EFFICACY OF SOME SPICES AS MAIZE GRAIN PROTECTANTS AGAINST *SITOPHILUS ZEAMAIS MOTSCH*

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Abstract

Studies were carried out to determine the efficacy of three spices (Allium sativum L., Capsicum frutescens L., and Zingiber officinale Rosc.) against Sitophilus zeamais reared on maize grains. Application rates of 0.5, 1.0 and 1.5 g of each of A. sativum, C. frutescens and Z. officinale and 0.12 g of Permethrin were applied to 20 g of maize grains infested with S. zeamais under controlled conditions of 30 ± 2°C and 65 ± 5% R.H. In all the treatments, 100% mortality of adult S. zeamais reared on maize was obtained. The effect of the spices on adult mortality was significantly different ($p<0.05$) between the powdered spices and the control. The effect of the different spices applied at varying rates on grain damage caused by S. zeamais was significantly ($p<0.05$) different with the highest difference (23.22%) in the 1.5 g treatment of C. frutescens and Z. officinale and the least (10.00%) from treatments of 0.5 g of Z. officinale and A. sativum respectively. The findings of this study indicate that the selected spices showed potential in reducing maize grain damage caused by S. zeamais.

Keywords: *Allium sativum, Capsicum frutescens, Protectants, Sitophilus zeamais, Maize grain, Zingiber officinale*

INTRODUCTION

Maize (*Zea mays L.*) belongs to the family *Gramineae* and is one of the most important cereal crops in Nigeria. After wheat and rice, maize is the third most grown cereal (Lyon, 2000). Its cultivation occupies less land area than either wheat or rice but has a greater average yield per unit area of about 5.5 tonnes per hectare (Ofori *et al*., 2004).

The grain is very nutritious, with about 70-72% digestible carbohydrate, 4 - 4.5% fats andoils and 9.5-11% proteins (Larger and Hill, 2011). Worldwide, about 66% of all maize is used for livestock feed, 25% for human consumption and 9% for industrial purposes. In the developing world, about 50% of all maize is consumed by humans as food while43% is fed to livestock and the remainder for industrial purposes (InternationalInstitute of Tropical Agriculture, 2003).

It is an important source of protein ranking only after meat, fish and legumes in terms of annual protein production Dasbak *et al*., 2008).

The maize kennel is also rich in vitamins and fats and makes the crop compare favourably as an energy source, with root and tuber crops per unit quantity (Dasbak *et al*., 2008).There are no cost effective methods for storage of large quantities of maize grain.

Even though maize grain can be stored for a considerable period of time, preservation of quality during long term storage is a problem in many parts of the world (Gras *et al*., 2000). An estimated 8-10% of total grains stored in warehouses or in silos is lost as aresult of inappropriate storage conditions yearly (Boxall, 2001). Degradation of grain quality is recorded as cracking of seeds due to over drying, weight loss due to respiration, rodents and insects' infestation and damage, and contamination with mycotoxins caused by

moulds and bacteria (Boxall, 2001).Maize is exposed to insect pest attack prior to harvest and in storage (Muyinza, 2008). These pests include *zeamais Motsch* (*Coleoptera*: *Curculionidae*), *S. oryzae L.* (*Coleoptera: Curculionidae Sitophilus*), *Tribolium castaneum Herbst.* (*Coleoptera: Tenebrionidae*), and *Ephestiacautella* Walker (*Pyralidae*: *Lepidoptera*). Of these *S. zeamais* is the most predominant and destructive (Peng and Morallo-Releisus, 2003).

S. zeamais is a small weevil measuring 2.5-4.5 mm in length. It can live up to 12 months,depending on environmental conditions (Longstaff, 2001). The female lays up to 150 eggs. Upon hatching, larvae bore into the grain and after developing through larval and pupal stages emerge as adults. Both adults and larvae feed causing substantial grain losses. Presence of the insects in the grain lowers its quality and value. It also brings about the establishment of mould infestations including *Aspergillus spp.* which produces aflatoxins making the grain unsuitable for food and feed (Kling, 2001). The maize weevil causes weight loss of stored grain up to 18.3% (Adam, *et al*., 2006).

The use of botanical products is more prevalent in the control of insect pests in storage systems; farmers can grow them and they can also be cheaper and easier to use than the synthetic insecticides (Govindan *et al*., 2010). Plant materials with insecticidal properties are one of the most important locally available, biodegradable and inexpensive methods for the control of pests of stored products (Jayakumar, 2010). Resource poor farmers in developing countries use different plant materials to protect stored grains against pest infestation by mixing grains with protectants made up of plant products (Udo, 2005). Many plant powders were evaluated and found effective in the management of *S. zeamais,* attacking maize grains in the stores (Danjuma *et al*., 2009; Suleiman *et al*., 2011). Spices are one of the important plant powders tested and found efficacious against insect pests of stored products (Rajapakse and Ratnasekera, 2008; Ukeh *et al*., 2008; Danjuma *et al*., 2009). This study describes laboratory bioassays to evaluate the efficacies of three local spices; *Allium sativum* (L.), *Capsicum frutescens* (L.) and *Zingiber officinale* (Rosc.) as possible stored maize grains protectants against *S. zeamais* in the Nigeria.

MATERIALS AND METHODS

Rearing of *S. zeamais*

Adults of *S. zeamais* were cultured in the laboratory at 30 ± 2°C in the Biology Laboratory Kaduna State University, Kaduna, Nigeria. The food media used was whole maize grains. Fifty pairs of *S. zeamais* were introduced into 1 L glass jar containing 400g weevil's susceptible maize grains. The jars were then covered with muslin cloth held in place with rubber bands, newly emerged adults of *S. zeamais* were then used for the experiment.

Preparation of Spices

Spice materials namely; Garlic (*Allium sativum* L.), Chilli pepper (*Capsicum frutescens* L.) and Ginger (*Zingiber officinale* Rosc.) used in this experiment were purchased from Tudun wada market, Kaduna South Local Government Area. Kaduna, Nigeria. The spices were dried in a well-ventilated area in the Laboratory for seven days before grinding into fine powder. The spices were ground using laboratory blender and made into fine powder. The powders were separately kept in polythene bags under room temperature for use during the experiment.

Adult Mortality Test

To study the adult survival of *S zeamais*, the method of Dawit and Bekelle (2010), was employed. Twenty gram of clean disinfested maize grains was weighed into sterilized Petri dishes. Quantities (0.5, 1.0 and 1.5 g) of each of the spices were added to first three Petri dishes separately, 0.12 g of Permethrin as chemical check to the fourth and zero spices was added to the fifth (control). The spices were thoroughly mixed with the disinfested maize grains with the aid of glass rod to ensure thorough admixture. The treated maize was left undisturbed for an hour. Thereafter five pairs of newly emerged adult weevils were introduced into each of the treated and untreated maize in the Petri dishes. Each of the Petridishes was covered with muslin cloth and tied with rubber band. All the Petri dishes were then kept in the incubator. Each treatment was replicated four times. The Petri dishes were arranged in Completely Randomized Design (CRD). Observations were made on adult mortality daily for 14 days during which dead adults were removed. The Petri dishes were kept in the incubator at 32 ± 2°C and 65 ± 5% R.H for another 14 days for damage assessment.

Damage Assessment

Damage caused by the weevils to the maize grains was assessed using the method of Asawalam *et al*, (2007). Ten grains were sampled randomly from each Petri dish. Grains with characteristics hole were separated from healthy ones and counted then percentage grain damage was calculated using the formula (Fatope *et al*., 1995):

$$\% \text{ Damage} = \frac{\text{Number of grains perforated}}{\text{Number of grains sampled}} \times 100$$

The weevil perforation index (WPI) is defined as follows:

$$\text{WPI} = \frac{\text{\% treated grains perforated}}{\text{Control grains perforated + \% Treated grains perforated}}$$

Statistical Analysis

Data obtained were subjected to analysis of variance (ANOVA) using a general linear model procedure (SAS, 2000) at 5% level of significance. Significantly different means were separated by using least significant difference (LSD).

RESULTS

The effect of the spicy powders on mortality of adults of *S. zeamais* is shown in Table 1. The Table shows that all the spices applied at varying rates (0.5, 1.0 and 1.5 g/20 g) resulted in 100% adult mortality 14 days after application, while 30% adult mortality was observed in the control at the same period. The spices were observed to show similar effects to the conventional insecticide (Permethrin). Adult mortality was observed to be significantly ($p<0.05$) different between the spices and control.

The effect of the different spices applied at varying amounts on maize grain damage caused by *S. zeamais* is presented in Table 2. The Table indicates that the least damage (10.00%) was observed from maize grains treated with 0.5 g of *A.sativum* and 0.5 g of *Z. officinale* respectively, while the highest grain damage (23.30%) was obtained from maize grains treated with 1.5 g of *C. frutescens* and 1.0g of *Z. Officinale* respectively. There grain damage caused by *S. Zeamais* was significantly ($p<0.05$) different between the treatments and the control.

Table 3 shows the weevil perforation index (WPI) obtained from the study conducted. The least (0.00) WPI value was obtained in Petri dish treated with 0.12 g of Permethrin, while the highest (30.42) WPI value was observed in 1.0 g of *Z.officinale* and 1.5g of *C. frutescens*. Statistical analysis showed that there was a significant ($p<0.05$) difference between the WPI values from the different spices applied and the control.

Table 1: Effect of the spices on mortality of adults of *S. zeamais* on maize grains(14 days)

Test powder	Amount applied (g/20g)	No. Of weevils Introduced	Adults mortality (percent)
	0.5	10	100.00
A. sativum	1.0	10	100.00
	1.5	10	100.00
	0.5	10	100.00
C. frutescens	1.0	10	100.00
	1.5	10	100.00
	0.5	10	100.00
Z. officinale	1.0	10	100.00
	1.5	10	100.00
Permethrin	0.12	10	100.00
Control	0.00	10	30.00
S. E	-	-	6.36

Table 2: Effect of the spices applied at varying amounts on maize grain perforation caused by *S. Zeamais.(14 days)*

Test powder	Amount applied (g/20g)	Mean No. of grain sampled	Mean No. of perforated grain	Grain damage (percent)
	0.5	10	1.00	10.00
A. sativum	1.0	10	1.33	13.30
	1.5	10	2.00	20.00
	0.5	10	1.67	16.60
C. frutescens	1.0	10	1.67	16.60
	1.5	10	2.33	23.30
	0.5	10	1.00	10.00
Z. officinale	1.0	10	2.33	23.30
	1.5	10	1.33	13.30
Permethrin	0.12	10	0.00	0.00
Control	0.00	10	5.33	53.30
S. E	-	-	0.405	4.09

Table 3: Effect of the spices on weevil perforation index (WPI) of maize grains.

Test powder	Amount applied (g/20g)	No. Of sampled maize grain	Mean W P I
	0.5	10	15.80
A. sativum	1.0	10	19.97
	1.5	10	27.29
	0.5	10	23.86
C. frutescens	1.0	10	2.86
	1.5	10	30.42
	0.5	10	15.80
Z. officinale	1.0	10	30.42
	1.5	10	19.97
Permethrin	0.12	10	0.00
Control	0.00	10	50.00
S. E	-	-	3.74

DISCUSSION

From the results obtained it shows that all the plant powders used during the investigation have significant ($p<0.05$) effect on the mortality of adult *S. zeamais* in which all the test powders resulted in 100% mortality at 14 days after application. The present findings agree with that of Al-Moajel (2004) who reported 100% mortality of *S. zeamais* 14 days after application of C. frutescens. Arannilewa *et al*., (2006) reported that 1.5 g of *A. sativum* applied to 25 g of maize grains caused mortality of 85% in adult *S. Zeamais*, 14 days after application. Similarly, Danjuma *et al*., (2009) reported that *A. sativum* gave 90% mortality at 1.5 g per 50 g of maize grain followed by *Z. officinale* with 86% after 7 days of application. *A. sativum* may have been very potent because of its strong odours which may have exerted a toxic effect by disrupting normal respiratory action of the weevils as suggested by Adedire and Ajayi (1996). Asawalam *et al*., (2007) also reported that application of 0.4 g of *C. frustecens* caused 75% mortality on adult *S. zeamais* in 20 g maize grains. The ability of these plants to cause mortality of *S. zeamais* adult on maize grains might be attributed to the contact toxicity of powder on the weevil. The findings of this study also revealed that the selected spices applied at varying amounts were effective in reducing maize grain damage caused by *S. zeamais*. Among the spices applied *A. sativum*and *Z. Officinale* were found to be the most effective spices in reducing grain damage.*C. frustecens* was also found promising in reducing grain damage. The results obtained revealed that all the spices applied had positive protectant ability of maize grains against *S. zeamais* by resulting in WPI value of <50 as suggested by Asawalam *et al*., (2007). *A. sativum* and *Z. officinale* was found to be the most effective spice in protecting maize grains against *S. zeamais*.

CONCLUSION

The findings of this research have revealed that the three spicy powders were effective in reducing maize grains damage caused by *S. zeamais* and had positive protectant ability against the weevil. In addition, the spices used are edible since they are used either as ingredients for soup or medicinal preparations. Therefore, they could be used as alternative insecticides against *S. zeamais* attacking maize grains.

These botanical powders should be incorporated into grain protection practice of resource-poor farmers.

ACKNOWLEDGEMENT

The authors acknowledge the laboratory access and support provided by the staff of Department of Biological Sciences, Kaduna State University, Kaduna.

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