

Insecticidal Action of Some Plant Powders on Maize Weevil [*Sitophilus zeamais* (Motschulsky) (Coleoptera: Curculionidae)] Affecting Stored Maize Grains (*Zea mays*)

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Abstract – This study evaluated the insecticidal action of seven (7) botanical plant powders against the bean weevil [*Sitophilus zeamais* (Motschulsky) (Coleoptera: Bruchidae)] infesting stored maize grains (*Zea mays*) under ambient laboratory conditions in Ado Ekiti, Nigeria. The research was conducted in two separate experiments. In the first experiment, two grams (2g) of each of the seven botanical powders were separately measured into Petri dishes with three (3) replicates and one control respectively. 20 unsexed *S. zeamais* adults from the weevil culture were introduced into each of the Petri dishes containing the botanical powders and the control, with no powder in it. The number of dead *S. zeamais* adult was counted after 24h, 48h and 72h of the insects' introduction into each of the Petri dishes. In the second experiment, two grams (2g) of each botanical powder was separately measured into Petri dishes containing thirty grams (30g) of Hybrid NS-1 White maize grains. Each treatment was replicated thrice (3ce) with one control respectively. 20 unsexed adults of *S. zeamais* from the weevil culture were introduced into each of the Petri dishes containing the maize grains with the botanical powders and also into the control with no powder in it. The adult *S. zeamais* introduced were left for seven (7) days before removal, for the insects to mate and lay eggs in the maize grains. After 45days of infestation / treatment, data were collected on the following parameters: number of holed / damaged seeds, total number of *S. zeamais* adults that emerged from seeds and final weight of infested seeds. Analysis of variance was carried out on data collected and significant means separated at 5% level of probability, using Duncan's Multiple Range Test (DMRT). Of the seven (7) plant materials tested, only *Corymbia citrodora* leaf powder exhibited a total control (100%) on *S. zeamais* in all its developmental stages, followed with a wide margin of 27.0% adult emergence, 28.2 number of damaged (holed) maize grains and 33.3% of dead *S. zeamais* adults after treatment. The level of reduction in the pestiferous activities of *S. zeamais* on stored maize grains, was significantly different from the control in all the botanical powders tested except Moringa leaf powder in which the level of reduction, was not significantly different ($p < 0.05$) from the control. However, none of the other six plant materials investigated for bio-pesticidal action against *S. zeamais*, exhibited up to 50% efficacy level or control on the insect; apart from *Corymbia citrodora*.

Keywords – Insecticidal Action, Plant Powder, *Sitophilus Zeamais*, *Zea Mays*.

I. INTRODUCTION

Maize plant (*Zea mays*) is an important and one of the oldest and the mostly cultivated world cereals. The crop is mainly grown for its grain, which is utilized for human

consumption and forms about 50-70% of the constituent of livestock feeds (David, 1994; Longe, 2010). The grain is very nutritious, with about 70-72% digestible carbohydrate, 4-5% fats and oils and 9.5-11% proteins (Larger and Hills, 2001). Maize belongs to the family *Graminae* and is one the most important cereal crops Nigeria. After wheat and rice, maize is the third most grown cereal (Lyon, 2000). It 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). Maize is an important source of carbohydrate in the tropics and is a major staple food in Nigeria for a large proportion of the population in addition to being an important poultry feed and also for industrial uses (Morris, 2001; Pingali and Pandey, 2001; FAO., 2007). It is an important source of protein ranking only after meat, fish and legumes in term of annual protein production (Dasbak e al; 2008). Worldwide, about 66% of maize is used for feeding livestock, 25% for human consumption and 9% for industrial purposes. In the developing world, about 50% of all maize is consumed by humans as food while 43% is fed to livestock and the remainder for industrial purposes (IITA, 2003). The maize kernel 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 (Kling, 2001; Dasbak et al; 2008). 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 grain stored in warehouses or silos is lost as a result of inappropriate storage conditions yearly. 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). In view of the great value of maize, it is imperative, that a greater attention should be paid to the crops during storage in order to make them available for use throughout the year (Longe, 2010). For the purpose of storage, peasant farmers treat grains with plant products and oils, use cultural methods such as open sun-drying and storing in barns, cisterns pots, jars and in airtight containers (Dobie, 1994). These are less cost effective for storage of large quantities of grain. Maize is exposed to insect pest attack prior to harvest and in storage (Muyinza, 1998). The maize weevil (*Sitophilus zeamais* Motschulsky) is a major pest of stored maize grains and its infestation causes severe post harvest losses of staple food crops in Nigeria (Oni and Ileke, 2008). *S.zeamais* is a

small weevil measuring 2.5-4.5mm in length. It can live up to twelve months, depending on environmental conditions. The female lays up to 150 eggs. Upon hatching, larvae bore in to the grain and after developing through several 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% (Adams, 1996). The destructive activities of this insect pest and other storage pests have before now been widely subdued by chemical control methods, such as fumigation of stored products with carbon disulphide and phosphine and dusting with pirimiphos methyl or permethrin (Adedire et al., 2011). The problems of many synthetic insecticides however include high persistence in the soil after use, high cost of application, environmental pollution and lethal effects on non-target organisms or directly toxic to users (Ofuya and Longe, 2009). They are also prone to user abuse, expensive, highly toxic, have low shelf life and farmers generally lack the technical expertise in handling and applying them (Giga and Mazarura, 2000). Some other researchers have also opined that though synthetic chemicals continue to play an important role in reducing storage losses due to insect pest activities, insecticides resistance, toxic residues in food, environmental pollution, adverse effects on beneficial and non target insects, increased risk to workers safety and high cost of the chemicals make them less attractive (Niber, 1994; Obeng-Ofori et al; 1998; Perez-Mendoza, 1999; Asawalam et al; 2000).

There has been a steady increase however in recent times, in the use of plant products as a cheaper and ecological safer means of controlling insect pests of stored grains, especially in the tropics (Lale,1992); while currently, attention is being given to the use of edible plant materials with medicinal properties as grain protectants (Longe, 2012). Any reduction in loss due to the discovery or development of cheaper, safer and ecologically friendly means of controlling insect pests of stored grains would go a long way to increase the availability of food grains and

ensure a successful millennium development goal on food security in Nigeria and beyond (Longe, 2012). The main objective of this study therefore, is to evaluate the efficacy of powders from seven (7) plant species: *Corymbia citrodora*, *Moringa oleifera* (Leaf and Seed), *Alstonia boonei*, *Citrus aurantifolia*, *Ocimum gratissimum*, *Nicotiana tabacum* and *Zingiber officinale*, against *Sitophilus zeamais* (Motschulsky) on maize grains during storage. The study is to specifically determine the number of dead adults on contact, adult emergence from seeds and seed weight loss after treatment.

II. MATERIALS AND METHODS

Experimental Site

The experiment was carried out in the Research Laboratory of the Department of Crop, Soil and Environmental Sciences, Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti.

Insect Culture

The maize weevil *Sitophilus zeamais* (Mots.) used for this study were obtained from an infested stock in Ado Ekiti market and confirmed in the Crop, Soil and Environmental Science Department Laboratory of Ekiti State University (EKSU) before use. The weevils were cultured on clean seeds of Hybrid NS-1 White maize variety, which was also used as substrate for the experiment.

Maize Variety

Hybrid NS-1 White maize variety, obtained from Ekiti State Agricultural Development Programme Farm Store, Ado Ekiti, was used for the experiment. The maize seeds were put in the freezer for two weeks to remove any possible weevil infestation before usage.

Plant Materials

The plant materials used as powders for the experiment, were obtained from the following plants and plant parts: Lemon-scented Gum plant: *Corymbia citrodora* (Leaf), Drumstick plant: *Moringa oleifera* (Leaf and Seed), Cheesewood: *Alstonia boonei* (Stem bark), Lime: *Citrus aurantifolia* (Fruit peel), Mint: *Ocimum gratissimum* (Leaf), Tobacco: *Nicotiana tabacum* (Leaf), Ginger: *Zingiber officinale* (Rhizome).

Table 1: The particulars of plants which powders were used against *S. zeamais*

Plant Powder Used Name	Plants Botanical Name	Plants Family Used	Plant Part/s
Cheesewood	<i>Alstonia boonei</i>	Apocynaceae	Stem Bark
Lemon-scented Gum	<i>Corymbia citrodora</i>	Myrtaceae	Leaf
Ginger	<i>Zingiber officinale</i>	Zingiberaceae	Rhizome
Lime	<i>Citrus aurantifolia</i>	Rutaceae	Fruit Peel
Mint	<i>Moringa oleifera</i>	Moringaceae	Leaf & Seed
Tobacco	<i>Nicotiana tabacum</i>	Solanaceae	Leaf

Description of Experimental Set-Up

The research was conducted in two separate experiments. In the first experiment, two grams (2g) each

of the botanical powders were separately measured into Petri dishes in three (3) replicates and one control respectively. 20 unsexed *S. zeamais* adults from the weevil culture were introduced into each of the Petri dishes

containing the botanical powders and the control, with no powder in it. Number of dead *S. zeamais* adult was counted after 24h, 48h and 72h of insects' introduction into the Petri dishes. In the second experiment, thirty grams (30g) of the Hybrid NS-1 White maize variety was measured into new Petri dishes with three (3) replicates and a control. Two grams (2g) of each botanical powder was measured into each Petri dish and the control containing the maize grains. 20 unsexed adults of *S. zeamais* from the weevil culture were introduced into each of the Petri dishes containing the maize grains and also into the control. The adult introduced were removed after 7 days, when enough eggs must have been laid in the maize grains. **Data Collection** In the first experiment, data was collected on the number of dead *C. maculatus* adults, in both the treatments and the control. In the second experiment, after 45days of infestation / treatment, data were collected based on the following parameters: number of holed / damaged seeds, total number of *C. maculatus* adults that emerged from seeds and final weight of infested seeds. **Data Analysis** Analysis of variance will be carried out on data collected and significant means separated at 5% level of probability, using Duncan's Multiple Range Test (DMRT).

III. RESULTS

Table 2 show significant variation ($p < 0.05$) among the different plant powders considered under various parameters, and in comparison with the control. All the botanical powders were significantly different from the control, except *Moringa* leaf powder in which the level of reduction in the pestiferous activities of *S. zeamais* on stored maize grains, is not significantly different ($p < 0.05$) from the control. *See table 2 for details. Of the seven (7) plant materials tested, only *Corymbia citrodora* leaf powder exhibited total control (100%) of *S. zeamais* in all the parameters tested. This is followed with a wide margin of 27.0% adult emergence, 28.2 number of damaged (holed) maize grains and 33.3% dead *S. zeamais* adults after treatment. None of the other six plant materials investigated for bio-pesticidal action against *S. zeamais*, recorded up to 50% efficacy or control. Treatments with the lowest amount of holed maize grains and adult emergence from the infested seeds, exhibited the lowest percentage weight loss from seeds and vice versa. This indicates a positive correlation between the tested parameters, viz: number of holed seeds, adult emergence from seeds and percentage weight loss from seeds

Table 2: The comparative effects of different plant powders on *S. zeamais* infesting stored maize grains

Plant Powder Used	Mean % Adult Mortality	Mean % Adult Emergence	Mean No. of Damaged (Holed) Seeds	Initial Seed Weight	Final Seed Weight	% Weight Loss From Seeds
<i>Alstonia</i>	13.3d	33.3d	34.6e	30.0a	26.1d	13.0d
<i>Corymbia</i>	100.0a	0.00a	0.00a	30.0a	30.0a	0.00a
Ginger	11.7e	32.5c	31.0c	30.0a	27.1c	9.67c
Lime	8.36f	31.7c	30.5c	30.0a	26.9c	10.3c
Mint	12.1e	35.0e	33.7d	30.0a	26.0d	13.3d
<i>Moringa</i> Leaf	18.5c	46.7f	45.9f	30.0a	21.5f	28.3f
<i>Moringa</i> Seed	5.00g	36.4e	33.3d	30.0a	24.8e	17.3e
Tobacco	33.3b	27.0b	28.2b	30.0a	28.7b	4.33b
Control	0.00h	47.1f	46.3f	30.0a	20.1f	33.0f

Mean in each column having the same letters are not significantly different by Duncan Multiple Range Test (DMRT) at 5% level of probability.

Table 3 shows the rating of the various plant powders tested against *S. zeamais*. The powders were rated as, very effective, moderately effective, slightly effective and not effective, as the case may be. *Corymbia citrodora* leaf powder was rated as very effective, based on its ability to completely control *S. zeamais* infestation 100% in all the

parameters tested. All the remaining plant powders were rated as slightly effective, as they exhibit slight differences ($p < 0.05$) in their performance against *S. zeamais* from the control. *Moringa* leaf powder was rated as not effective, as the level of reduction in *S. zeamais* pestiferous action on stored maize is relatively insignificant ($p < 0.05$).

Table 3: Performance rating of powders from the tested plant parts against *S. zeamais*

	Plant Material	Performance Level
1	Lemon-scented Gum Leaf	Highly Effective
2	<i>Moringa</i> Leaf	Not Effective
3	<i>Moringa</i> Seed	Slightly Effective
4	Ginger Rhizome	Slightly Effective
5	Mint Leaf	Slightly Effective
6	Lime Fruit Peel	Slightly Effective
7	<i>Alstonia</i> Stem Bark	Slightly Effective
8	Tobacco Leaf	Slightly Effective

IV. DISCUSSION

Results from the study has unequivocally shown that *Corymbia citrodora* leaf dust (powder) is highly effective against *Sitophilus zeamais* affecting stored maize grains; going by its 100% efficacy showing in the experiment against the insect in all its developmental stages. The mechanism of bio-insecticidal activity of *C. citrodora* leaf dust in the study can be observed from the great and rapid kill of the adult insects and the remarkable high reduction in the emergence of new adults from the treated seeds, compared with the control. The observed toxicity of *C. citrodora*, was rather fascinating; as the rate of powder application at which complete mortality of all stages of the insect was achieved (*less than 2% the weight of protected seeds*), was not very normal and not excessive (Golob et al,1999; Boeke et al, 2001). In view of the observed total control exhibited by *C. citrodora* leaf dust against the maize weevil (*S. zeamais*) in the experiment, treatment of field infested maize grains with any of the two powders will kill all eggs laid by founder insects, thereby halting further build up of the weevil and subsequent maize seeds damage by the pest during storage. Apart from the fact that *C. citrodora* leaf powder is highly effective against *S. zeamais*, the botanical is locally available, cheaper to get and environmental friendly compared with the synthetic or chemical pesticides like Force Toxin (Aluminium phosphide) (Longe, 2013). The aromatic volatile oil in the leaf glands *Corymbia* species has anti-microbial and protective properties and is very useful traditionally in the prevention and treatment of ulcers and also protect against some disease causing organisms such as *E-coli*, *Candida albicans* and *Pseudomoniaspp.*(Oguntola, 2003). *C. citrodora* leaf oil, also known as *Eucalyptus* leaf oil, is industrially produced into the very popular, pure and powerful “Silver Bird Eucalyptus oil” that is highly effective against colds, coughs, catarrh and headaches in man, if inhaled. The volatile oil is also useful as an antiseptic, deodorant and stimulant, and in the treatment of lumbago and rheumatic pains, (Longe, 2013). In view of the aforementioned usefulness of *C. citrodora* products locally, using the leaf powder of the plant for *S. zeamais* control in stored maize grains will definitely not be injurious to human and animal health. Powder from *Corymbia citrodora* leaves therefore, is worthy of being recommended as an effective bio-pesticides in disinfecting small and large quantities of maize grains against *S. zeamais* in storage containers.

V. CONCLUSIONS AND RECOMMENDATIONS

Result from the study indicated that there is great potential in using botanical plant powders as seed protectants against insect pests in storage. That powder from Lemon-scented Gum plant (*Corymbia citrodora*) was sufficiently insecticidal to exhibit total (100%) control of *S. zeamais* in all its developmental stages. Economic, environmental and health implications indicate that it would be better to use botanical pesticides like *C. citrodora* that is cheaper, safer and more environmentally

friendly, than to use the costly, poisonous and environmentally hazardous chemical pesticides like Force Toxin in insect pests' control.

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