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DIATOMACEOUS EARTH
AN EFFECTIVE TOOL IN INTEGRATED PEST MANAGEMENT

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SUMMARY

Diatomaceous Earth (DE) has many advantages of use including low toxicity to vertebrates, leaves no toxic or harmful residues, and has long lasting insecticidal activity. DE insecticides can be used safely with minimal protective clothing (only goggles and dust mask) and have no adverse effects on the quality of end-products (Korunic at al., 1996a). DE insecticides can be directly applied to stored grain as it enters a granary for stored-product insect control.

To date, there have been problems associated with the use of DE that have prevented its wide-scale application as a stored-grain protectant. The recommended dosages of DE of 500 parts per million (mg DE per kg grain or ppm) to 3,500 ppm adversely affect physical and mechanical properties of grain, including reduced bulk density (test weight) and grain flowability, visible residues, and production of excessive amounts of airborne dusts during handling (Korunic at al., 1996a). The magnitude of the adverse effects of DE can be reduced by using lower concentrations through improving the efficacy of the existing formulations of DE (Korunic, 1994).

Protect-It™, a new diatomaceous-earth-based insecticide formulation, developed jointly by Hedley Technologies Inc., and Agriculture and Agri-Food Canada, is specifically designed to minimize the effect of grain bulk density reduction and other adverse effects of DE (Korunic and Fields, 1995). It has proved effective at controlling stored-grain insects in laboratory and field tests at application rates well below the recommended rates of other DE-based insecticides. It has low, almost unmeasurable toxicity (generally recognized as safe by the United States EPA), is environmentally safe and has long-lasting effectiveness (Korunic and Fields, 1995; Fields and Timlick, 1995; Korunic et al. 1996b).

Due to concerns regarding application of poisonous and dangerous pesticides and the growing public pressure to replace chemical pesticides with less toxic or dangerous pesticides, it is likely that some formulations of DE, especially the improved formulations such as Protect-It™ that can be used at very low concentrations of 75 to 300 ppm, will soon play a significant role within

integrated pest management (IPM) programs especially for stored grains (Desmarchelier et al., 1987; Bridgeman, 1994; Nickson at al, 1994; Subramanyam at al. 1994; Korunic and Ormesher, 1996). In an effective IPM program, methods of prevention and control are integrated to give maximum protection at the lowest possible cost.

FIELD OF USE

There are several ways that new, more effective DE formulations can be integrated to an effective IPM program for cereal and food commodities:

1. Spraying or dusting of structure gives residual control of grain feeding insects in empty granaries and transportation vehicles (general treatment).
In laboratory trials, Protect-It™ used as a surface treatment was able to control insects within a week when relative humidity was under 60% (Fields and Timlick, 1995). In Australia, DE has effectively replaced residual synthetic insecticides for empty granary treatments (Desmarchelier et al., 1993; Bridgeman, 1994).

2. Direct commodity treatment at time of storage.
During 1994 and 1995 Hedley Technologies Inc. and Agriculture and Agri-Food Canada tested Protect-It™ for effectiveness against the rusty grain beetle (*Cryptolestes ferrugineus* (Stephens)), red flour beetle (*Tribolium castaneum* (Herbst)), and other insect species under laboratory and field conditions in Western Canada. Results have shown that Protect-It™ is an effective grain protectant when applied to grain as a dust or as an aqueous spray using concentrations of 75 to 300 ppm. Treatment with Protect-It™ at time of storage can be a very effective preventive measure, an essential part of an IPM program. Not only is Protect-It™ highly effective at low concentrations but problems such as visible residues on grain, airborne dust, reduced flowability of grain, bulk density reduction, and problems with machinery are avoided or greatly reduced when used at 100 ppm (Fields and Korunic, 1995; Fields and al., 1996; Korunic et al., 1996a,b). Treatment of all grain may be particularly desirable when the pest infestation occurs regularly every year or storage is potentially long term.

3. Surface application and/or top dressing.
An alternative to mixing Protect-It™ throughout the grain mass is using Protect-It™ for grain surface treatment or top dressing as a preventive aid in protecting grain from surface infestation or reinfestation. Surface treatment and top dressing are measures of IPM currently in commercial use. DE can be used successfully for surface treatment in combination with aeration, cooling or other procedures such as fumigation. The combination of cooling grain bulk with the surface application of DE to control insects is an improved strategy of IPM currently in commercial use (Nickson at al., 1994). Protect-It™, as a safe, effective and environmentally friendly natural insecticide, that leaves no chemical residues in food products, can replace other synthetic insecticides for the treatment of the grain surface after cooling.

4. Spot and crack and crevice treatment in grain and food processing facilities.
DE can be applied sucsesfully as dust formulation to limited areas on which insects are likely to occur. These areas may occur on floors, walls and bases or undersides of equipment.

INTEGRATING DE WITH IPM STRATEGIES

DE formulations act by absorbing fats the protective waxy epicuticle of the insects so the insects loose water from their bodies, dry and die. There are several factors that determine the rate of mortality for each insect species and commodity combination. The ambient relative humidity and temperature, the grain type and moisture content and insect species must be factored in to determine the appropriate application dosage for a given DE formulation.

Insects cause economic damage in direct proportion to their population. Higher levels of infestation cause higher levels of economic damage. It is the goal of all IPM tools to reduce insect populations to lower levels to reduce economic damage. It is sometimes not economically viable or necessary to reduce insect populations to zero.

The cost of any pest management program should be weighed in relation to the full economic benefits which it delivers. In each region, IPM practitioners and researchers need to determine the optimum balance between treatment cost and economic benefits for these more effective DE formulations. Protect-It dosage rates should be determined in relation to the commodity and insect pest and adjusted for local conditions, for the reduction of insects below the economic damage level.

DE formulations in general, and Protect-It in particular, can now become an essential part of IPM program in the grain and food processing industry as a grain protectant and a residual insecticide for general, spot and crack and crevice application to reduce insect problems and partly to replace the fumigant methyl bromide and other synthetic insecticides.

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