in 1989 was 470.3 million tonnes from 129.6 million hectares.

S. zeamais is a serious pest of stored maize. It attacks grains in the field and it is generally regarded as one of the most dangerous storage pests in tropical countries. Owing to the economic importance attached to grains especially maize in Nigerian agriculture, it became necessary to protect the crop against damage by the insect while in storage. The problem of protecting the surplus stocks of grains led to the search for chemical insecticides whose effects are long lasting and which ideally can be applied at the time when the grains are first put in storage.

Synthetic pesticides are effective and reliable, their use can prevent loss of yield and reduce losses. They work quickly, which makes them suitable for use in emergency situations and frequently, they are the only remedy when crops are under immediate threat of infestation. But there are the ever increasing dangers from the dispersion of these chemical agents into the environment.

The process of spraying pesticides has obvious disadvantages of contamination of drinking water. Chemical residue is left on most agricultural and horticultural produce. The pest can develop resistance but its natural enemies do not and are eliminated. Moreover, pesticides often put a burden on the budget of small scale farmers. Because of these, more thought is being given to a res-

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Table 1. Effect of the plant product powder on the *S. zeamais* mortality, four weeks after treatment mortality percentages of *S. zeamais* on maize after four treatment weeks under three different concentrations of the two plant product powders

Treatment	Inoculated insects	Dead insects	Insects mortality
C. *odorata* 15g	20	15	64.30%
C. *odorata* 10g	20	14	57.14%
C. *odorata* 5g	20	12.75	48.21%
C. *limon* 15g	20	12.50	42.86%
C. *limon* 10g	20	10	28.57%
C. *limon* 5g	20	9.50	25%
Actellic 0.04g	20	15.50	64.64%
Control	20	6	0%
FLSD ($P < 0.05$)		4.19	

tricted use of pesticides. The negative effect on nature and environment are then reduced, as well as the destruction of the production environment and hazards to public health, so that sustainable agriculture becomes possible. The risks to human lives and to the environment are now so great that there is no longer any question about the necessity for changing the crop protection techniques which are far less reliant on chemical (Van Schoubroeck, 1992).

As a field to storage pest, the maize weevil has always created problems, which farmers have generally tried to solve by the use of plant materials such as neem leaves, peels of rough lemon, *C. odorata* and substances such as ashes (Dennis, 1990). He also added that in India many housewives put some bird chilies or neem into their maize storage jars to reduce the infestation of *S. zeamais*. According to (Orji, 1994) maize seeds inoculated with maize weevil and treated with ground seeds of *Xylopia aethiopica* were free from infestation after 3 months of storage. Mbah (2003) similarly reported the protection of stored cowpea from damage by the weevil *Callosobruchus maculates* using the African Ethiopian pepper *X. aethiopica*. Asawalam et al. (2006) stated that *C. odorata* leaf powder caused 69% mortality of *S. zeamais* on stored maize. Ibe and Nwufo (2001) also found lime (*Citrus aurantifolia*) rind powder a promising locally available grain protectant against *S. zeamais* as it achieved over 505 mortality of the weevil after 12 weeks of storage. According to Don-Pedro (1985) citrus peels effectively protected stored fish against the insect *Dermestes maculates*.

In the current investigation, the insecticidal potential of C. *odorata* leaf powder and the pericarp powder of *C. limon* were evaluated against the maize weevil with a view to develop a protectant of natural origin for which the raw materials could be easily sourced by the resource – poor farmers.

MATERIALS AND METHODS

The potency of the candidate insecticides of plant origin *C. odorata* leaf powder and the pericarp powder of *C. limon* were assessed against the maize weevil *S. zeamais* Motsch. Two varieties of maize were used during the course of the study. A local variety, Bende white was used for culturing the test insect and TZSR was used for the bioassay.

An insect culture that spanned 6 weeks was raised under laboratory conditions i.e. at 26 $\pm$ 2°C and 70% relative humidity, the fruit of *C. limon* collected from the citrus orchard, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria was washed and the pericarp sliced and dried under shade for 4 days and ground into powder. *C. odorata* leaves were collected from bushes around the farm, dried and ground into powder similar to the technique described by Dennis (1990) and Mbah (2003). The maize grains were fumigated for 72 h with phostoxin to keep the grains completely sterile. One hundred g of TZSR maize grains were weighed into kilner jars for each treatment and powderised *C. odorata* leaf and *C. limon* fruit peel were each applied at 15, 10 and 5 g concentrations into different jars. As a check, a 0.04 g of *Actellic* dust (*Pirimiphos–methyl*) was weighed into a kilner jar. Each insecticidal concentration was replicated four times and a control jar with no chemical was run for each concentration. Both the control and treatment jars were infested with 20 freshly emerged adult *S. zeamais*. All the experimental jars were randomly assigned to positions in a completely randomized design (CRD) and left undisturbed. After 4 weeks, adult mortality was assessed. Abbot (1925) formula was employed to correct percentage mortality of the weevil as:

$$P_T = (P_o\ P_c) / (100 - P_c)$$

Where,

P_T = corrected mortality (%),
P_o = observed mortality (%),
P_c = control Mortality (%).

Two months after storage, progeny emergence, grain damage, germinability test, taste of maize grains and seed quality after treatment were examined. Data were statistically analyzed according to Steel and Torrie (1980) and means separated by a Fisher least significant difference test.

RESULTS AND DISCUSSION

Table 1 shows the effects of *C. odorata* leaves and *C. limon* pericarp on *S. zeamais* adult mortality. Among the treatments, there were significant differences on percen-

Table 2. Biopesticides effect of two plant powders at three different concentrations on the progeny emergence of *S. zeamais* two months after storage

Treatment	Inoculated insects	Dead insect mean in the FI generation	Dead insects in the FI generation
C. *odorata* 15g	20	12.25	61.25%
C. *odorata* 10g	20	14.25	71.25%
C. *odorata* 5g	20	15	75%
C. *limon* 15g	20	14.75	73.75%
C. *limon* 10g	20	14.25	71.25%
C. *limon* 5g	20	14.50	72.50%
Actellic 0.04g	20	11.75	50.75%
Control	20	17.50	87.50%
FLSD (P < 0.05)		NS	

Table 3. Two plant product powder effect at three concentrations on grain damage caused by the weevil after two months of storage.

Treatment	Grains randomly selected	Grains mean with adult emergent holes	Damaged grain
C. *odorata* 15g	100	6.25	6.25%
C. *odorata* 10g	100	7.25	7.25%
C. *odorata* 5g	100	9.00	9.00%
C. *limon* 15g	100	9.00	9.00%
C. *limon* 10g	100	10.00	10.00%
C. *limon* 5g	100	9.25	9.25%
Actellic 0.04g	100	5	5.00%
Control	100	12.50	12.50%
FLSD (P < 0.05)		3.54	

tage of mortality after four weeks (P < 0.05). The *C. odorata* 15 and 10 g treatments with mortality percentages of 64.30 and 57.14, respectively were significantly more potent than *C. limon* 10 and 5 g treatments, and compared with Actellic dust treatment (64.64% mortality). However, the *C. limon* pericarp powder at 15g and 10g concentrations provided significantly better control of *S. zeamais* than the untreated control (P < 0.05). There was a positive correlation between concentration and the potency of the trial insecticidal biomaterials. This result fortifies the previous findings of Ibe and Nwufo (2001) who reported that oil palm product mixed with *Paperoma pellucida* proved effective in protecting maize grain against infestation by *S. zeamais*. Similarly, investigations carried out by Okonkwo and Okoye (1996) revealed 50% mortality in adult *S. zeamais* and reduced adult emergence by *Monodora myristica*. Asawalam et al. (2006) stated that *C. odorata* leaf powder caused 69% mortality of *S. zeamais* on stored maize. Stoll (2000) used 50% of lime to treat 1kg of maize and was found very potent against *S. zeamais* on stored maize. On progeny emergence of this study, there were no significant differences between the insecticidal treatments treatments.

Control jars recorded the highest percentage F_1 generation of 87.50% (Table 2), while the higher doses of *C. odorata* and the *Actellic* dust treatments offered the least percentage emergence inhibiting thus the post – embryonic development.

Treatments differed significantly in their protection against damage by the weevil as shown in Table 3. The highest damage percentage of 12.50% was inflicted on untreated control grains and the *C. odorata* leaf powder offered the best protection of the stored grains after two months at 15 g concentration with least damage percentage of 6.25%. There was no significant difference (P < 0.05) between maize grains treated with *C. odorata* at the highest dosage rate and those treated with *Actellic* dust. The *C. limon* fruit powder at all dosage rates nevertheless offered better protection than the control. The reduced damage recorded by the bio-pesticide is an indication of their efficacy against weevil infestation, hence, damage and seem to follow the trend of potency of the trial insecticides on insect mortality (Knock down).

The effective protection offered by *C. odorata* seems to be consistent with the findings of Ibe and Nwufo (2001)

Table 4. Two plant powder effect at three concentrations on seed viability two months after storage

Treatment	Planted seeds	Germinated seeds mean	Germination seed
C. *odorata* 15g	15	9.75	65.00%
C. *odorata* 10g	15	9.50	63.33%
C. *odorata* 5g	15	9.50	63.33%
C. *limon* 15g	15	7.25	48.33
C. *limon* 10g	15	7.75	51.67%
C. *limon* 5g	15	7.00	46.67%
Actellic 0.04g	15	12.00	80.00%
Control	15	4.50	30.00%
FLSD (P < 0.05)		NS	

who found lime (*C. aurentifolia*) rind powder a promising locally available grain protectant against *S. Zeamais* and caused over 50% mortality of the weevil after 12 weeks of storage. Dike and Mbah (1992) similarly used lemon grass products to protect Cowpea grains in storage. Although, the modes of action of these plant materials are yet to be fully determined, it is possible that their ability to cause the mortality or toxicity to *S. zeamais* on maize grains could be ascribed to the contact action of the powders on the weevil. The active principles in these botanicals (still a subject of further investigation) appear to be responsible for their insecticidal properties against the maize weevil.

Viability test conducted at the end of the storage revealed no significant differences between treatments at 5% level of significance (Table 4). Numerically, however, *Actellic* dust, which was used as a standard achieved the highest percentage grain germinability. Similarly, samples with the bio-pesticides had better germination percentages than the control. The cooking quality and taste of maize grains were not negatively affected by the insecticidal materials of plant origin. Similar effects of plant materials on grain viability and taste have been observed in the treatment of Cowpea weevils (Oparaeke and Dike, 2005). The fact that these plant products did not adversely affect seed viability and taste suggest that they could be used effectively in the storage of food grains and seed stocks by farmers. Both *C. odorata* and *C. limon* are common weed and tree crop, respectively in west tropical Africa, which make them easily available and affordable by farmers in the region. Besides, the technology of their preparation into powder is simple and could be easily adopted by the rural farmers.

Conclusion

The conflict revolves around the protection of food plants from pests and diseases and whether achieving this protection is only possible with synthetic pesticides or whether it is also possible without. In all parts of the world, there are examples to prove that agriculture can be practiced without synthetic pesticides. Thus the efficacy of these plant products *Chromolaena* leaf powder and the *C. limon* pericarp powders in the protection of grains against infestation by the weevil reveal their considerable potential as stored product pesticides. Their effect on seed viability and equality are within manageable/tolerable levels and are not hazardous to man or the ecosystem. For the vast majority of small holder farmers in Nigeria and other developing countries, site – appropriate and sustainable agriculture represent a way to escape poisoning and indebtedness.

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