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Short Communication **Open Access**

EFFECTIVENESS OF *Imperata cylindrica, Sida acuta, Chromolaena odorata* AND *Gmelina arborea* AGAINST *Sitophilus zeamais* (MOTSCHULSKY, 1855) (COLEOPTERA: CURCULIONIDAE)

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Abstract

The effectiveness of powdered leaves of *Imperata cylindrica* (Spear grass), *Sida acuta* (Wire weed), *Chromolaena odorata* (Siam weed) and *Gmelina arborea* (Gmelina) at different dosages (0, 2.5, 5.0 and 7.5 g) against *Sitophilus zeamais* infesting stored maize grains was assessed. Treatments were mixed with 100 g of maize grains (landrace, *Esa' mayewangha*), infested with 30 adults *S. zeamais* and stored in 200 ml glass jars with perforated lids. The setup was maintained under ambient conditions (25 - 30^{0}C and 70 - 90% RH) between April and June, 2017. Mortality assessment was at 2, 4 and 6 days after treatment (DAT). The trial was laid out in a completely randomized design (CRD) and replicated four times. Analysis of variance showed that Cypermethrin caused significantly higher mortality than the tested plant powders. Cumulative mortality of adult *S. zeamais* significantly ($P \leq 0.05$) increased with increased treatment dosages and durations of storage. There were significantly ($P \leq 0.05$) higher mortality in maize grains treated with 7.5 g/100 g of *S. acuta* (55.00 and 64.17%) and *I. cylindrica* (53.33 and 60.00%) compared with *C. odorata* (44.17 and 50.83%) and *G. arborea* (35.83 and 40.00 %), respectively at 4 and 6 DAT.

Key words: Botanicals, storage duration, *Sitophilus zeamais,* mortality

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Introduction

According to WASDE (2017), the world is projected to produce 1.04 billion metric tons of maize (*Zea mays* L.) in 2017 with United States leading with 384.7 million tons followed by China, 219.5 million tons. In Africa, South Africa has the highest with 13 million tons and Nigeria accounts for 7.2 million tons (WASDE, 2017).

In Nigeria, maize is the third most important crop after wheat and rice. It has the largest area devoted for cultivation (Adedire & Lajide, 2003), which has continued to expand because of technological advancements (Adedire & Lajide, 2003). Maize occupies less land area than either wheat or rice but has a greater average yield per unit area of about 5.5 tons per hectare (Ofori *et al*., 2004). The crop is grown throughout the year in all states in Nigeria for various purposes; including for fodder, human consumption and as a basic raw material for many industrial products (IITA, 2009) including for the production of starch, textile, etc.

Despite its importance, much of the harvest is lost to infestation by the maize weevil (*Sitophilus zeamais*) which attacks both field crops and stored grains (Haines, 1991). *Sitophilus species* populations grow well in food that contains more than 10 % moisture (Haines, 1991). *S. zeamais* has been recognized as an increasingly important constraint to maize production in Africa (Markham *et al*., 1994). Adults and larvae of *S. zeamais* feed on undamaged grains and reduce them to powdery forms (Adedire, 2001). Voracious feeding by *S. zeamais* on the whole grain causes weight loss, fungal growth, and quality loss through the increase in free fatty acids which can completely destroy stored grains in all types of storage systems/facilities (Trematerra *et al*., 2007). Under serious infestations, the maize weevil can cause grain losses of up to 90 % on smallholder farms (Coyne & Hoeschle-Zeledon, 2001). *S*. *zeamais* is also implicated in the reduction in aesthetic and market value, germinability and nutritive value of maize (Pingali & Pandey, 2001).

There is a dire need for the use of a natural and sustainable method that would not only control the pest but pose no hazards to man and the environment (Isman, 2006; Arabi, 2008; Abdelgaleil, 2009).

Readily available and affordable plant materials such as *Sida acuta, Imperata cylindrica, Chromolaena odorata* and *Gmelina arborea* were screened against *S. zeamais* in stored maize grains to provide benign substitutes to synthetic chemicals. This study will therefore determine the efficacy and appropriate concentration of selected botanicals for the management *S. zeamais* in store maize grains. Information from this study will promote research aiming at the development of new biopesticides against this important pest.

2. Materials and Methods

The trial was conducted in the Postgraduate Laboratory, Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture (MOUA), Umudike to determine the toxicity of powdered leaves of *Imperata cylindrica*, *Sida acuta*, *Chromolaena odorata* and *Gmelina arborea* at different dosages (2.5, 5.0 and 7.5 g) against *Sitophilus zeamais* infesting stored maize grains..

2.1 *Test plants*

Leaves of *Imperata cylindrica*, *Sida acuta*, *Chromolaena odorata* and *Gmelina arborea* (Table 1) were selected on the basis of their ethnomedical properties and endemicity (Ogban *et al.,* 2015).They were collected from fields at MOUA, Umudike. Each was washed separately and air-dried in a well-ventilated area for two weeks; thereafter milled and sieved to obtain their respective powders. Plant powders were kept in clean air-tight opaque containers to maintain their potency.

2.2 Synthetic insecticide

Cypermethrin powder (Trade Name: Pestox, Ingredients: Cypermethrin 2.3%, Talc 97.5% and Fragrance 0.2% (Manufacturing date, 04-2016 and Expiry date, 12-2018) was bought from Arinzechi Agro Industrial Enterprises No. 17 Ohafia Street in Umuahia, Abia State, Nigeria, and stored in a cool dry place in the laboratory as directed by the manufacturer to effectively maintain its shelf life.

2.3 *Test insects and maize*

The initial stock of adult *S. zeamais* were obtained from infested maize grains and reared for six weeks; only adults were used for this experiment. The maize cultivar used for the trial was a local land race (*Esa' mayewangha*) obtained from cobs harvested at Ugep, Cross River State, Nigeria. To ensure that there was no post-harvest treatment of the grains, they were de-threshed from the cobs and sun-dried for two weeks before storage in an air-tight container. Maize grains were then placed in the oven (GNP-9082 model) at 60 ºC for 6 hours to disinfest prior to the experiment. *S. zeamais* adults were subsequently maintained on the sterilized maize grains in a 10 L plastic jar and kept in a laboratory under prevailing (as previously mentioned) conditions. On the seventh day, the adults were sieved out and eggs laid were allowed to develop to F_1 progeny in order to obtain adult *S. zeamais* of uniform age (modified after Zakka *et al*., 2010).

2.4 *Sexing of adult Sitophilus zeamais*

Adults of *S. zeamais* were sexed using their morphological characteristics; the males have a rougher, distinctly shorter and wider rostrum when compared to the females (Ojo & Omoloye, 2012).

2.5 *Infestation procedure*

Treatments consisting of 2.5, 5.0 and 7.5 g of the four types of powders from *I. cylindrical*, *S. acuta*, *G. arborea* and *C. odorata*, and Cypermethrin, along with controls with no insecticide or plant powders were maintained in sixty-four glass jars (200 ml) containing 100 g of the maize cultivar. Thirty newly emerged (1-3 days) adult *S. zeamais* were introduced into each jar and was left undisturbed on a work bench.

Table 1. Test botanicals and their phyto-chemical constituents

Specific name	**Family**	**Phytochemical constituents**	**References**
Imperata cylindrica	Poaceae	Alkaloids, Saponins, Terpenoids, Flavonoids, Glycosides and phenol	Ayeni &Yahaya, 2010
Sida acuta	Malvaceae	Flavonoids, Tannins, Phenolic compounds, Saponins, Alkaloids, Terpenoids	Raimi *et al*., 2014
Chromolaena odorata	Asteraceae	Saponins, Phytates, Tannins, Alkaloids, Flavonoids, Cyanogenic glycosides	Igboh *et al*., 2009
Gmelina arborea	Verbenaceae	Saponins, Flavonoids, Tannin and Phenolics, Steroids and Triterpens	Daya & Patel, 2012

The experiment was carried out in a completely randomized design (CRD) in which treatments and controls were replicated four times.

2.6 *Tested end points* Mortality

At 2, 4 and 6 days after treatment (DAT), the content of each jar was poured onto a transparent plastic tray and the numbers of adults were counted taking note of living and dead insects.

2.7 *Statistical analysis*

At 2, 4 and 6 DAT, the numbers of dead adult *S. zeamais* were counted after which it was subjected to a one-way ANOVA. Significant means were tested for using the Studentized Newman Keul's (SNK) test (p=0.05) (SAS, 2001).

3. Results

Table 2 presents variations in mortality levels in *S. zeamais* in maize grains treated with four selected plant powders and an insecticide over a six day trial. Cypermethrin treated jars recorded significantly (p < 0.05) higher mortality compared with those treated with the plant powders irrespective of the treatment dosage and storage duration. Mean mortality of maize grains treated with 2.5 g/100 g of *S. acuta* (25.83 %) and *I. cylindrica* (20.80 %) gave significantly (p< 0.05) higher mean mortality compared with those treated with *C. odorata* (8.33%) and *G. arborea* (2.50%) at 2 DAT. A similar trend was observed at 4 and 6 DAT in grains treated with 7.5 g / 100 g of plant powders. *Sida acuta* and *I. cylindrica* killed (55.00 and 64.17 %) and (53.33 and 60.00 %) of *S. zeamais* population, respectively, and with values being significantly (p< 0.05) higher than in those treated with *C. odorata* and (44.17 and 50.83%) and *G. arborea* (35.00 and 40.00 %), respectively.

4. Discussion

This study showed that ground leaves of *S. acuta, I. cylindrica, C. odorata,* and *G. arborea* bear insecticidal properties comparable to that of the synthetic commercial Cypermethrin against *S. zeamais*.

factors such as their chemical composition and the susceptibility of the species of maize weevils.

However, the present study showed that plant species and their applied dosages influenced the degree of toxicity of the plant powders. Mulungu *et al*. (2007) work concluded that leaf powders have the tendency of blocking the spiracles of the insect thereby impairing respiration, leading to the death of the parent and F_1 progeny weevils, which may have been the case in the present study.

Table 2. Variation in percentage cumulative mortality levels (mean ± standard error) in *Sitophilus zeamais* treated with four selected plant powders and an insecticide over a six day trial. Mortality in controls is also shown for comparison

DAT	Control	Dosage (g)	*G. arborea*	*I. cylindrica*	*S. acuta*	*C. odonata*	Cypermethrin
2	0.00 (±0.00)	2.5	2.50(±0.83)[c]	20.83 (±3.70)[b]	25.83(±5.83)[b]	8.33 (±3.97)[c]	75.83 (±2.10)[a]
		5.0	13.33 (±4.71)[b]	24.12 (±8.75)[b]	17.50 (±3.70)[b]	11.67 (±8.44)[b]	76.67 (±4.91)[a]
		7.5	23.33 (±8.61)[b]	31.67 (±5.69)[b]	22.33 (±9.56)[b]	15.00 (±5.00)[b]	84.17 (±0.83)[a]
4	0.00 (±0.00)	2.5	7.50 (±2.10)[c]	44.17 (±2.85)[b]	48.33 (±6.87)[b]	12.50 (±6.44)c	100.00 (±0.00)[a]
		5.0	26.67 (±7.82)[b]	40.83 (±8.32)[b]	38.33 (±4.41)[b]	27.50 (±16.41)[b]	100.00 (±0.00)[a]
		7.5	35.00 (±13.10)[b]	53.33 (±5.27)[b]	55.00 (±7.99)[b]	44.17 (±5.83)[b]	100.00 (±0.00)[a]
6	0.00 (±0.00)	2.5	13.33 (5.61)[c]	50.83 (±4.59)[b]	51.67 (±6.16)[b]	21.67 (±6.87)[c]	100.00 (±0.00)[a]
		5.0	35.83 (±10.40)[b]	55.00 (±9.57)[b]	50.00 (±4.91)[b]	33.33 (±20.14)[b]	100.00 (±0.00)[a]
		7.5	40. 00 (±15.21)[b]	60.00 (±4.71)[b]	64.17 (±11.42)[b]	50.83 (±3.44)[b]	100.00 (±0.00)[a]

DAT – Day after Treatment

Means are derived from four replicates

Different letters within rows indicate significant differences at p > 0.05 (Proc GLM, SNK).

The efficacies of the powders of the different plants tested in this study were in the order; *S. acuta>I. cylindrica>C. odorata>G. arborea.* The utilization of different plant powders as stored grain protectants has been previously reported by Ogban *et al*., (2015) and Bhubaneshwari *et al*. (2014). A report by Akhtar & Isman (2004) stated that the effects of different plant materials on maize weevils may depend on several

The effectiveness of these botanical powders might be also attributed to feeding on whole grains by *S. zeamais* picking up lethal doses of the plant leaf powders thereby leading to stomach poisoning (Muzemu *et al*., 2013). An earlier report by Obeng-Ofori & Amiteye (2005) followed similar trends. A recent study by Ukpai *et al*. (2017) buttressed the efficacy of *Jatropha curcas*, *Thevetia peruviana* and *Piper guineense* for the management of *Sitophilus zeamais* in stored maize grains.

Surveys conducted in Ghana by Colbbinah *et al*., (1990), and recently in Cameroon by Youmsi *et al*. (2017), revealed the use of *C. adorea* leaves as a repellent with insecticidal properties. In Nigeria, Okparaeke (2004) reported that *G. arborea* effectively controlled *Megolurothrips sjostedti* infesting cowpea. According to Govindaragan *et al.* (2010), crude extracts of *Sida acuta* provided excellent control of *Culex quinquefasciatus*, *Aedes aegypti* and *Anopheles stephensis* mosquitoes.

5. **Conclusions**

The results from this study revealed that the tested botanicals significantly decreased the population of *S zeamais* on stored maize grains. Maize grains treated with *S. acuta* and *I. cylindrica* were significantly more toxic than those treated with *C. odorata* and *G. arborea*. Irrespective of the plant powder used, toxicity increased with increasing dosage and duration of storage with significantly more mortality recorded in grains treated with 7.5 g / 100 g of maize at 4 and 6 DAT.

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References

Abdelgaleil, S. (2009) Fumigant and contact toxicity of monoterpenes to *Sitophilus oryzae* (L.) and*Tribolium castenum* Herbst and their inhibitory effects on acetylcholinesterace activity. *Journal of Chemical Ecology* **42**:1-8.

Adedire, C. (2001) Ecology and control of insect pests of stored cereal grains. In: Ofuya, T. I. andLale, N.E.S., editors. Pest of stored Cereals and Pulses in Nigeria: *Biology, Ecology and Control*. Dave Collins Publications.

Adedire, C., Lajide, L. (2003) Ability of extracts of ten tropical plant species to protect maize grains against infestation by the maize weevil, *Sitophilus zeamais,* during storage. *Nigerian Journal of Experimental Biology* **4**:175-179.

Akhtar,Y., Isman, M.B. (2004) Comparative growth inhibitory and antifeedant effects of plant extracts and pure allelochemicals on four phytophagous insect species. *Journal of Applied Entomology* **128**: 32-38.

Arabi, F. (2008) Chemical composition and insecticidal activity of essential oil from *Perovskia abrotanoides* (Lamiaceae) against *Sitophilus oryza* (Coleoptera: Curculionidae) and *Tribolium caestanum* (Coleoptera: Tenebrionidae). *International Journal of Tropical Insect Science* **28(3)**:2-8.

Ayeni, K.E., Yahaya, S.A. (2010) Phytochemical screening of three medicinal plants neem leaf (*Azadirachta indica*), hibiscus leaf (*Hibiscus rosasinensis*) and spear grass leaf (*Imperata cylindrica*). *Continental Journal of Pharmaceutical Sciences***4**: 47-50.

Bhubaneshwari, D.M., Victoria, D.N., Noren, S.S. (2014) Effects of six botanical plant powder extracts on the control of rice weevil *Sitophilus oryzae* L in stored rice grains. *International Journal of Agriculture Innovations and Research* **2(5)**: 2319-1473.

Cobbinah, J.R., Moss, C., Golob, P., Belman, S.R. (1990) Conducting ethnobotanical surveys: an example from Ghana on plants used for the protection of stored cereals and pulses. *NRI Bulletin 77*.Chatham UK. Natural Resources Institute.

Coyne, D., Hoeschle-Zeledon, I. (2001) Handbook major pests and diseases of important crops in Malawi.Typo-Druck-ROBdorfGbH, RoBdorf, Germany.

Daya, L.C., Patel, N.M. (2012) Preliminary phytochemical screening, Pharmacognostic and Physicochemical evaluation of leaf of *Gmelina arborea*. *Asian Pacific Journal of Tropical Biomedicine* **2(03)**:1333-1337

Govindarajan, M. (2010) Larvicidal and repellent activities of *Sida acuta* Burn.F. (Malvaceae) against three important vectors mosquitoes.*Asian Journal of Tropical Medicine* **3(9)**: 691-695.

Haines, C.P. (1991) Insects and Arachnids of Tropical Stored Products. Their Biology and Identification, a Training Manual. Natural Resource Institute *UK*, Pp. 246.

Igboh, M.N., Ikewuchi, C.J., Catherine, C. (2009) Chemical Profile of *Chromolaena odorata*L. (King & Robinson) Leaves.*Pakistan Journal of Nutrition* **8**: 521-524.

IITA.(2009) Maize.*International Institute of Tropical Agriculture* (IITA) Publications, Ibadan.(Internet Information Retrieved, March, 24 2017).

Isman, M.B. (2006) Botanical insecticides, deterrents and repellents in modern agriculture and an increasing regulated world. *Annual Review in Entomology* **51:** 45-56.

Little, T.M., Hills, F.J. (1978) Agricultural Experimentation Design and Analysis.John Wiley and Sons.

Markham, R.H. Bosque-Perez, N.A. Borgemeister, C., Maikle, W. (1994) Developing pest management strategies for *Sitophilus zeamais* and *Postephanus truncatus* in the Tropics. *FAO Plant Protection Bulletin* **42(3):** 97 - 116.

Mulungu, L., Lupenza, G., Reuben, S., Misangu, R. (2007) Evaluation of botanical products as stored grain protectant against maize weevil, *Sitophilus zeamais* (L.) on maize. *Journal of Entomology* **4**: 258-262.

Muzemu, S., Chitamba, J. Mutetwa, B. (2013) Evaluation of *Eucalyptus tereticornis*, *Tagetesminuta* and *Carica papaya* as stored maize grain protectants against *Sitophilus zeamais* (Motsch.) (Coleoptera: Curculionidae). *Agriculture, Forestry and Fisheries* **2(5)**: 196-201. doi: 10.11648/j.aff.20130205.13

Obeng-Ofori, D., Amiteye, S. (2005) Efficacy of mixing vegetable oils with pirimiphos-methyl against the maize weevil, *Sitophilus zeamais* Motschulsky in stored maize. *Journal of Stored Products Research* **41**: 57-66.

Ofori, E., Kyei-Baffour, N., Agodzo, S. (2004) Developing effective climate information for managing rainfed crop production in some selected farming centres in Ghana. *Proceedings of the School of Engineering Research (KNUST)* held at Ho. (Internet Information Retrieved April, 21 2017).

Ogban, E., Ukpong, I., Oku, E., Usua, E., Udo, S., Ogbeche, J., Ajang, R. (2015) Potentials of two indigenous plants powder for the control of stored maize weevil, *Sitophilus zeamais* (Motschulsky). *American Journal of Experimental Agriculture* **5(1):** 12-17.

Ojo, J.A., Omoloye, A.A. (2012) Rearing the maize weevil, *Sitophilus zeamais*, on an artificial maize-cassava diet..*Journal of Insect Science* **12:**69.

Okparaeke, A.M. (2004). Studies on the insecticidal potential of extracts of *Gmelina arborea* L. products for insect pest control in cowpea. The legume flower bud thrip, *Megolurothrips sjostedti* Trybom. *Archives of Phytopathology and Plant Protection* **39(3):** 209-214.

Pingali, P.L., Pandey, S. (2001) Meeting world maize needs Technology opportunities and priorities for the public sector. In: Pingali P.L. (ed.). CIMMYT 1999-2000, World maize facts trends. CIMMYT, Mexico City.

Raimi, M.M., Oyekanmi, A.M., Adegoke, B.M. (2014) Proximate, Phytochemical and Micronutrient Composition of *Sida acuta. Journal of Applied Chemistry* **7(2):** 93-98.

SAS Institute. (2001) The Statistical Analytical Systems for windows. Release 8.1. Cary. North Carolina, USA.

Trematerra, P., Valente, A., Athanassiou, C. & Kavallieratos, G. (2007) Kernel-kernel interactions and behavioral responses of the adult maize weevil, *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae). *Applied Entomology and Zoology* **42(1):**129-135.

Ukpai, M.O., Ibediugha, B.N., Ehisianya, C.N. (2017) Potential of seed dusts of *Jatropha curcas, Thevetia peruviana*, and *Piper guineense* against the maize weevil, *Sitophilus zeamais,* (Motschulsky, 1855) (Coleoptera: Curculionidae) in storage of corn grain. *Polish Journal of Entomology* **86(3):** 237-250.

WASDE (2017) World Agricultural Supply and Demand Estimates (WASDE). Domestic Corn Production forecast. 565. Internet Information Retrieved June 2, 2017.

Youmsi, R.D.F., Fokou, P.V.T., Menkem, E.Z., Bakamga-Via, I., Keumoe, R., Nana, V., Boyam, F.F. (2017) Ethnobotanical survey of medicinal plants used as insect repellents in six malaria endemic localities of Cameroon. *Journal of Ethnobiology and Ethnomedicine* **13(33):** 1-14.

Zakka, U., Lale, N.E.S., Ehisianya, C.N. (2010) Infestation of two products processed from dry tubers of sweetpotato by the rust-red flour beetle, *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae) in the humid environment. *Nigerian Journal of Plant Protection* **24:** 48-53.