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Evaluation of two new insecticide formulations based on inert dusts and botanicals against four stored-grain beetles

Zlatko Korunic[1], Paul G. Fields[2]

1. Diatom Research and Consulting Inc., 14 Tidefall Dr., Toronto ON, M1W 1J2, Canada, zkorunic@rogers.com
2. Morden Research and Development Centre, Agriculture and Agri-Food Canada, paul.fields@agr.gc.ca

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Extended Abstract

Diatomaceous earth (DE) is toxic to insects because it absorbs their cuticular waxes causing insects to die from desiccation. DEs are obtained from geological deposits around the world, are skeletons of diatoms, and are mainly made up of SiO_2, with very low mammalian toxicity They can be applied with approximately the same technology as other powder insecticides (Korunic, 1998; Subramanyam and Roesli, 2000). Several DEs are effective at doses of 500 ppm or higher. However, these doses cause unwanted effects on grain quality and flowability and their application for direct mixing with grain has limited acceptance by the grain industry (Korunic et al., 1996; Subramanyam and Roesli, 2000). Therefore, it is essential to develop formulations that are effective at lower doses of DE. One of the solutions is to combine DE with other substances, primary with botanicals (Athanassiou and Korunic, 2007; Athanassiou et al., 2009). Our objective was to develop effective insecticides using as much as possible Generally Recognized as Safe (GRAS) compounds that would not significantly reduce grain flow or test weight.

We developed two new insecticide formulations that combine: diatomaceous earth (DE), silica gel, pyrethrin, piperonyl butoxide (PBO) and dill essential oil (F2Z) or with these same ingredients and disodium octaborate tetrahydrate (F3DOTZ). Silica gel (Sipernat® 50 S) is synthetic amorphous silicon dioxide and, has similar mode of action as DE. Amorphous silicon dioxide is (GRAS) and, is used as a food additive. Pyrethrin is one of the most common botanical insecticides. To prevent the recovery of insects after the treatment, the pyrethrin formulations contain a synergist, most frequently piperonyl butoxide (PBO) (Ware and Whitacre, 2004). Dill essential oil is extracted from the seeds or leaves/stems of the dill (*Anethum sowa* and *A. graveolens*). Dill oil is known as a natural synergist for pyrethrin (Liu et al., 2014). Disodium octaborate tetrahydrate (DOT) is a naturally occurring mineral salt commonly called borate or sodium borate. It is used to treat lumber and other wood products to control fungi, termites, and other wood infesting pests (Ware and Whitacre, 2004). DOT is effective against *Sitophilus oryzae* (L.) and does not reduce bulk density as much as DE reduces bulk density (Korunic et al., 2017).

Sitophilus oryzae L., *S. granarius* (*L.*) (Coleoptera: Curculionidae*),* and *Rhyzopertha dominica* (F.) (Coleoptera: Bostrychidae) and one external feeder*, Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae*)* were held on clean wheat (13.5% moisture) treated with different doses of the insecticides and held at 28 ± 1°C and 60 ± 5 % RH for 3, 5 and 7 days, and then held for progeny emergence. In the series of three experiments both formulations were applied either as dusts or as wettable powders, F2Z at 150 ppm and F3DOTZ at 200 ppm.

After 3 days, with powders and wettable powder of F2Z and F3DOTZ formulations there was 100% mortality for *S. oryzae* and *R. dominica*. After 7 days, the mortality of *T. castaneum* was from 96 to

100%. All formulations completely reduced the progeny (100%). In another experiment, 75, 125, 175 and 225 ppm of F2Z and F3DOTZ formulations and 300, 400, 500 and 600 ppm of diatomaceous earth alone (Celatom MN 23) were tested. After 3 days, with 175 ppm of F2Z and F3DOTZ caused adult mortalities from 99 to 100%. The DE alone at 300 ppm after 3 days only caused 80% mortality of *S. oryzae*, 60% mortality of *R. dominica* and no mortality for *S. granarius* and *T. castaneum*, and the progeny of *S. granarius* was reduced by 77%, *S. oryzae* by 78%, *R. dominica* by 92% and *T. castaneum* by 100%.

The effective concentrations of 150 ppm of F2Z, 200 ppm of F3DOTZ and 300 ppm of DE reduced bulk densities by 4.9, 3.4 and 6.4 kg/hL, respectively.

These new formulations were effective at controlling insects better than DE alone, yet do not reduce the bulk density as much as DE alone. Further testing is required to determine if these formulations should be brought to market; duration of efficacy, cost of formulations, testing for their effect on non-target organisms, human safety and effect on end-use quality.

Keywords: diatomaceous earth, synergy, natural, mortality, bulk density

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Protecting Stored Maize Grain Against the *Sitophilus Zeamais* with Rice Husk Ash

Joseph O. Akowuah*, George Obeng-Akrofi, Emmanuel Minka, Alberta Barima

Department of Agricultural and Biosystems Engineering, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

Corresponding author*: akuahjoe@yahoo.co.uk

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Abstract

Maize weevil (*Sitophilus zeamais*) is an important insect that affect the maize grain on the field and in storage. There are several ways of controlling this insect but the most commonly used is the use of chemicals. Although these chemicals are very effective, they are often expensive and not available to poor rural farmers resulting in high post-harvest losses of their harvested grains. In this study, the potential of using rice husk ash (RHA) as a protectant against maize weevil during storage was investigated. Cultured maize weevils were introduced into 400g of maize admixed with RHA at concentrations of 5g, 10g and 20g. A control set-up of both Actellic 50EC and no RHA was set-up to compare the effect of the ash treatments on weevil mortality, re-emergence and grain damage. The treatments were replicated and set-up in the lab at room temperature condition. Results showed that, 100% mortality was observed for the Actellic 50EC treatment 5days after application. However, there was no significant difference ($p>0.01$) after 60 days of storage between the 20g RHA application and the Actellic 50EC relative to weevil mortality, emergence and grain damage. With the 20g RHA admixture recording the highest mortality and suppression effect on adult weevil emergence as well as the lowest grain damage, the use of RHA can provide a significant economic advantage to farmers for storage of maize in tropical developing countries if reliable recommendations on application rate can be made for the protection of stored maize.

Keywords: Maize storage; maize weevil; rice husk ash; protectant, mortality