EVALUATION OF THE VIABILITY AND PROTECTION OF CONVENTIONAL AND BT CORN SEEDS UNDER INSECTICIDE TREATMENT AND STORAGE CONDITIONS

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ABSTRACT

In the process of seed production and marketing, the preservation of quality during storage is fundamental, especially until the time of sowing. A critical factor is protection against pests, such as those of the orders Coleoptera and Lepidoptera, which can cause losses of up to 20% in the stored product and compromise the germination power and vigor of the seeds. Preventive treatment with insecticides on seeds is a recommended practice to prevent pest attacks on the soil and shoots of young plants, reducing the need for later applications. Although effective, the use of insecticides can, in certain cases, cause phytotoxicity, reducing germination and seedling survival, especially when combined with fungicides. In the case of corn, treatment with insecticides is common in processing units, but there is a lack of data on its effects on genetically modified seeds (such as BT corn). The objective of the study is to evaluate the impact of the main insecticides recommended for corn crops, alone or in combination, both on conventional and BT seeds, focusing on seed germination and vigor in varying storage periods.

Keywords: Seed quality. Treatment with insecticides. Storage.

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INTRODUCTION

In the process of seed production and commercialization, one of the main factors that the producer must be aware of is the preservation of seed quality throughout the storage period, and seed quality must be maintained at least until the time of sowing (Carvalho 1992).

During storage, for example, the presence of pests in seeds should be avoided, especially those of the Coleoptera and Lepidoptera orders, which can cause losses of around 20% of the stored product (Carvalho, 1978; Carvalho & Nakagawa, 1988). In addition to quantitative losses, pest attacks on seeds can cause losses in germination power and vigor (Barney et al., 1991).

The preventive use of insecticide in seed treatment has been proposed as an alternative to avoid possible losses resulting from the actions of insects, soil and shoot pests, which can attack seeds and young plants (Silva, 1998). This practice, when properly performed, makes it possible to reduce the number of foliar applications, which often need to be started soon after seedling emergence (Menten, 1991).

Although seed treatment is considered one of the most efficient methods of using insecticides (Gassen, 1996), in some research results it has been evidenced that some products, due to the effect of phytotoxicity, when applied alone or in combination with fungicides, can, in certain situations, cause a reduction in seed germination and seedling survival (Oliveira & Cruz, 1986; Pereira, 1991).

As the treatment of corn seeds with insecticide is routinely carried out in the processing unit and due to the lack of information about its effect on genetically modified seeds, it is of great importance to evaluate the effects of insecticides available on the market, both in seed quality and in the control of pest insects that attack corn seedlings in their early stages.

The objective of this study was to evaluate the effect of the main insecticides recommended for maize crops, or the combination of these, on conventional material and BT (Yieldgard), on seed germination and vigor in different storage periods.

MATERIAL AND METHODS

The research was carried out in the Seed Analysis Laboratories and in the experimental area of the Department of Agriculture of the Federal University of Lavras, Lavras, Minas Gerais.

Seed samples of the simple hybrid DKB390 in its conventional and transgenic versions produced in the 2009/10 harvest were used.

The seed samples of each hybrid were divided into six equal portions, with about 3 kg each, which were treated at the dosages recommended by the manufacturers. The recommended product quantities for 60,000 seeds were Thiamethoxan (Cruiser 350 FS) 0.12L; Fipronil (Standak) 0.4L and Imidacloprid + Thiodicarb (Cropstar) 0.35L, in addition to the combinations of Fipronil + Thiamethoxan, Imidacloprid + thiodicarb + Fipronil (Cropstar + Standak) and Thiamethoxan + Fipronil (Cruiser 350 FS + Standak) and the control (without insecticidal treatment),

Each treatment was carried out with two replications and the seeds were stored in paper bags under controlled conditions, at a temperature of 25°C.

At zero, seven, fourteen, twenty-one and twenty-eight days after treatment with insecticide, germination tests were carried out, (Brasil, 2009); cold test and seedling emergence in bed, according to Barros et al. (1999) and Vieira & Krzyzanowski (1999).

In the cold test, 4 replicates of 50 seeds were evaluated on the fifteenth day after sowing, computing the number of normal seedlings emerged. The seedling emergence test in the bed was carried out with the sowing of 50 seeds per treatment and the use of four replicates for each treatment and each storage season, in substrate, sand and soil in the proportion of 2:1. The moisture was adjusted to 70% of the water retention capacity in the soil. The evaluations were carried out at 7 and 15 days after sowing, accounting only for normal seedlings.

The experimental design was DIC with four replications, in a 2x6x5 factorial scheme. The effect of the factors studied was evaluated through deviance analysis based on generalized linear models. The inferences were adjusted to the superdispersion parameter that was estimated based on Pearson's residuals. The statistical model considered for analysis is represented by

$$y_{ijkl} \sim Binomial(n, \pi_{ijk})$$

$$\ln \frac{\pi_{ijkl}}{1-\pi_{ijkl}} = \mu + \alpha_i + \beta_j + \gamma_k + \alpha\beta_{ij} + \alpha\gamma_{ik} + \beta\gamma_{jk} + \alpha\beta\lambda_{ijk}$$

where: *yijkl* is the proportion of germinated seeds in *the ijkl-th experimental unit containing* n *seeds,* □ijk is the probability of germination which is a function of μ, a constant inherent in all observations, □i *the fixed effect of* the *i-th* level of the insecticidal factor, □ *j* is the fixed effect *j-th* double combinations. The index *l* represents the repetitions of each combination between levels of the factors (treatments).

The chi-square tests were applied, corresponding to the reduction of sequential deviance for each term of the model, according to the order of the terms of equation 1. After deviance analysis, multiple hypothesis comparison tests were performed on the differences between levels of the factors. The FDR (false dicovery rate) criterion was applied to control the type I error rate caused by the multiple hypothesis comparison procedure. For all tests, a nominal significance level of 5% was considered.

The analyses were carried out with the aid of the R application (R Development Core Team, 2010) and through resources available in the contrast (Kuhn et. al, 2010) and multcomp (Hothorn et. al, 2008) supplementary packages.

RESULTS AND DISCUSSION

Table 1 shows that the seeds treated with the products Imidacloprid + thiodicarb, Thiamethoxam and Fipronil showed similar behavior in the germination and cold tests. For the emergency test, treatment with Fipronil was superior to the others, followed by treatments with Thiamethoxam and Imidacloprid + thiodicarb. For both transgenic and conventional seeds, a reduction in physiological quality was observed when the combination of two commercial insecticides was used. The mixture Imidacloprid + thiodicarb + Fipronil provided lower germination and vigor, so the recommendation of this treatment should be made with caution.

Differences in the performance of insecticides used in seed treatment have been frequently cited in the literature. Dan et al. (2010) evaluated the effect of insecticides on the physiological quality of soybean seeds and found no difference in the results of germination and emergence tests between seeds treated with Thiamethoxam and Fipronil when compared to the control without treatment. The same was not observed for the mixture Imidacloprid + thiodicarb, which provided worse performance than the insecticides mentioned, both in the germination test and in the cold test.

In the present study, the controls showed higher averages of germination, vigor and emergence than the other treatments, in at least one evaluation test (Table 1), indicating interference of the active ingredients used on the physiological quality of the stored seeds. This reduction in seed viability and vigor can be attributed to possible damage to the mitochondrial membrane, which promotes a decrease in aerobic respiration and ATP production and ethanol additions, which are important indicators of respiration intensity and energy availability for the germination process (Reedy and Knapp, 1990; Horri and Shetty, 2007).

Table 1. Predicted proportions for germination (TG), cold test (TF) and emergence test (ET) tests in conventional and transgenic maize seeds. UFLA, Lavras, MG, 2010

	Conventional1 Transgenic					1	
Treatments2	**TG**	**F**	**T**	**IN**	**TG**	**TF**	**IN**
Imid+th	97,	2,20a	4	94,04c	75,	36,	54,
I	30a				25c	59bc	30c
Imid+th	92,		4	89,24d	62,	35,	55,
io+ Fp	60b	2,00b			50d	84c	91c
Thiamet	98,		4	96,25bc	90,	35,	83,
Hoxan	40a	6,70a	4	95,57bc	91from	95bc	90b
Thia +	96,				90,	36,	83,
FP	31from	3,05b	4	97,47from	52b	70bc	19b
Fipronil	98,				94,	38,	91,
Test	15a	5,95a	4	98,60a	21from	00b	75a
	97,				94,	41,	89,
One	69a	5,55a			47a	45a	64a

[1]Averages followed by the same lowercase letter in the column do not differ from each other, at a 5% probability. [2]Imid (Imidacloprid), Thio (thiodicarb), Fp (Fipronil), Thia (Thiamethoxan).

It should be emphasized that despite the differences observed in the viability and vigor of seeds treated with insecticides, in most treatments seed germination values higher than 85% were observed and, therefore, are within the accepted standards for the commercialization of certified maize seeds (IN 25, 2005).

When performing the germination, cold and emergence tests on seeds stored for five different periods, only the cold and germination tests detected significant differences (Table 2). For these two tests, the controls showed equal or superior performance to the treatments in which insecticides were used. The performance of seeds treated with Fipronil was superior to those treated with the other insecticides, in all storage periods. In the seeds where the mixtures Imidacloprid + thiodicarb + Fipronil and Imid + thio were used, lower average vigor and germination were observed, both initially and during storage, again reinforcing that the use of these mixtures should be avoided.

Table 2. Predicted proportions for cold and germination tests performed on conventional and transgenic maize seeds at different storage times. UFLA, Lavras, MG, 2010.

Treatments2	Cold test1				
	0d	7d	14d	21d	28d
Imid+thio	42,41a b	41,62b c	40,82b c	40,04c d	39,25c d
Imid+thio + Fp	39,97b	39.42d	38,87d	38,33e	37,79d
Thiameth oxan	40,00b	40,61c d	41,22b c	41,83a b	42,45a b
Thia + Fipronil	40,58b	40,21c d	39,83c d	39,46d and	39,08c d
Fipronil	43,23a	42,58a b	41,92b	41,27b c	40,62b c
Testimmun Has	43,57a	43,53a	43,49a	43,45a	43,41a

Treatments	Germination Test1				
	0d	7d	14d	21d	28d
Imid+thio	70,26b	76,18c	81,24c	85,43c	88,82b
Imid+thio + Fp	70,89b	73,76c	76,44d	78.92D	81,21c
Thiameth oxan	92,73a	92,39b	92,04b	91,67b	91,29b
Thia + Fipronil	93,53a	92,44b	91,18b	89,73b	88,08b
Fipronil	93,39a	94,48a b	95,39a	96,16a	96,81a
Witness	95,04a	95,61a	96,11a	96,56a	96,9a

1Averages followed by the same lowercase letter in the column do not differ from each other, at a 5% probability. 2Imid (Imidacloprid), Thio (thiodicarb), Fp (Fipronil), Thia (Thiamethoxan).

CONCLUSIONS

The effect of storage of treated seeds on germination and vigor depends on the insecticide product used. The product Fipronil was the least toxic during the entire storage period.

Regardless of the type of seed, transgenic or conventional, or the period in which they are stored, there is a reduction in their physiological quality when using the combination of commercial insecticides Imidacloprid + Thiodicarb, Fipronil and Thiamethoxan.

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