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SHORT COMMUNICATION

Activity of Spinosad against Adults of *Rhyzopertha dominica* (F.) (Coleoptera: Bostrichidae) Is Not Affected by Wheat Temperature and Moisture

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ABSTRACT: Spinosad, a commercial bacterial pesticide, was evaluated against adults of the lesser grain borer, *Rhyzopertha dominica* (F.), on 12.5 or 14.5% moisture wheat stored at 22, 28, and 34°C. Adults of *R. dominica* were exposed for 14 days to untreated wheat and wheat treated with spinosad at 0.1 and 1 mg (AI)/kg every month for four months. Mortality of adults exposed to untreated wheat ranged from 0 to 39%. All *R. dominica* adults exposed to spinosad-treated wheat were killed. The activity of spinosad during the four-month test period was not affected by the three temperatures and two moisture levels tested.

KEY WORDS: Reduced risk pesticide, spinosad, grain protectant, residual activity

Introduction

The lesser grain borer, *Rhyzopertha dominica* (F.), is a destructive pest of stored wheat and is prevalent in all wheat producing regions of the United States (Reed *et al.,* 1991; Vela-Coiffier *et al.,* 1997). Chlorpyrifos-methyl (Reldan®), the organophosphate pesticide currently registered for use on wheat, is not effective against *R. dominica* because of insecticide resistance (Zettler and Cuperus, 1990). Futhermore, under the 1996 Food Quality Protection Act, the future of chlorpyrifos-methyl remains uncertain (Anonymous, 1997). Spinosad, a commercial bacterial insecticide, from the actinomycete bacterium *Saccharopolyspora spinosa* Mertz and Yao (Mertz and Yao, 1990), was reported to be effective against *R. dominica* on 11–13% moisture wheat stored at temperatures between –10 and 32°C (Fang *et al.,* 2002a, b). Additional work was needed to determine the stability or efficacy of spinosad residues at moistures greater than 13% and at temperatures greater than 32°C. Furthermore, Fang *et al.* (2002b) did not specifically test how wheat moisture, temperature, and their interaction influenced efficacy of spinosad against stored-product insects, including *R. dominica*. In Kansas and other regions of the United States, stored wheat temperatures and moistures can vary widely (Reed and Pedersen, 1987; Hagstrum and Heid, 1988), depending on whether the bin is aerated or unaerated. In addition, insecticide degradation is influenced by wheat temperature and moisture (Arthur *et al.,* 1992). The objective of this study was to determine the performance of spinosad against *R. dominica* in 12.5 or 14.5% moisture wheat stored at 22, 28, and 34°C.

Materials and Methods

Unsexed adults (1–3 wk old) of *R. dominica* were used in this study. Insects were reared on hard red winter wheat at 28°C, 65% RH, and a photoperiod of 14:10 (L:D) hr. Spinosad (SpinTor 2SC; Lot No. PE01160P22), of 240 mg(AI)/ml purity, was provided by Dow AgroSciences, Indianapolis, IN. Hard red winter wheat was obtained from the milling laboratory in the Department of Grain Science and Industry, Kansas State University, Manhattan, KS.

Spinosad was diluted in distilled water to make solutions of 0.1 and 1 mg (AI)/ml. Hard red winter wheat was tempered to 12.5 or 14.5% moisture content by adding distilled water to a known amount of wheat (Adams and Schulten, 1978) and tumbling it for 10 min on a ball-mill roller. The 12.5 or 14.5% moisture wheat (1 kg) was treated with 1 ml of spinosad solution to obtain rates of 0.1 and 1 mg (AI)/kg of wheat. Untreated wheat (1 kg) receiving 1 ml of distilled water served as the control treatment. Wheat treated with distilled water or spinosad was placed in 0.95-liter glass jars with lids. These jars were tethered to the inside of a cardboard drum, which was tumbled for 10 min on a ball-mill roller. After tumbling, wheat at 12.5 or 14.5% moisture was divided into 100 g lots and placed in 150-ml round plastic containers with lids. A 10-mm round hole was made in the lid of each container, and a piece of wire mesh screen (0.6 mm^2 openings) was glued over the round hole to facilitate

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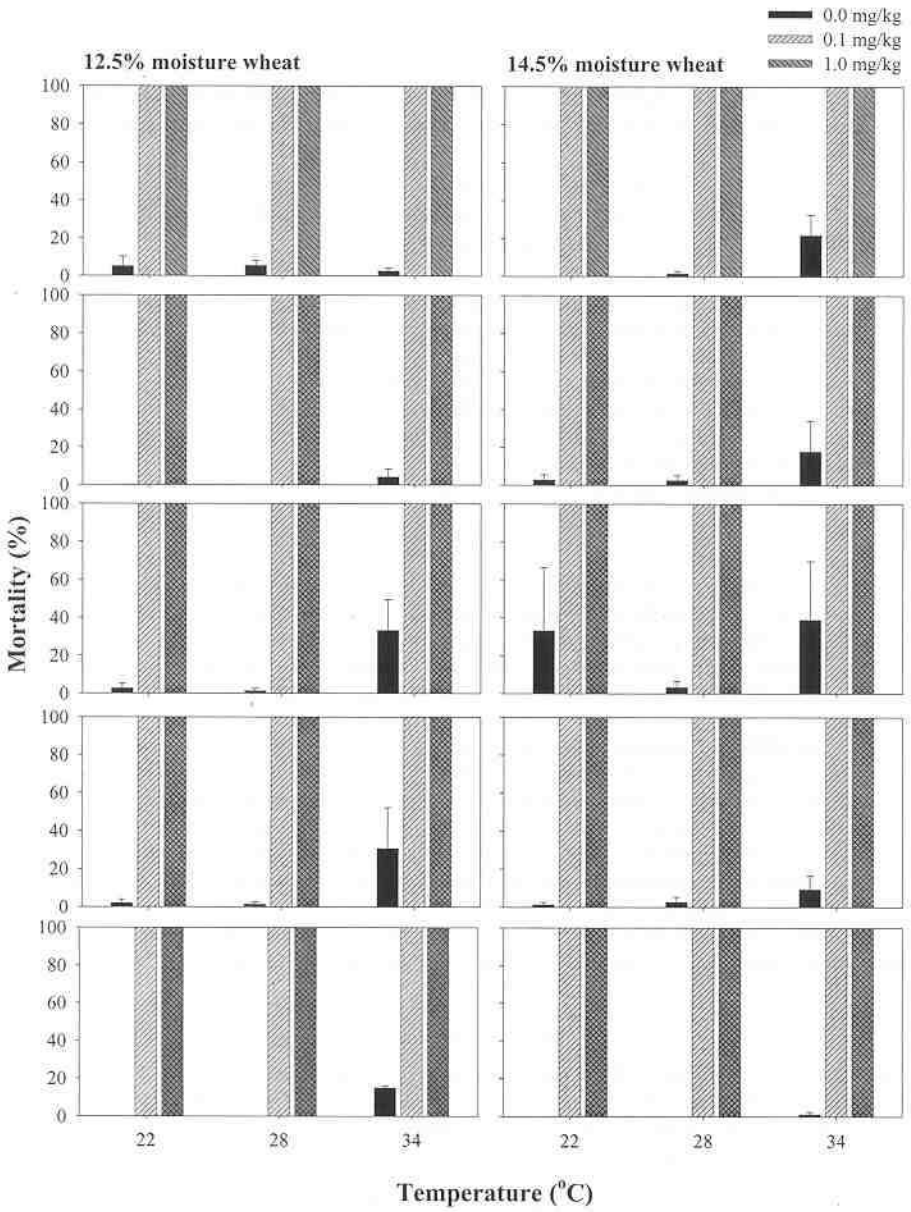

Fig. 1. Mortality (%mean ± SEM) of *R. dominica* adults on 12.5 or 14.5% moisture wheat stored at 22, 28, and 34°C during the four month storage period. Independent untreated and spinosad-treated wheat samples were exposed to insects at 0, 1, 2, 3, and 4 months.

air diffusion. These containers were placed on a wire rack in a 41.2 × 28.7 × 25.3 cm plastic storage box. The relative humidity inside the box was maintained using a glycerol and water mixture (Rees, 1994) in such a way that the humidity was in equilibrium with the 12.5 or 14.5% moisture wheat in the containers (Sun and Woods, 1994). Moisture content of the wheat was checked periodically using the Perten Single Kernel Characterization System (Model 4100, Perten Instruments, Inc., Reno, NV) (Gaines *et al.*, 1996; Psotka, 1999). Each box held 15 containers—five for untreated wheat, five for wheat treated with 0.1 mg/kg of spinosad, and five for wheat treated with 1 mg/kg of spinosad. Boxes were kept in growth chambers set at 22, 28, and 34°C. There were two boxes

at each temperature, one for 12.5% moisture wheat and the other for 14.5% moisture wheat. Each temperature, moisture, and rate combination was replicated three times and the replicates were blocked over time. Each container with untreated and spinosad treated wheat was infested with 25 unsexed adults of *R. dominica*. The wheat was checked after 14 days to count the number of live and dead adults. Wheat was infested with *R. dominica* adults immediately after spinosad treatment (age 0) and at 1, 2, 3, and 4 months after treatment.

A split-split plot design was used for the experiment. Temperature was the whole plot and moisture content was the subplot within a temperature, and the combination of spinosad rate and exposure month was nested within each moisture level. The number of adults dead out of the total was expressed as a percentage. Mean (SEM) mortality data were computed using the MEANS procedure (SAS Institute, 1988). Statistical analysis of data was not deemed necessary because there was 100% mortality of *R. dominica* adults on all spinosad-treated wheat.

Results and Discussion

Mean mortality of *R. dominica* adults on untreated wheat at the three temperatures and two moistures tested over time varied from 0 to 38.9%. Mean mortality on untreated grain across the moistures and temperatures tested was <10% in 77% of the bioassays (Fig 1). Mortality of *R. dominica* adults was 100% on 12.5 and 14.5% moisture wheat treated with spinosad at all three temperatures and at 0, 1, 2, 3, and 4 months post-treatment (Fig. 1). Adults of *R. dominica* are highly susceptible to spinosad on wheat when compared with the rice weevil, *Sitophilus oryzae* (L.), sawtoothed grain beetle, *Oryzaephilus surinamensis* (L.), and red flour beetle, *Tribolium castaneum* (Herbst) (Fang *et al.*, 2002a). Fang *et al.* (2002b) reported that spinosad residues of 0.1 and 1 mg/kg are stable for one year on wheat stored on farms in Kansas and the residues provided 100% mortality of *R. dominica* adults during the one year of storage. The laboratory results reported here confirm that spinosad is stable on 12.5 to 14.5% moisture wheat at 22, 28, and 34°C and provides excellent control of *R. dominica* adults at these conditions. Therefore, changes in grain temperature and moisture during wheat storage should not significantly affect the performance of spinosad against *R. dominica* adults.

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