Fate and Efficacy of Spinosad-Treated Wheat Samples Under Field Conditions

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Introduction

Spinosad is a mixture of spinosyns A and D, metabolites of *Saccharopolyspora spinosa* bacteria. It is a broad-spectrum insecticide with ingestion and contact toxicities (Wanner et al. 2000). Spinosad has low acute mammalian and avian toxicities (Thompson et al. 2000). Laboratory tests showed spinosad to be effective against several stored-product insect pests (Fang et al. 2002, Subramanyam et al. 2002).

Objectives

❖To determine stability of spinosad residues on hard red winter wheat samples stored in farm-stored grain between November 2000 and November 2001.

❖To determine effectiveness of fresh and aged spinosad residues against adults of the lesser grain borer (*Rhyzopertha dominica* F.) and red flour beetle (*Tribolium castaneum* Herbst).

Materials and Methods

Each of three farm grain bins (5 m diam), located at the Grain Storage Training Center, Manhattan, KS, was filled with 23 metric tons of hard red winter wheat harvested in 2000. From each bin, 50 kg of wheat were taken to the laboratory. Wheat (1 kg) was treated with 1 ml distilled water or 1 ml of aqueous suspension of spinosad to obtain rates of 0, 0.1, 0.5, 1.0, 3.0, and 6.0 mg (AI) /kg. Each rate was replicated three times, and each replicate was treated separately. Untreated and spinosad-treated wheat (250 g) were placed in separate large-size mesh (2.2 mm^2 openings) or small-size mesh (0.6 mm^2 openings) pouches. Each nylon pouch was 23 cm long x 17 cm wide. After placing grain, pouches were heat-sealed. Pouches were placed in 7 different locations within each bin at a depth of 2.5 cm below the grain surface. These pouches were sampled bimonthly starting Nov. 2000 until Nov. 2001. At each spinosad rate, there were 21 large-size mesh pouches (7 sampling occasions x 3 bins) and 42 small-size mesh pouches (2 pouches x 7 sampling occasions x 3 bins). At each location, two Hobo® units (Onset Computer Corporation, Pocasset, MA) were placed near pouches to measure grain temperature and relative humidity. Bioassays with *R. dominica* and *T. castaneum* adults were performed in the laboratory at 28ºC and 65% RH with wheat (100 g) from 21 small mesh pouches. Wheat was infested for 14 d to determine mortality. Wheat from the remaining 21 small size mesh pouches (750 g per sampling occasion [samples pooled across bins]) was sent to Dow AgroSciences for residue analysis. Wheat samples in large-size mesh pouches were used to monitor insect infestation in the bins (Data not presented here).

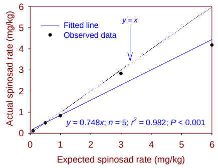

Figure 1. Expected vs actual rates.

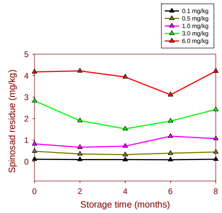

Figure 2. Stability of spinosad residues on stored wheat samples. Residues for months 10 and 12 are not yet available.

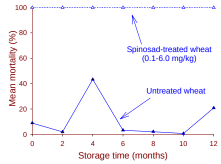

Figure 5. Consistent performance of spinosad residues against *R. dominica* adults.

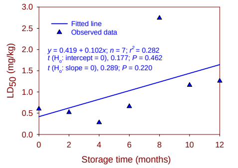

Figure 6. Liner regression model showing no loss in toxicity of spinosad residues to *T. castaneum* adults.

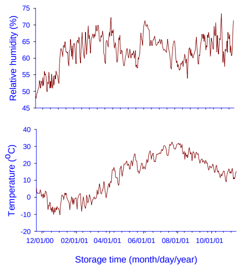

Figure 3. Changes in temperature and relative humidity of grain at 2.5 cm below the surface as measured by HOBO® units.

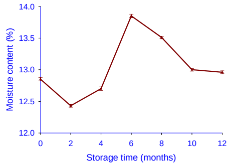

Figure 4. Changes in grain moisture content as measured by the Single Kernel Characterization System (n = 300 kernels).

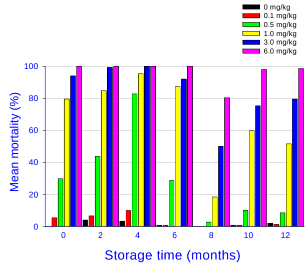

Figure 7. Mortality of *T. castaneum* adults exposed to untreated and spinosad-treated wheat.

Grain bins

Pouches

Results and Conclusions

❖ The actual spinosad rate on wheat samples was 25% less than the expected rate (Figure 1).

❖ No significant spinosad degradation occurred during 8 months of storage (Figure 2), despite changes in grain temperature, relative humidity, and moisture (Figures 3 and 4). This was indirectly confirmed through bioassays. The performance of spinosad against *R. dominica* and *T. castaneum* adults was consistent over time (Figures 5-7).

❖ All *R. dominica* were killed on spinosad-treated wheat. Mortality on untreated wheat was 2-9%, except in May (43%) and Nov., 2001 (21%). Reasons for the high natural mortality are unknown (Figure 5).

❖ *T.castaneum* mortality increased with spinosad rate, and was 80-100% at ≥3 mg/kg. Although *T. castaneum* LD_{50}s varied from 0.52 to 2.74 mg/kg, linear regression of LD_{50} over time showed that this variation was not significant (Figures 6 and 7).

Pouches being placed below the grain surface

Containers used for insect bioassays

References

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Wanner, K. W., B. V. Helson, and B. J. Harris. 2000. Laboratory and field evaluation of spinosad against the gypsy moth, *Lymantria dispar*. Pest Manag. Sci. 56: 855-860.

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