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Insecticidal Potential of Some Plant Extracts and Synthetic Dusts for Control of *Sitophilus zeamais* (Motscholsky) Infesting Maize Seeds

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Abstract

The use of inorganic chemicals has proven to eradicate pests with an efficiency record of up to 100% mortality to target pest, hence, the need to adopt integrated pest management system (IPM). Sequel, to this, bio-insecticidal potentials of some plant extracts and synthetic dust on control of *Sitophilus zeamais* in maize seeds was investigated. Two botanicals: *Eugenia aromatica* and *Piper guineense,* were used in combination with synthetic dust at different treatment combinations for the control of *S. zeamais*. The *S. zeamais* used were derived from a culture maintained in Kilner jars under ambient laboratory conditions of 28± 2°C, and relative humidity of 70 ± 2% and maintained on DMR-S-W maize variety. The maize variety seeds were obtained from IAR&T, Ibadan, Nigeria. The botanical plant extracts were obtained from a herbal store in Owerri. They were oven- dried at 60°c for 48hrs and grounded to a powder form in an electric mill. Both the synthetic dust and the plant extracts were used singly and in combination. **Exactly** 20g of maize grain in a plastic plate (8.5cm diameter) was treated with the plant powders alone and in combination with pirimiphose-methyl or permethrin dust in 20 adults of *S. zeamais* (less than 1 week old and unsexed) were introduced. The mortality of *S. zeamais* was monitored within the time intervals of 12, 24, 48 and 72hrs. The result showed that at 72hrs post-treatment, 100% mortality of *S.zeamais* was recorded in three (3) treatments. Treatment involving *Eugenia powder* (0.1g) mixed with pirimiphos-methyl (0.1g) was significantly the highest but was not different from mortality in treatments involving *Eugenia powder* (0.08g) mixed with pirimiphos-methyl (0.1g) and *Eugenia powder* (0.1g) mixed with permethrin (0.1g). Eighteen treatments, including the control, recorded zero mortality even at 72hrs post infestation. The study revealed that there is great potential in reducing the rate of application of synthetic organic insecticides by mixing with a sub-lethal. The result showed that a sub-lethal dose of *Eugenia powder* (0.08g) mixed with pirimiphos-methyl (0.1g)/20grams of DMR-S-W maize variety seeds produced 100% adult mortality of *S.zeamais at 72hrs post-infestation thus* recommended at a dose of insecticidal materials.

Keywords: Integrated pest management, storage pest, seeds, insecticidal plant

Introduction

Sitophilus zeamais (Motscholsky), commonly known as maize weevil is a cosmopolitan pest of kind and wholesome grains in both the tropic and the temperate regions of the world. It is a serious primary pest of maize (Abbas *et al*., 2014). *S. zeamais* belongs to the insect order Coleoptera in the family *Curculionidae.* Pest can be controlled in several ways, natural resistance, sealed storage, chemical, fumigation and biological control (Abdullahi *et al*., 2015). These various pest attacks are major reasons for low yields obtained by African farmers, resulting in downward trend in income. *S. zeamais* is extremely pestiferous to the stored seeds of these legumes (Asmanizar and Idris, 2012). Prominent, among the control methods, is the use of chemical in the control of pests; this can be either through the use of organic or inorganic pesticides.

The most effective method of controlling *S. zeamais* damage to maize is currently the use of conventional synthetic insecticides (Biswas *et al*., 2016). Synthetic pesticides have proven to be one of the most effective control agents against all pests of major pulses; this is because they eradicate pests faster with an efficient rate of up to 100% mortality. Nevertheless, its residual effect on soil micro-organisms, toxicity to animals and human being, disruption of eco-system and many more, necessitated the need to curb these menace. However, the use of organic pesticides which have always been a better substitute, has also, been observed recently to be slower in eradication of the pest when compared to inorganic chemicals. They are also, easy to apply and can get to the way of pests that hide in small craves and other hidings. However, considering the drawbacks of pesticide residues in the grain, this has several effects such as vertebrate toxicity, pest resistance, resurgence, widespread environmental hazards and the high cost of the chemical products. They also cause damage to natural enemies associated with synthetic pesticide use, toxic to animal and human beings, deteriorates the natural quality of soil and in long run, causes pollution when run-off with surface water table. Also, the use of resistant varieties which would have served as an alternative is associated with the problem of the loss of resistance genes in the subsequent generations. In lieu of these, organic insecticides usage is being advocated, to curb the misuse of synthetic insecticides.

However, Doukkali *et al*. (2015) highlighted some advantages of organic pesticides over synthetic chemicals. They considered bio- insecticides as biological methods of controlling pests which introduces bio-pesticides organisms in the crop fields as natural predators with ultimate motive to check on the pests, but not to eliminate the pest entirely. Also, biodiversity of the crop field is not changed nor its ecosystem hampered. Karunakaran and Arulnandhy, (2018), in their research, recorded that bio-insecticides generally have features of strong selectivity, in addition of controlling pest and diseases, they produce little toxic residue which are of minimal risk to both animal and human health. They further established that many bio pesticides have zero or low re-entry and handling interval where microbial biopesticides can produce on or near to the target pest and disease, thereby, giving some self perpetuating control. The study affirmed that, botanical insecticides have many insecticidal ingredients with special modes of action, which makes it difficult for pest to develop resistance. However, Tesema *et al*. (2015), and Kuhns *et al.* (2016), observed that there are several lapses recorded even in the organic pesticides among which are: been too slow in action of killing pests when compared to conventional chemicals pesticides, have shorter persistence in the environment and this makes them susceptible to unfavorable environmental conditions. Sequel to the above, integrated pest management schemes for cereals are being developed to avoid unnecessary pesticide applications. The adoption of these integrated practices by farmers in resource-poor communities has improved food security in rural areas tremendously. This potentially decrease management cost, reduce the use of pesticides and adopt a more sustainable pest management practice by minimizing reliance on chemical to control and ultimately keeping the target pest number below action thresholds (Khedir *et al*., 2017)**.** Sequel to these, the combination of synthetic insecticides (pirimiphos-methyl and permethrin) and plant extracts derived from *Eugenia aromatic and Piper guineense leaves* in the control of *Sitophilus zeamais* was evaluated.

Materials and Methods

Experimental materials and source

The study was carried out at the Crop production, Research laboratory of the University of Agriculture and Environmental Sciences, Umuagwo, Owerri. The *S. zeamais* used were derived from culture maintained in Kilner jars under ambient laboratory conditions 28± 2°C and 70 ± 2% relative humidity. *S. zeamais* was maintained on DMR-S-W maize variety obtained from the Institute of Agricultural research and Training (IAR&T) Ibadan, Nigeria. Clean seeds showing no visible sign of beetle egg covers, presence of adults or their exit holes were used. The maize seeds were disinfested by storing them in a deep-freezer for two weeks before use.

Preparation of Insecticidal of Eugenia aromatic **Powders**

Dry flower buds of *Eugenia aromatic* Baill and fruits of *Piper guineenses* Chum and Thomn were purchased from local herbal store in Owerri, Nigeria. The plant parts were oven dried at 60°C for 48hrs and ground to powder form in an electric mill and sieved through a 300um mesh using a British Laboratory Test standard sieve. Each powder was stored in an air tight polythene bag placed in a wooden cupboard in the laboratory. Each prepared powder was used within one month of preparation. The two synthetic insecticides dust used were pirimiphos-methyl (Actellic) and permethrin (Coopex) and both were obtained from an Agro allied chemical store located within Owerri metropolis.

Experiment 1- Mortality of S.zeamais in maize treated with E. aromatic powder alone and in combination with pirimiphose- methyl or permethrin dust. In this experiment, 20g of maize grain in a plastic plate (8.5cm diameter) was treated with ***E. aromatic*** powder alone and in combination with pirimiphose-methyl or permethrin dust in 20 adults of ***S. zeamais*** (less than 1 week old and unsexed) were introduced. Five rates of ***E. aromatic*** powder (0.02, 0.04, 0.06, 0.8 and 0.lg) were each applied sole, and each rate in combination with either 0.lg of pirimiphos-methyl or permethrin dust included. A control was set up involving no application of plant powder or synthetic insecticide. Each treatment was replicated three times, including the control. The experiment set-up was placed in a wooden cupboard in the Research Laboratory. Adult, mortality in the introduced *S. zeamais* was taken 24, 48 and 72 hours post-treatment. Number of adult exit holes on seeds was used to determine seed damage after F1 progeny emergence and this was taken 50 days post-treatment. This is because; it takes an average of 50days from mating to laying of eggs on the maize and emergence of the F1progeny of *S. zeamais* .

Experiment 2- Mortality of S. zeamais in maize treated with P. guineense powder alone and in combination with pirimiphos- methyl or permethrin dust at (0.1g) each. The procedure described in Experiment 1 was followed except that ***P.guineense*** was used instead of ***E. aromatica.***

Data Analysis
All data were subjected to analysis of variance, percentage data were transformed using arcsine transformation before analysis. Mean values were separated using Duncan's Multiple Range Test at the 5% level of probability.

Results and Discussion
Results
Adult *Sitophilus zeamais* mortality in maize seed treated with *Eugenia aromatic* in combination with *permethrin and pirimiplios methyl* powder are presented in Table 1. At 24hrs post-infestation, percentage mortality of ***S. zeamais*** was significantly higher in treatments involving 0.08g ***Eugenia*** *aromatic* mixed with 0.1 g permethrin than in other treatments (Table 1). Eleven treatments, including the unprotected control and those involving synthetic insecticides recorded zero percentage mortality. At 48hrs post-infestation, treatment involving ***Eugenia*** *aromatic* (0.lg) mixed with permethrin (0.lg) produced the highest significant adult mortality of 81.6% which was significantly different from values recorded mortality in treatments involving ***Eugenia*** *aromatic* (0.08g) mixed with permethrin (0.lg) and ***Eugenia*** *aromatic* (0.lg) mixed with 0.lg pirimiphos- methyl (Table 1). Nine treatments, including the unprotected control and those involving use of synthetic insecticides alone recorded zero percentage mortality. At 72hrs post-infestation, 100% mortality was recorded in treatments involving ***Eugenia*** *aromatic* + permethrin (0.lg + 0.lg) and ***Eugenia*** *aromatic* **+** pirimiphos- methyl (0.lg + 0.lg) and ***Eugenia*** *aromatic* + pirimiphos-methyl (0.08g + 0.lg). Seven treatments, including the unprotected control and those involving use of synthetic insecticides alone recorded zero percentage mortality. Number of adult exit holes was significantly highest in the control treatment and lowest in treatments involving combination of ***Eugenia*** *aromatic* powder with permethrin or pirimiphos-methyl (0.lg + 0.lg and 0.1 + 0.08g). Adult *Sitophilus zeamais* mortality in maize seed treated with *Piper guineense* in combination with permethrin and pirimiphos methyl powder are presented in Table 2. Eleven treatments including control recorded zero % adult mortality of ***S. zeamais*** at 24hrs post-infestation (Table 2). The significant highest adult mortality was recorded in treatment involving 0.1g ***Piper*** powder mixed with 0.lg pirimiphos-methyl (15.0gcd) and this was maintained up till forty eight hours post infestation. Seven treatments didn't record any adult mortality including control. No treatment combination showed 100% adult mortality rate, at 72hrs post infestation (Table 2). However, nine treatments recorded zero adult mortality. Maize seeds in the control treatment had the highest number of adult exit holes. Maize seeds treated with ***Piper*** powder mixed permethrin (0.lg + 0.lg) recorded significantly fewest adult exit holes (Table 2).

Discussion
There have been global calls for caution in the use of synthetic organic insecticides in crop protection against pest attacks because of human health hazards posed by them and other environment concerns (Ofuya and Akingbohungbe, 2007). A method of achieving this is to reduce the rate of application. The results of this study have shown that there is great potential in reducing the rate of application of synthetic organic insecticides by mixing with sub-lethal doses of insecticidal plant materials or botanicals. Botanicals are usually perceived to be relatively safe and nontoxic to humans and more environment- friendly (Raghuram, 2015) and may reduce the undesirability of the synthetic organics in this duration. In this study three treatments were outstanding with 100% mortality [*Eugenia aromatic* + permethrin (0.lg + 0.lg), *Eugenia aromatica* + pirimiphos-methyl (0.lg + 0.lg) and *Eugenia aromatica* + pirimiphos-methyl (0.08g + 0.lg)] at 72hrs post-infestation. Ofuya and Arogundade (2008) reported that an application rate of 0.4 g/20g of *E. aromatic* and *P.guineense* powder alone was effective in the control of *S. zeamais* as 100% adult mortality was recorded at 48 and 72 hrs post-infestation. In this study, a sub lethal dose of 0.lg *E. aromatica* mixed with a low rate (0.lg) of either permethrin or pirimiphos-methyl per 20 grams of maize seeds also produced 100% adult mortality of *S. zeamais* at 72 hrs. *E. aromatica* singularly applied produced highly significant mortality (56%) of *S.zeamais; this however, confirm its insecticidal efficacy of the plant.* Some studies, like Asmanizar and Idris., (2012) had indicated that a few plants in the Nigeria flora with confirmed biological efficacies against species of stored products insects were sufficient insecticidal to merit scientific formulation. Mixing insecticidal plant materials with synthetic organics can be regarded as mixed formulation of insecticidal (Doukkali *et al.*, 2015). Suleiman *et al*. (2018) demonstrated that pirimiphos- methyl can be used at reduced rates if combined with vegetable oils to control infestations of *S. zeamais* in stored maize. The low rate of the synthetic organic appeared to have synergized the sub-lethal dose of the botanical to produce increased toxicity to the insects. For instance, the low rate of each synthetic organic used did not cause mortality of the insects at the times of observations, but when mixed with 0.08g and especially 0.lg of each botanical, the mortality caused to the insects was about doubled. Synergism in mixed formulations of insecticides has been reported (Ofuya, and Akingbohungbe, 2007) which must have triggered homologous processes in *S. zeamais*. Homologous is a phenomenon in which a stimulating effect is induced in insects or other arthropods with a sub-lethal dose of

possible combinations which causes the female to lay more viable eggs that develop into adults. In this study, there appears to be the semblance of this phenomenon when *Eugenia powder* alone was applied for the control of *S. zeamais,* a significantly higher number of adult weevils, indicated by the number of exit holes that emerged.

Conclusion

The result of this work has further substantiated a good potential of combining low doses of insecticidal plant powder and low doses of synthetic organic dusts for effective protection of stored grains against insect infestation arid damage. The best rate of application was the treatment involving a sub-lethal dose of *Eugenia powder* (0.8g) mixed with pirimiphos-methyl (0.1g)/ 20grams of DMR-S-W maize variety seeds which produced 100% adult mortality of *S. zeamais* at 72hrs post-infestation, therefore this study recommends this rate as the most effective to achieve desired pest control of *S. zeamais* in maize storage.

References

Abbas, A.B., Ndunguru, G., Mamiro, P., Alenkhee, B., Mlingi, N. and Bekunda, M. (2014). Post-harvest food losses in a maize-based farming system of semi-arid savannah area of Tanzania. *Journal of Stored Products Research* 57:49-57.

Abdullahi, N., Umar, I., Tukur, Z. and Babura, S.R. (2014). Comparative efficacy of the bark and root powders of Acacia nilotica against maize weevil *Sitophilus zeamais* (Motsculsky) (Coleoptera: Curculionidae) in Kano State of Nigeria. *African Journal of Agricultural Research,* 9:(6): 588-592. https://doi.org/10.5897/AJAR2012.1131

Asmanizar, A.D. and Idris, A.B. (2012). Effect of four selected plant powder as rice grain protectant against Sitophilus zeamais (Coleoptera: Curculionidae). *Sains Malaysiana*, 41: (7):863-869.

Biswas, K.K., Sharmin, N. and Rabbi, M.A. (2016). Evaluation of the insecticidal activity of *Lawsonia inermis* Linn. against the red flour beetle, *Tribolium castaneum* (Herbst). *Natural Products*, 12:(1):8-11.

Doukkali, Z., Taghzouti, K., Bouidida, E.H., Nadjmouddine, M., Cherrah, Y. and Alaoui, K. (2015). Evaluation of anxiolytic activity of methanolic extract of Urtica urens in a mice model. *Behavioral and Brain Functions*, 11:19-25 https://doi.org/10.1186/s12993-015-0063-y

Karunakaran, S. and Arulnandhy, V. (2018) - Insecticidal activity of selected botanicals on maize weevil, Sitophilus zeamais L., in stored maize grains. *AGRIEAST: Journal of Agricultural Sciences*, 12:(1);1-6. https://doi.org/10.4038/agrieast.v12i1.46

Khedir, S.B., Bardaa, S., Sahnoun, Z. and Rebai, T. (2017) - Chemical composition, phytochemical constituents, antioxidant and anti-inflammatory activities of *Urtica urens* L. leaves. *Archives of Physiology and Biochemistry*,123: (2): 93-104. https://doi.org/10.1080/13813455.2016.1255899

Kuhns, E.H., Martini, X, Hoyte, A and Stelinski, L.L (2016). Repellent activity of botanical oils against Asian Citrus Psyllid, Diaphorina citri (Hemiptera: Liviidae). *Insects* 7:(35):1-13.

Ofuya, T.I. and Akingbohungbe I. T. A. (2007). Oviposition deterrent and ovicidal properties of some plant powders against *Callosobruchus maculatus* in the store cowpea (*vigna unguiculata*). *Journal of Agricultural. Science Cambridge*, 115: 343-345.

Ofuya, T.I. and Arogundade. (2008). Multiple mating in the male of *Callosobruchus maculatus* (Coleoptera Bruchidae) and its consequences. *Journal of Stored Product Research, 31*:71-75.

Raghuram, C. P. (2015). Insecticidal activity of botanical pesticides on *Callosobruchus Chinensis* L (*Coleoptera: Bruchidae*) on the stored green gram, *Vigna radiata* (L.). *International. Journal of Agricultural Science Research*, 4:13–20.

Silva, K.F., Baldin, E.L. and Pannuti, L.E.R. (2016). Use of botanical insecticides as an alternative for the management of the mexican bean weevil. *Revista Caatinga*, 29:(2):348-357. https://doi.org/10.1590/1983-21252016v29n211rc.

Suleiman, M., Rugumamu, C.P. and Ibrahim, N.D (2018). Insecticidal Toxicity of Some Botanicals against Sitophilus zeamais Motsch. (Coleoptera: Curculionidae) in Stored Sorghum Grains in Nigeria. *Journal of Entomology and Zoology Studies* 6(1):1280-1287.

Tesema, K., Kurabachwe, H. and Tadesse, T.F (2015). Evaluation of the efficacy of plant powders, cow dung ash and melathion dust against *Callosobruchus chinensis L.* (Coleoptera: Bruchidae) on chickpea in Jole Andegna: Southern Ethiopia. *Journal of Agricultural Studies* 3(2):129-144.

Table 1: Adult *Sitophilus zeamais* mortality in maize seed treated with *Eugenia aromatic* in combination with *permethrin and pirimiplios methyl* powder

Treatment	Rate of application (g)	Mean adult (%) mortality 24hrs	48hrs	72hrs	Mean no of adult exit hole/20g
Eu- alone	0.02	0.0a	0.0a	0.0a	40.0gf
	0.04	0.0a	0.0a	0.0a	27.3 fg
	0.06	1.6a	6.6ab	16.6ab	I8.0bc
	0.08	3.3ab	21.6bc	46.6cd	18.0bc
	0.10	10.0cd	36.6cd	56.6cd	15.0b
Eu+permethrin	0.02+0.1	0.0a	0.0a	0.0a	38.0fg
	0.04+0.1	0.0a	0.0a	0.0a	31.0fg
	0.06+0.1	0.0a	11.6ab	30.0bc	25.0bc
	0.08+0.1	16.6e	75.0de	85.0de	10.0ab
	0.1+0.1	16.6e	81 6e	100.0g	7.0ab
Eu+pirimiphos	0.02+0.1	0.0a	0.0a	0.0a	45.2fg
	0.04+0.1	0.0a	0.0a	1.6a	35.0cd
	0.06+0.1	0.0a	11.6ab	23.3bc	22.0bc
	0.08+0.1	11.6cd	60.0cd	100e	5.0ab
	0.1+0.1	13.3d	76.6cd	100g	5.0ab
Permertrin alone	0.1	0.0a	0.0a	0.0a	47.5gf
Piri-methyl alone	0.1	0.0a	0.0a	0.0a	45.0fg
Control		0.0a	0.0a	0.0a	60.0g

Note: Means bearing the same letters are not significantly different at p=0.05(DMR)
EU-Eugenia aromatica, per-permithrin, piri-pirimiphos

Table 2: Adult *Sitophilus zeamais* mortality in maize seed treated with *Piper guineense* in combination with *permethrin and pirimiphos methyl* powder

Treatment combination	Rate of application (g)	Mean adult % mortality 24hrs	48hrs	72hrs	Mean number of adult exit hole/20g
Piper alone	0.02	0.0a	0.0a	0.0a	47.6fg
	0.04	0.0a	0.0a	0.0a	24.3bc
	0.06	0.0a	1.6a	13.3ab	21.0bc
	0.08	1.6a	16.6bc	28.3bc	1 8.0bc
	0.10	10.0cd	20bc	40.0bc	I4.0bc
piper+permethrin	0.02+0.1	0.0a	0.0a	0.0a	3.0fg
	0.04+0.1	0.0a	0.0a	0.0a	35.0fg
	0.06+0.1	0.0a	30.0bc	30.0bc	32.0cd
	0.08+0.1	8.3 be	75.0de	75.0dc	I4.0ab
	0.1+0.1	11.6cd	86.6de	86.6de	11 .0ab
Piper+pirirmiphos	0.02+0.1	0.0a	0.0a	0.0a	38.0 fg
	0.02+0.1	0.0a	0.0a	0.0a	38.0fg
	0.04+0 1	0.0a	0.0a	0.0a	34.0fg
	0.06+0.1	0.0a	11.6ab	30.0bc	30.2fg
	0.08+0.1	8.3bc	63.3cd	83.3de	20.0bc
	0.1+0.1	15cd	68.3cd	83.3de	18.0bc
Permertrin alone	0.1	0.0a	0.0a	0.0a	47.8 fg
Pirimiphos- Methyl	0.1	0.0a	0.0a	0.0a	48.2fg
Control		0.0a	0.0a	0.0a	42.0f

Note: Means bearing the same letters are not significantly different at p=0.05 (DMRT)