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Efficacy of Spinosad and IGR Plus to control the pests *Rhyzopertha dominica* and *Sitophilus zeamais* on stored wheat grain

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Abstract

The efficacy of the bacterium-derivate insecticide Spinosad and IGR Plus which contains methoprene (an insect growth regulator) and fenitrothion (an organophosphate protectant) against the two main pests of stored grain in Brazil: *Rhyzopertha dominica* and *Sitophilus zeamais* was assessed. Two strains of *R. dominica* were used in the experiment, the insecticide susceptible strain BR4 and the pyrethroid resistant strain BR12. The *S. zeamais* SOZ20 strain has unknown susceptibility. The insecticides were compared with two standard protectants deltamethrin (K-Obiol) and bifenthrin (ProStore) used in Brazil to control these pests. The experimental design was randomized blocks with seven treatments replicated four times. Each experimental unit was made of 1.0 kg of organic wheat grain treated with the chemicals and stored in bags in a room with 25 ± 1 ºC of temperature and 60 ± 5 % of relative humidity. The dosages, per kg of grain of each insecticide used were 1.0 and 2.0 mg a.i. of Spinosad, 1.0 + 6.0 and 2.0 + 12.0 mg a.i. of the mixture of methoprene + fenitrothion (IGR Plus), 0.4 mg a.i. of deltamethrin and 0.4 mg a.i. of bifenthrin. Also a control treatment (grain without insecticide) was used to assess the natural mortality of the pests. After one and 60 days of the grain treatment, a 100 g sample was taken from each experimental unit and infested with 20 adults of each species, separately. Fifteen days later the grain was sieved and the number of dead insects was recorded to assess the pests mortality. The results showed that Spinosad caused 100 % of *R. dominica* mortality of BR4 (susceptible) and BR12 (resistant) strains at both dosages, but achieved the same level of mortality of *S. zeamais* only with 2.0 mg a.i. IGR Plus caused a 100 % of *S. zeamais* mortality with both dosages but less than 80% mortality of *R. dominica*. Deltamethrin and bifenthrin showed lower mortality of both species, except to *R. dominica* BR4 strain and deltamethrin to *S. zeamais* at one day after treatment.

Key words: Spinosad, growth regulator, pest control, stored grain pests, new pesticide.

Introduction

The main problem in controlling pests in stored grain is the resistance to pesticides. When a pesticide resistant strain of a pest of stored grain

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is detected in a storage unit, the grain must be used immediately and the store unit cleaned and sprayed with insecticides to minimize the resurgence of the infestation. Where strains persist they should be left without treatment for as long as possible until susceptibility is restored and, if possible, other chemicals with the same toxic action should not be used to prevent cross-resistance (Prickett, 1980). Action should be taken also to prevent a wider spread of the problem. Strategies to minimize the factors that influence the selection of pest resistance to insecticides in field populations should be adhered as much as possible (Georghiou, 1983; Metcalf, 1983; Anonymous, 1986 a; b; Hawkins, 1986; Keiding, 1986; Leeper et al., 1986; Croft,1990; Tabashnik, 1990; Tabashnik et al., 1991). To support this management, further studies with new pesticides should be encouraged.

Spinosad is an insecticide based on a fermentation of the bacterium *Saccharopolyspora spinosa* Mertz & Yao, which was found in the earliest 80s (Mertz and Yao, 1990). This insecticide is being studied and recommended in many countries to control several pests. Reports about its effectiveness against stored grain pests have been published by Subramanyam et al. (1999); Fang et al. (2002), Fang and Subramanyam (2003); Nayak et al. (2005). Combinations of an insect growth regulator and an organophosphorus protectant such as IGR Plus, which contains methoprene + fenitrothion, is another option to control resistant pests in stored grain facilities.

The aim of this study was to assess the efficacy of Spinosad and IGR Plus to control *R. dominica* and *S. zeamais* which are the two main stored grain pests in Brazil. Because pyrethroid resistance is a problem in Brazil (Lorini and Galley, 1999) both resistant and susceptible strains of *R. dominica* were tested.

Material and methods

The experiment was set at the Stored Grain Laboratory of Embrapa Wheat in Passo Fundo, RS, Brazil in 2005/2006.The experimental design was randomized blocks with seven treatments replicated four times. Each experimental unit was made of 1.0 kg of organic wheat grain treated with the pesticides and stored in bags in a room with 25 ± 1 ºC of temperature and 60 ± 5 % of relative humidity. The dosages per kg of grain of each insecticide used were 1.0 and 2.0 mg a.i. of Spinosad, 1.0 + 6.0 and 2.0 + 12.0 mg a.i. of the mixture of methoprene + fenitrothion (IGR Plus), 0.4 mg a.i. of deltamethrin (K-Obiol) and 0.4 mg a.i. of bifenthrin (ProStore). A control treatment (grain without insecticide) was used to assess the natural pest mortality in the experiment.

After one and 60 days of the grain treatment, a 100 g sample was taken from each plot and infested with 20 adults of each species and strains, separately. The test species were *R. dominica* and *S. zeamais*. Two strains of *R. dominica* were the insecticide susceptible strain BR4 and the pyrethroid resistant strain BR12. The *S. zeamais* SOZ20 strain has unknown susceptibility. These insects came from a laboratory culture from Stored Grain Laboratory of Embrapa Wheat. Jars containing grain and insects were sealed with filter paper and arboseal and maintained in a room with temperature and relative humidity of 25 ± 1 ºC and 60 ± 5 %, respectively. Fifteen days later the grain was sieved and the number of dead insects was recorded to assess the insect mortality.

The results were submitted to statistical analyses (ANOVA) and to F test ($p \leq 0.05$). The means were compared between themselves by Tukey test ($p \leq 0.05$).

Results and discussion

The results (Tables 1 and 2) showed that Spinosad caused 100 % mortality of *R. dominica* at both dosages, 1.0 and 2.0 mg a.i. per kg of grain, in both resistant (BR12) and susceptible (BR4) strains. Complete mortality occurred also at one and 60 days after the grain treatment, showing the potential for long term protection with this insecticide. To achieve the same mortality level in *S. zeamais*, a dosage of 2.0 mg a.i. per kg was needed.

IGR Plus caused 100 % mortality of *S. zeamais* at both dosages one day after treatment, but the same mortality was achieved only with 2.0 + 12.0 mg a.i./kg 60 days after treatment. IGR Plus showed low efficacy against *R. dominica* as seen by the lower mortality level. Deltamethrin and bifenthrin showed lower mortality against both species except for susceptible *R. dominica* (BR4 strain), and deltamethrin to *S. zeamais* at one day after treatment.

Among the protectant treatments tested, Spinosad showed the best potential as an alternative treatment for control of *R. dominica*, which is the most serious pest of stored wheat in Brazil. Spinosad also has the advantage of having low mammalian toxicity (Thomson et al., 2000).

Table 1. Insecticide treatment of wheat grain to control adults of *Rhyzopertha dominica* (BR12 strain) and *Sitophilus zeamais* (SOZ20 strain) at one day after the treatment. Embrapa Wheat, Passo Fundo, RS, 2006.

Treatment and dosage (a.i./kg)	*Rhyzopertha dominica*[1] (BR12)	*Sitophilus zeamais*[1] (SOZ20)
Spinosad (1.0 mg)	20.00 a	17.25 a
Spinosad (2.0 mg)	20.00 a	20.00 a
IGR Plus (1.0 + 6.0 mg)	6.50 cd	20.00 a
IGR Plus (2.0 + 12.0 mg)	15.50 ab	20.00 a
Deltamethrin (0.4 mg)	9.25 bc	16.75 a
Bifenthrin (0.4 mg)	6.00 cd	7.00 b
Control	2.72 d	4.00 b

[1] Mean number of dead insects 15 days after infestation with 20 adult insects per replicate.

Means followed by the same letter in the column do not differ statistically between themselves, by Tukey test ($p \leq 0.05$).

Table 2. Insecticide treatment of wheat grain to control adults of *Rhyzopertha dominica* (BR12 and BR4 strains) and *Sitophilus zeamais* (SOZ20 strain) at 60 days after the treatment. Embrapa Wheat, Passo Fundo, RS, 2006.

Treatment and	*Rhyzopertha dominica*[1]		*Sitophilus zeamais*[1]
dosage (a.i./kg)	(BR12)	(BR4)	(SOZ20)
Spinosad (1.0 mg)	20.00 a	20.00 a	17.25 a
Spinosad (2.0 mg)	20.00 a	20.00 a	20.00 a
IGR Plus (1.0 + 6.0 mg)	7.75 b	7.50 b	16.00 a
IGR Plus (2.0 + 12.0 mg)	6.75 b	4.25 b	20.00 a
Deltamethrin (0.4 mg)	6.25 b	19.75 a	5.50 b
Bifenthrin (0.4 mg)	4.75 b	20.00 a	1.50 b
Control	4.50 b	5.25 b	0.25 b

[1] Mean number of dead insects 15 days after infestation with 20 adult insects per replicate.

Means followed by the same letter in the column do not differ statistically between themselves, by Tukey test ($p \leq 0.05$).

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