Attractancy of maize solvent extracts to *Sitophilus zeamais* Motschulsky (*Coleoptera: Curculionidae*)

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ABSTRACT

A simple, easy and uncomplicated method of assessing the level of insect pest infestation in stored maize was investigated in the laboratory. Four solvents (Acetone, Ethanol, N – Hexane and Diethyl-ether) were used to extract maize at different concentration levels (0.03 mls, 0.06 mls and 0.09 mls) to determine their attractiveness to the maize weevil, Sitophilus zeamais Motsch. Distilled water served as the control. Diethyl-ether extracts attracted more insects (8.11) than other solvents, with the control (distilled water) recording the lowest (3.22 insects). The highest concentration level (0.09 mls) attracted more insects than other concentration levels. T he effectiveness of the solvent extracts on maize weevil attractancy were; Diethyl-ether > N – Hexane> Acetone > Ethanol > Distilled water.

Keywords: Attractancy, *Sitophilus zeamais*, solvents

INTRODUCTION

Maize, *Zea mays* L., belongs to the family gramminae, and is speculated to have originated from Mexico. It is considered as one of the major food crops in Nigeria and indeed a major cereal staple in West Africa. Nigeria produces about 1.5 million metric tons of maize in about 1.7 million hectares of land (IITA, 1983).

Maize is the most important cereal crop in sub-Saharan Africa (SSA) and an important staple food for more than 1.2 billion people in SSA and Latin America. The grain contains about 25 % protein, 45 % fiber and 50 % corn starch and can be processed into cornflakes, flour, beer, malt drink, dextrose and animal feeds. Maize can be cooked, roasted, fried, ground, pounded or crushed to prepare various food items like pap, 'tuwo', 'gwate', 'donkunu' and so on (Abdulrahaman and Kolawole, 2006; IITA, 2009; Anon., 2011).

Insect pests of stored maize include Angoumois grain moth (*Sitrotroga cereellella*), Sitophilus *granarius*, *Sitophilus zeamais*, *Sitophilus oryzae*, *Tribolium castaneum*, *Acanthoscelides obtectus*, *Rhyzopertha dominica* and *Prostephanus truncatus.* Of these pests, *S. zeamais* is well-known as a major pest of stored cereal grains; particularly maize. They are able to establish themselves on whole, undamaged and not so exceptionally dry grains. The occurrence of these storage pests in maize has occasionally led to drastic reduction in yield of the crop (Proctor, 1994). These huge post-harvest losses and quality deterioration is a major obstacle to achieving food security in developing countries (Asawalam *et al*, 2008).

S. zeamais, found in all warm and tropical parts of the world, is a curculionid, a field- to- store pest which attacks stored maize leaving circular holes on the surface of the grain. Initial infestation of maize grain occurs in the field just before harvest and insects are carried into the store where the population builds up rapidly (Adedire and Lajide, 2003; Iloba and Ekrakene, 2006).

Total examination of grains for pests may be possible if the quantity to be examined is small, but this is usually neither practicable nor economical when large quantities are involved. The choice is to examine the consignment by taking samples to obtain information on the level of pest infestation (Proctor, 1994).

Little information is available on pest monitoring in storage. In Nigeria, the simple sampling cylindrical auger is the most commonly used instrument for taking samples from bags. Being relatively cheap, simple and quick, local farmers use these augers to pierce through the grain sacs to sample for insect pests on stored grains.

However, the main disadvantage of obtaining samples with these instruments is that the holes created in bags may be avenues for further re-infestation and spillage of stored grains. Grain damage may also occur due to mechanical abrasion while inserting the spear. This could lead to a distorted quality assessment.

Trapping methods have, therefore, been developed to access insect infestation level on stored grains (Proctor, 1994).

The primary aim of this study is to determine the potentials of different concentrations of solvent extracts of maize that could be used to attract and therefore estimate the infestation level of *S. zeamais* without piercing the storage container.

MATERIALS AND METHODS

Sitophylius zeamais Motsch Culture

Laboratory culture of *S. zeamais* was reared under ambient room temperature of 28^{o}- 30^{o}C with adult insects collected form infested maize seeds procured from Owerri Main Market in Imo State, Nigeria. The insects were introduced into two breeding containers containing susceptible maize seeds. On emergence at about 28 days after introduction, the insects were sieved out and placed in empty kilner jars for up to 24 hours until needed.

Bio-Assay

50 g of the locally purchased maize was selected to remove contaminants. The maize was dried in an oven for 2 hours, cooled and there after milled or ground into powder. 150 mls of each of the solvents (Ethanol, Acetone, Diethyl-ether and N-Hexane) were measured out and placed in conical flasks or beakers. 50 g of the milled maize was placed in each container with the different solvents and allowed to stand for two and half hours. The solution was decanted and used immediately. Pure distilled water without the milled maize served as the control.

Forty-five plastic Petri-dishes were perforated with hot iron in two places at the bottom. Each hole was 6mm in diameter. Plastic vials measuring 6 x 12 mm were procured. The inside bottom of the Petri-dishes were abraded with sand paper. This was to facilitate the movement of the insects. The plastic vials were inserted through the holes in such a way that the mouth of the vial flushed with the bottom of the Petri-dish (Plate 1). Filter papers were cut into strips of 5 x 15 mm and treated with 0.03 ml, 0.06 ml and 0.09 ml of the four different solvent extracts of the ground maize, as the case may be. These were placed inside the vials with a pair of forceps and replicated thrice. Similarly, another filter paper (treated with pure water only, as the control) was

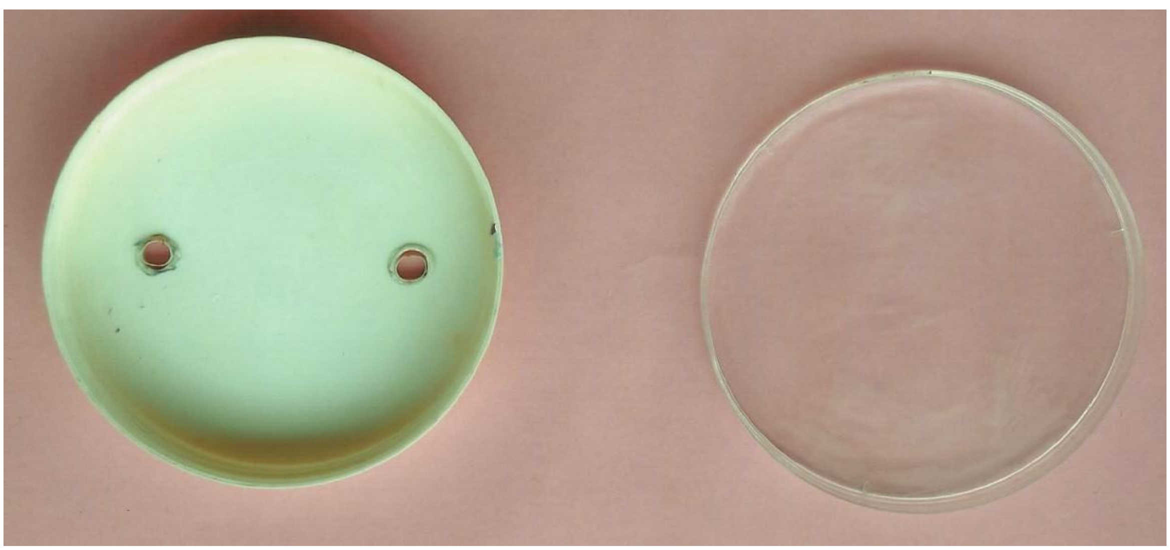

Plate 1: Sample of the petri dish and the cover used for the attractancy test
Left: The mouth of the veil inserted to flush with the bottom of the petri dish
Right: Cover of the petri dish.

Plate 2: Sample of the petri dish and the cover used for the attractancy test

Left: Inside of the petri dish showing the treated and untreated (control) filter paper inserted inside the veils.
Right: Cover of the petri dish

placed inside the bottom of the second vial (Plate 2). The plastic vials were marked to differentiate the pure water (control) from the other solvent extracts of maize. The Petri-dishes were placed in rows according to the treatment.

Ten adult *S. zeamais* were chilled in a refrigerator for 5 minutes (to reduce their mobility) and placed at the centre of each of the petri-dishes. The petri-dishes were randomized on the laboratory table and covered with an over-lapping lid to preclude entry or exit of insects (Plate 3). The setup was covered with black polythene sheet to shield the insects from direct sunlight and allowed to stay for two hours before recording the number of insects that had migrated to the vials

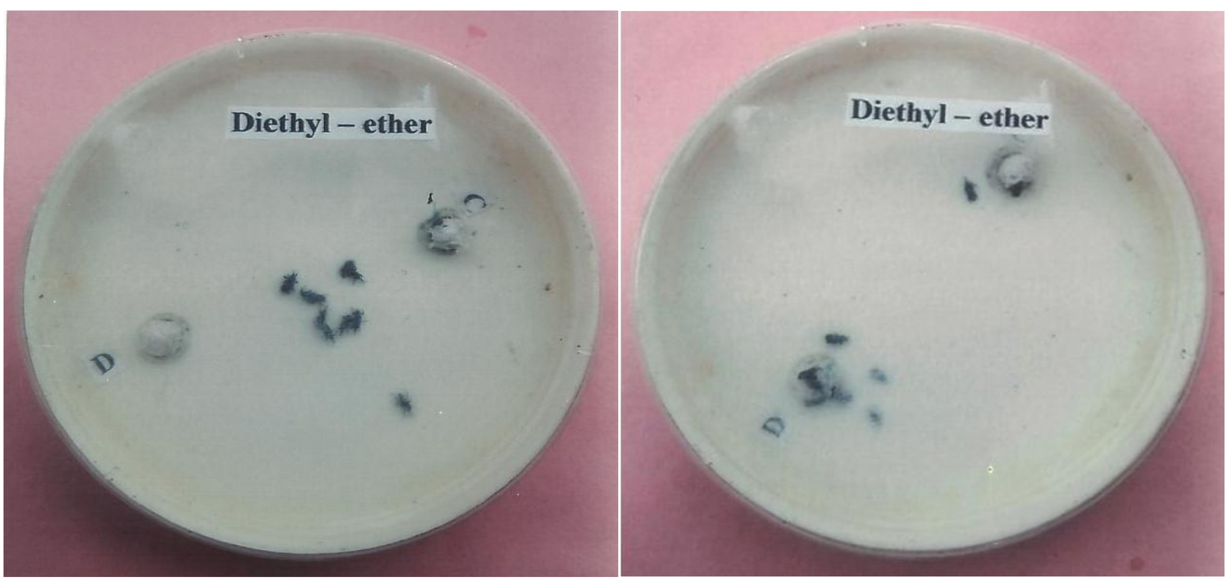

Plate 3: Sample of the petri dishes with their covers after the introduction of the insects.

Left: Inside of the petri dish showing the treated (Diethyl- ether, marked 'D') and untreated (control, 'C') filter paper inserted inside the veils and the insects placed at the centre of the dish.
Right: The *S. zeamais* attracted to the Diethyl-ether solvent extract corner after 2 hours of the experiment.

The experiment was laid out in a 5 x 3 factorial fitted into a completely randomized design (CRD). The analysis was done using analysis of variance (ANOVA) and least significant difference (LSD) to separate the means.

RESULTS AND DISCUSSION

The result of the attractiveness of *Sitophilus zeamais* to different solvent extracts after two hours of treatment are presented in Table 1. Diethyl-ether extracts recorded the highest mean number of insects attracted (8.11). This result did not differ statistically from N-Hexane extracts which recorded the second highest number of insects (7.11). Acetone and Ethanol extracts came next with 5.89 and 5.56 insects, respectively. Distilled water, which served as the control attracted the least number of insects (3.22).

Table 1: Effects of Solvent Types on Mean Number of Insects Attracted

Solvents	**Mean Number of Insects Attracted**
Acetone	5.89
Diethyl Ether	8.11
Ethanol	5.56
N-Hexane	7.11
Control (Distilled Water)	3.22
LSD $_{0.05}$	**0.518**

Tipping *et al*. (1986) had shown that the maize weevils, *Sitophilus oryzae* (L.) and *S. zeamais* Motsch, were attracted to methanol, acetone, hexane and ether extracts from two corn genotypes, A619 and B37. *S. zeamais* was observed to have responded more quickly than *S. oryzae*. In a later experiment to determine the behavioural responses of *Sitophilus granarius*, *S. oryzae* and *S. zeamais* to synthetic 4S,5R-sitophinone alone and in combination with volatiles from kibbled carob (ground meal from edible pods of the evergreen tree, *Ceratonia siligua),* Wakefield *et al*, (2005) observed that the volatiles from kibbled carob attracted all the three species.

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The mean number of insects attracted differed significantly from each other (P = 0.05) at various concentration levels (Table 2). The highest level (0.09 ml) recorded the highest number of insects (6.27), followed by the higher level (0.06 ml) with 6.00 insects. The lowest number of insects attracted was recorded by the least level (0.03 ml) with 5.67 insects. These figures though not statistically different from each other, suggest that higher concentrations may be needed to attract larger numbers of the insects

Table 2: Effects of Concentration Levels on Mean Number of Insects Attracted

Concentration	**Mean Number of Insects Attracted**
C1	5.67
C2	6.00
C3	6.27
LSD $_{0.05}$	**0.400**

KEY:

C1: 0.03mls
C2: 0.06mls
C3: 0.09mls

This result agrees with the findings of Treaterra *et al* (1999) who observed that *Sitophilus oryzae* were attracted, in different ways, to intact and damaged kernels of 5 types of cereals—*Triticum aestivum*, *T. durum*, *T. dicoccum*, *T. monococcum* and *T. spelta*. They noted that the cereals released volatile substances once artificially dehulled or split and that the volatile substances, released from different parts of the kernel, act independently of one another and are highly attractive to cereal weevils at higher concentrations. Stubbs *et al* (1985), had earlier observed that vacuum distillation of heat-treated carobs gave an aqueous, colorless, sweet-smelling distillate which when tested over a wide range of concentrations were found to be highly attractive to adult *Oryzaephilus surinamensis* (L.), especially at higher concentrations.

The result of the interaction between the different solvents and their concentration levels is presented in Table 3. It was observed that Diethyl-ether had the highest number of insects across all concentration levels (7.67, 8.00 and 8.67), with the control (Distilled water) attracting the lowest number of insects (2.67 – 3.67). It should be noted, however, that the different solvents did not interact significantly (P = 0.05) with the concentration levels.

Table 3: Effects of Different Solvents and Concentration Levels Interactions on Maize Weevil Attractancy.

	Concentration Levels		
Solvents	**C1**	**C2**	**C3**
Acetone	6.00	5.33	6.33
Diethyl Ether	7.67	8.00	8.67
Ethanol	5.33	5.67	5.67
N-Hexane	6.67	7.33	7.53
Control (Distilled Water)	2.67	3.67	3.33

$LSD_{0.05}$:
Interaction: NS

KEY:
C1: 0.03mls
C2: 0.06mls
C3: 0.09mls

CONCLUSION

The use of metal augers in piercing storage maize bags could be detrimental to the farmer as the holes created in the bags may be avenues for further re-infestation, grain damage and spillages.

Though the use of grain extracts for the assessment of infestation levels of grain weevils has gained currency, farmers in Nigeria still rely on the physical methods of evaluation.

The choice of the medium (solvent) for the extraction is critical to the overall attractiveness of the extracts to the insects. This experiment has, therefore, confirmed that Diethyl-ether is the solvent of choice. Other solvents, in the order: N – Hexane > Acetone > Ethanol > Distilled water, may however, be used with varied degrees of successes. It should be noted that higher concentration of the substrates would be needed for best results.

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