Control of *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae) with local plant materials in the western highlands of Cameroon

AKOB C. A.1,2*, and EWETE, F. K. 1

1 Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan, Nigeria:
2 Regional College of Agriculture Bambili, Northwest Region Cameroon

**ABSTRACT**

*Sitophilus zeamais* Motschulsky is the main insect damaging stored maize in the western highlands of Cameroon. High cost, unreliable supply and environmental hazards of chemical insecticides necessitate search for cheaper, safe and easily available local alternatives. This study identifies and evaluates some local plant materials for control of *S. zeamais*. Field survey and laboratory studies were conducted and four plant materials consisting of leaves and/or roots; *Cupressus arizonica*, *Eucalyptus grandis*, *Ocimum gratissimum* and *Vetiveria zizanioides* identified were powdered and investigated. The experimental design used was randomized complete block. Data collected were analysed using F-test and significant means were separated using Least Significant Difference.

The powdered plant materials showed no significant toxicity against F1 progeny but *V. zizanioides* significantly (P≤0.01) repelled *S. zeamais*, giving ≥50% at the lowest dosage of 0.1g/25g grains. *V. zizanioides* root powder had potential for control of *S. zeamais* as repellent. This could form part of an integrated pest management package for the Western highlands of Cameroon.

**Keywords:** Survey, *Vetiveria zizanioides*, *Sitophilus zeamais*, control, maize, Cameroon

**RESUME**

*Sitophilus zeamais* Motschulsky est l'insecte principaux détruiante le maïs pendant le stockage dans les hauts plateaux de l'Ouest du Cameroun. Les coûts élevés, l'offre inconsistante et l'hazard environmental des insecticides chimique necessite la cherche des mesures corollarie locaux, sans danger, facilement trouvé et moins cher. Cette étude identifie et évalue quelques matériels végétaux locaux pour le traitement de *S. zeamais*. Les études du terrain et du laboratoire sont conduit et quatre matériels végétaux consistent les feuilles et/ ou racines; *Cupressus arizonica*, *Eucalyptus grandis*, *Ocimum gratissimum* et *Vetiveria zizanioides* identifié était poudrer et examiner. Le modèle experimental utilisé était le bloc complètement randomisé. Les données collectées ont été analysées en utilisant le test de Fischer et les moyens significatifs étaient séparés en utilisant les plus petites differences moins significatives. Les matériels poudrées n'ont pas donnée une toxicité significatif mais une repelence significatif (P≤0.01) contre *S. zeamais* avec *V. zizanioides* donnant plus de 50% au dosage le plus bas de 0.1g/25g grains. Les racines de *V. zizanioides* poudre avaient le potentielle pour controller *S. zeamais* comme repellent. Ça peut formé partie d'un strategie de lutte intégré pour *S. zeamais* dans les hauts plateaux de l'Ouest du Cameroun.

**Mots clés :** Enquête, *Vetiveria zizanioides*, *Sitophilus zeamais*, lutte, maïs, Cameroun.

* Corresponding author
Email: apanakob@yahoo.com
1. INTRODUCTION
Maize, *Zea mays* (L) is one of the most important cereal crops in the world today with industrial and household uses. It is consumed as food by humans in various forms, feed for animals and used as raw material for the manufacture of bio-fuels, among many other industrial products. Insect pests are among the most serious factors limiting maize production in various maize growing areas of the world (Bosque-Pérez, 1995). The maize weevil, *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae) is a major post-harvest insect pest of stored maize in the tropics. In the western highlands of Cameroon (WHC), it is the main insect pest that damages maize in storage (Ngoko, 1999; Akob and Ewete, 2007). In 1990-91 McHugh (1994) reported that quantitative losses in Ndop due mainly to *Sitophilus zeamais* was up to 33% while qualitative losses attained 52%.

The high cost of synthetic chemical insecticides, risk of contamination of users and their unreliable supply necessitate the search for safer, cheaper and easily available local alternatives such as natural materials of plant origin. The use of plant materials in pest control could be come an important supplement to imported synthetic pesticides because they have an important potential for integrated pest management programmes in developing countries, since they are cheap and readily available Bekele et al., (1996). The use of locally available plant materials to protect stored products against pest damage is common practice in traditional farm storage systems in most developing countries (Poswal and Akpa, 1991; Bekele et al., 1996; Achiano et al., 1999; Boeke et al., 2004). They are biodegradable and so do not persist in the environment or accumulate in the food chain (Jood et al., 1993; Onu and Aliyu, 1995; Ewete et al., 2000).

The objective of this study was to identify and evaluate some local plant materials for control of *S. zeamais* in the western highlands of Cameroon, where the use of botanicals for post-harvest protection of grains is prevalent.

MATERIALS AND METHODS

**Source of maize grains**
Clean, healthy, uninfested grains of KASAI maize variety collected from the Institute of Agricultural Research for Development (IRAD) Bambui, Cameroon were used for the study. The maize grains were stored in a deep-freezer for a month to kill any insects resulting from field infestation. They were removed from the freezer at -5 to -20°C and allowed to remain under ambient temperature of 13.8 - 26.8°C and 41-82% relative humidity for moisture equilibration for 3 weeks before use.

**Insect culture**
*Sitophilus zeamais* culture was established using adults collected from the maize barn of the Regional College of Agriculture (RCA) Bambili, Cameroon. One hundred weevils were introduced into 250g maize grains in each of 5 kilner jars with mesh lids. These were kept in the crop protection laboratory of RCA Bambili under ambient temperature of 13.8-26.8°C and 41-82% relative humidity to start the insect culture. After 3 weeks of mating and oviposition, the adult weevils were removed. The kilner jars were observed daily and teneral adult weevils removed from the cultures and sexed using the method of Halstead (1963). This insect culture was maintained and used as source of *S. zeamais*.

**Identification and preparation of plant materials**
A survey was conducted in geographically representative locations in each of the seven divisions of the Northwest Region, western highlands of Cameroon to identify plant species being used locally by farmers to control the maize weevil, *S. zeamais*.

A random sample of 50 farmers from each of the seven divisions of the province (i.e. 350 farmers for the whole province) was interviewed to get information on plant materials being used as maize grain protectant as well as some other basic information on *S. zeamais* and its control in the region (Table 1). A questionnaire was used in the survey so as to allow for an orderly collection of information as well as to facilitate analysis of the information so collected. Personal observations on the field and available literature were also used to properly identify plant species. Those that could not be identified immediately were carefully preserved and later identified with assistance of plant taxonomist in the Department of Forestry, University of Ibadan.

All identified plant materials to be investigated were collected and air-dried under shade for 7 days in the screen house of the Institute of Agricultural Research for Development (IRAD) Bambui. This was to ensure that volatile active principles were retained in the dried samples. Each of the dried plant materials was ground to powder in a milling machine and then sieved through a 0.5mm mesh and 250g of each, packaged in plythene bag, labeled and kept in the refrigerator for the bioassay.
Bioassay with powdered plant materials
The 250g milled samples of each of the four plant species kept in the refrigerator were used for the bioassay. They were used as direct admixtures to the maize grains at rates calculated on a weight of powdered material per weight of grain (wt/wt) basis, for the toxicity on F1 progeny as well as repellency evaluation against *S. zeamais*.

Toxicity of powdered materials on F1 progeny
The effects of treated maize grains on F1 progeny of *S. zeamais* were investigated using powdered samples from the four test plant species; *C. arizonic*, *E. gands*, *O. gratissimum* and *V. zizanioides* at five rates of 0, 0.1, 0.25, 0.5 and 1.0g/25g of maize grain, determined by preliminary tests and as has been used in previous similar studies.

Twenty-five grammes of maize grains were placed in five separate kilner jars for each of the four powdered plant materials and treated with the five different rates of powdered plant materials. Each kilner jar containing maize grains and powdered materials was shaken for even coverage of grains. Ten 1-2 day-old adult maize weevils of mixed sexes (1male:1female) were introduced into each kilner jar and covered with a lid having mesh. The experiment was laid out as a 4x5 factorial, in four replications and with the treatments arranged in a RCB design. After 7 days, all adult weevils were removed and the kilner jars with grains left undisturbed for about 30 days. This was followed by daily observations and recording of F1 progeny emergence. The data collected on emerged F1 progeny were analyzed using ANOVA and treatment means that showed significant difference (P < 0.05) were separated using LSD.

Repellent activity of powdered plant materials
The repellent action of the four powdered plant materials; *C. arizonic*, *E. gands*, *O. gratissimum* and *V. zizanioides* each applied at five different rates (0, 0.1, 0.25, 0.5 and 1.0g/25g of maize grains) were evaluated in a choice experiment (in which, *S. zeamais* had to select either treated or untreated maize grains). The treated and untreated grains were placed opposite each other with a space of 24cm in between them in a round plastic tray of 30cm diameter, under-lain with rough paper to facilitate crawling by the insects. The tray was covered using a nylon mesh with a hole cut in the middle for introduction of the test insects and held in position with a rubber band fastened over the mesh around the tray. Five lots of 25g maize grains were each treated with one of the five rates of powdered plant materials, and each placed near the circumference inside a circular plastic tray. Another 25g of untreated grain were also placed near the circumference inside the circular plastic.
tray but at the diameter position or directly opposite the treated grains of each tray and covered. Ten 1-2
day-old adult *S. zearmis* were introduced into each tray
through the hole in the middle of the mesh cover,
with a small funnel. A randomized complete block
(RCB) design was used with the five rates of powdered
plant material as treatment in four replications. The
number of weevils present on the control and treated
maize grains were recorded after one hour and the
Percent Repellency (PR) computed as:

\[
PR = \frac{(N_c - N_t)}{(N_c + N_t)} \times 100
\]

Where \((N_c) = \) number of weevils present on the
untreated (control) maize grains and
 \((N_t) = \) number of weevils present on treated
maize grains.

A negative PR value was treated as zero and the data
analyzed using ANOVA after transforming them into
arcsine values (Little and Hills, 1978).

**RESULTS**

Identification of plant materials for control of *S. zearmis*

Survey of locally available plant species used by
farmers in Cameroon as grain protectants against
infestation revealed that 99.7% of the farmers
(respondents) recognized *S. zearmis* as the most serious
insect pest of stored maize.

For the control of the weevil, 43% used local plant
materials, 38.3% used synthetic insecticides while some
farmers (18.6 %) did not treat their maize before
storage (Table 1). In addition, 19.1% of the
respondents indicated that insecticides were available
when needed while 22.3% indicated that they were
affordable.

**DISCUSSION**

The survey revealed that 99.7% of the farmers
(respondents) recognized *S. zearmis* as the most serious
insect pest of stored maize. This is in conformity with
Ngoko (1999) that *S. zearmis* is the main damaging
insect in storage reported by all farmers interviewed in
three agro-ecological zones including the western
highlands of Cameroon. Thus, *S. zearmis* infestation is
an important constraint that needs to be tackled.

**Table 2:** Botanical identity of plant materials being used against *Sitophilus zearmis* in the Northwest region, Cameroon.

<table>
<thead>
<tr>
<th>Botanical name</th>
<th>Family</th>
<th>Common name</th>
<th>Part used</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Vetiveria zizanioides</em></td>
<td>Gramineae</td>
<td>Vetiver</td>
<td>root</td>
</tr>
<tr>
<td><em>Cupressus arizonica</em></td>
<td>Cupressaceae</td>
<td>Cypress</td>
<td>leaf</td>
</tr>
<tr>
<td><em>Eucalyptus grandis</em></td>
<td>Myrtaceae</td>
<td>Eucalyptus</td>
<td>leaf</td>
</tr>
<tr>
<td><em>Ocimum gratissimum</em></td>
<td>Labiatae</td>
<td>O cimum</td>
<td>leaf</td>
</tr>
<tr>
<td><em>Nicotiana tabacum</em></td>
<td>Solanaceae</td>
<td>Tobacco</td>
<td>leaf</td>
</tr>
<tr>
<td><em>Capsicum frutescens</em></td>
<td>Solanaceae</td>
<td>Chilli pepper</td>
<td>fruit</td>
</tr>
<tr>
<td><em>Aframomum melegueta</em></td>
<td>Zingiberaceae</td>
<td>Alligator pepper</td>
<td>fruit</td>
</tr>
<tr>
<td><em>Cola acuminata</em></td>
<td>Sterculiaceae</td>
<td>Kola nut</td>
<td>fruit shell</td>
</tr>
<tr>
<td><em>Afrostyrax lepidophyllum</em></td>
<td>Styracaceae</td>
<td>Country onion</td>
<td>seed</td>
</tr>
</tbody>
</table>

Figure 1 shows plant materials being used for control
of *S. zearmis* in the Northwest region, western highlands
of Cameroon while Table 2 shows the botanical identity
of the plants and plant parts being used. The most
frequently used four plants were short-listed for the
bioassay included cypress leaves (*Cupressus arizonica*
Greene), Eucalyptus leaves (*Eucalyptus grandis* Hill ex
Maiden), O cimum leaves (*Ocimum gratissimum* Linn.) and
vetiver roots (*Vetiveria zizanioides* (Linn.) Nash).
Therefore appropriate and affordable control measures of this pest are required in order to enable farmers preserve their maize longer and obtain higher market prices. Akob and Ewete (2007) observed that little *S. zeamais* infestation occurs on the field unless harvest is delayed, suggesting that most of the infestation occurs in storage.

<table>
<thead>
<tr>
<th>Plant powdered dosage (g/25g of grains)</th>
<th>Mean no. (± S.D.) of emerged F₁ progeny</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cupressus arizonica</td>
</tr>
<tr>
<td>0</td>
<td>14.5 ± 3.0</td>
</tr>
<tr>
<td>0.10</td>
<td>14.3 ± 2.9</td>
</tr>
<tr>
<td>0.25</td>
<td>12.0 ± 2.6</td>
</tr>
<tr>
<td>0.50</td>
<td>12.5 ± 2.3</td>
</tr>
<tr>
<td>1.00</td>
<td>13.5 ± 2.7</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>NS</td>
</tr>
<tr>
<td>C.V. %</td>
<td>22.5</td>
</tr>
</tbody>
</table>

NS = Not Significant

The finding that up to 43.1% of respondents (farmers) in the Northwest region of Cameroon use various local plant materials against *S. zeamais* is in agreement with Jilani (1984), that plants have been known to possess insecticidal properties and grain protectants in particular and that physiochemicals were used as pesticides before the advent of synthetic insecticides (Jacobson 1989). The wide disparity between percent users of *Cupressus*

<table>
<thead>
<tr>
<th>Plant Powder dosage (g/25g of grains)</th>
<th>Percentage repellency (± S.D.) of powdered plant materials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cupressus arizonica</td>
</tr>
<tr>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>0.10</td>
<td>35.3 ± 9.1</td>
</tr>
<tr>
<td>0.25</td>
<td>56.4 ± 9.0</td>
</tr>
<tr>
<td>0.50</td>
<td>60.4 ± 7.7</td>
</tr>
<tr>
<td>1.00</td>
<td>68.4 ± 6.2</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>10.6</td>
</tr>
<tr>
<td>C.V. %</td>
<td>21.0</td>
</tr>
</tbody>
</table>
arizonica and Vetiveria zizanioides from results of survey and those obtained from bioassay is probably because the introduction of V. zizanioides and its use as a grain protectant in the area is recent and needs widespread application and acceptability like C. arizonica. V. zizanioides root powder at the rate of 0.1-1.0g per 25g of maize grains showed the highest percentage repellency (64.0-86.8) compared to all other plant materials studied. This is in conformity with Glasby (1991) and National Research Council, (1993), that vetiver contains mainly bicyclic and tricyclic sesquiterpenes-hydrocarbons, alcohols and carboxylic acids as well as minor constituents including α-vetivone, β-vetivone, khusimone and khusitone that are insect repellent.

Though powdered plant materials showed no significant toxicity to F1 progeny of S. zeamais infesting maize in the present study, Bekele et al., (1996) found that the ground leaves (powder) of Ocimum suave, a very close relative of O. gratissimum, provided protection to maize and sorghum grains against attack by S. zeamais. Similarly, Dike and Mshelia (1997) using cowpea treated with eucalyptus leaf powder also reported that the powder significantly (P = 0.05) inhibited oviposition and progeny development of Callosobruchus maculatus at 10 and 20g/100g cowpea seed. The differences in toxicity observed in these studies could be attributed to the differences in the genera and species of the powdered materials and grain types used.

ACKNOWLEDGEMENTS
The authors wish to thank farmers interviewed for the useful information provided, which formed the basis of this research. We are equally grateful to the following persons for their inputs, Prof. J. A. Odebiyi, Prof. I. Fawole and Dr. O. Oni. This forms part of the work of a Ph.D. thesis submitted to University of Ibadan, Ibadan, Nigeria.

REFERENCES


Bekele, A. J., Obeng-Ofori, D. & Hassanali, A.


Received: 25/10/08
Accepted: 24/05/10