Notas Científicas

Agrochemicals and storage times on soybean seed vigor

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Abstract – The objective of this work was to investigate the potential physiological damage of the treatment of '97Y07RR' soybean seeds with different pesticides at different storage times, in order to define the optimal period of sowing. The germination rate, the germination speed index, and shoot fresh matter were evaluated. Thiamethoxam did not cause losses in seed vigor with increasing storage time; however, the other agrochemicals caused significant losses. Seed treatment should be performed up to 90 days before sowing.

Index terms: *Glycine max*, germination, germination speed index, physiological quality, seed treatment.

Agroquímicos e tempos de armazenamento no vigor de sementes de soja

Resumo – O objetivo deste trabalho foi investigar o dano fisiológico potencial do tratamento de sementes de soja '97Y07RR' com diferentes pesticidas em diferentes tempos de armazenamento, para definir o período ótimo de plantio. Avaliaram-se a percentagem de germinação, o índice de velocidade de germinação e a massa fresca das plântulas. O thiamethoxam não promoveu perdas no vigor das sementes com aumento do tempo de armazenamento; no entanto, os demais agroquímicos produziram perdas significativas. O tratamento de sementes deve ser realizado até 90 dias antes do plantio.

Termos para indexação: *Glycine max*, germinação, índice de velocidade de germinação, qualidade fisiológica, tratamento de sementes.

Agrochemicals are well characterized for the control of diseases and pests, but some molecules may promote physiological and biochemical effects, which can sometimes modify plant growth, morphology, and production (Macedo & Castro, 2011). Currently, the use of pesticides on seed treatment is considered a technology that offers some benefits, such as the protection against diseases and pests during the plant's initial life cycle; the mitigation of environmental impacts due to the reduced amount of chemicals applied on the field; and the reduction of the exposure time of farmers to products during their preparation and application (Sirchio & Sutton, 2007; Elbert et al., 2008).

Nowadays, farmers adopt many technologies to improve seed viability, with special focus on storage and industrial treatment. The main purpose of storage is maintaining seed characteristics after processing (Deuner et al., 2014), whereas that of seed treatment with fungicide and/or insecticide before storage is allowing greater shelf life and suitable plant stand (Vazquez et al., 2014).

However, the environmental conditions of storage, without temperature and humidity control, as well as the application of pesticides on seeds, may reduce germination and seedling survival, due to potential phytotoxic effects (Dan et al., 2010, 2013). It should be noted that pesticide use associated with a long storage period is also harmful to seed vigor (Krüger et al., 2016).

The objective of this work was to investigate the potential physiological damage of the treatment of '97Y07RR' soybean (*Glycine max* L.) seeds with different pesticides at different storage times, in order to define the optimal period of sowing.

The experiment was conducted at the crop physiology, metabolism, and production laboratory of Universidade Federal de Viçosa, in the state of Minas Gerais, Brazil, between May and October, 2015. '97Y07RR' soybean seeds (DuPont Pioneer Brasil, Formosa, GO, Brazil), produced in the municipality of Coromandel, also in the state of Minas Gerais, were evaluated during the 2014/2015 crop harvest. This variety is resistant to the herbicide glyphosate and to the soybean cyst nematode race 3.

The material for seed treatment was selected by discarding seeds with pathogens, with cracked coats, and that were malformed or underdeveloped. The separated material was then disinfected with 1% bleach, for 5 min. After drying, 100-g samples were treated according to the recommendations for the crop, using the following products, which are currently the most commercialized in Brazil: thiamethoxam, Cruiser 350 FS, (Syngenta Brasil, São Paulo, SP, Brazil), at the dose of 200 mL commercial product (c.p.) per 100kg^{-1} seeds; imidacloprid+thiodicarb, Cropstar FS, (Bayer Cropscience, Agro Bayer Brasil, São Paulo, SP, Brazil), at the dose of 500 mL c.p. per 100kg^{-1} seeds; pyraclostrobin+thiophanate methyl+fipronil, Standak Top TS, (Basf S.A., São Paulo, SP, Brazil), at the dose of 200 mL c.p. per 100kg^{-1} seeds; and chlorantraniliprole, Dermacor FS, (Dupont do Brasil S.A., Barueri, SP, Brazil), at the dose of 100 mL c.p. per 100kg^{-1} seeds. A control treatment, without the application of pesticides, was maintained for comparative purposes.

The treatments were performed regularly on: May 13, 2015, at 90 days before germination (DBG), when seed moisture content was 14.6%; on June 13, 2015, at 60 DBG, when seeds presented 13% moisture; on July 13, 2015, at 30 DBG, when seed moisture content was 12.8%; and on August 14, 2015, at 0 DBG, when seeds presented 12.6% moisture.

The seed treatment was performed in plastic bags with a capacity of 2 kg. The material was stirred for 2 min, until complete homogenization, and was subsequently dried at room temperature. Next, the seeds were packed in permeable Kraft paper bags, which were identified and stored in the seed laboratory. These conditions are similar to those for seed processing, in a well-ventilated environment, with temperature between 23.5 and 37.5°C, and no contact with the floor.

The seed germination test was conducted to assess seed germination potential, on August 14, 2015. Four replicates of ten seeds each were placed on moistened paper (2.5 times the weight of the dry paper) in a gerbox, which was kept in a Mangelsdorf germination chamber at 25±2°C, for seven days, to determine the germination rate. The results were given as the percentage of normal seedlings.

Emerged seedlings were counted daily to obtain the germination rate index (GRI), from the fourth to the seventh germination day; at the end of seven days, the plantlets were collected and their fresh weight was measured in grams. The GRI was calculated according to Maguire (1962), using the equation: $GRI = (E_1/N_1) + (E_2/N_2) + (E_n/N_n)$; in which GRI is the germination rate index; E_1, E_2, and E_n are the number of plantlets in the first, second, and last count; and N_1, N_2, and N_n are the number of days at the first, second, and last sowing.

The experimental design was completely randomized. Data were subjected to the analysis of variance (Anova), and means were compared by Dunnett's test, at 95% reliability. The statistical analysis was performed using the SAS software, version 9.1 (SAS Institute Inc., Cary, NC, USA). There was no data transformation, according to the tests for normality and homogeneity of variances.

Regarding the germination rate, the use of pyraclostrobin+thiophanate methyl+fipronil caused a reduction of 29.7 and 37.8% at 60 and 90 days after storage, respectively, in comparison with the control. With the application of imidacloprid+thiodicarb and clorantraniliprole, reductions of 43.2 and 40.5% were observed only during the 90-day period, respectively. However, thiamethoxam did not affect soybean germination (Figure 1 A). At 90 days after storage, in all treatments, the germination rate was less than 80%, lower than the value recommended by the current legislation in Brazil (Tecnologias…, 2008) for certified seeds, including C1, C2, S1, and S2.

Similar results were found for the GRI – when compared with the control –, which showed reductions in the germination rate of: 27.4 and 45.5%, respectively, after 60 and 90 days of storage, with the use of pyraclostrobin+thiophanate methyl+fipronil; 47.9% using imidacloprid+thiodicarb at 90 days of storage; and 45.1% with clorantaniliprole, also at 90 days of storage. Again, no significant differences were verified when using thiamethoxam (Figure 1 B).

However, for the variable fresh mass, it was observed that imidacloprid, applied at 0 days of storage, reduced significantly the accumulation of seedling mass (Figure 1 C).

Seed deterioration is a natural process that reduces germination viability and vigor (Delouche & Baskin, 1973). However, during storage, the aging process can be retarded by controlling temperature and moisture conditions in the environment or by preventing pest attacks using chemical treatment (Deuner et al., 2014). Despite this, the use of agrochemicals on seeds during prolonged storage periods significantly reduces seed germination and vigor (Dan et al., 2010, 2013; Deuner et al., 2014).

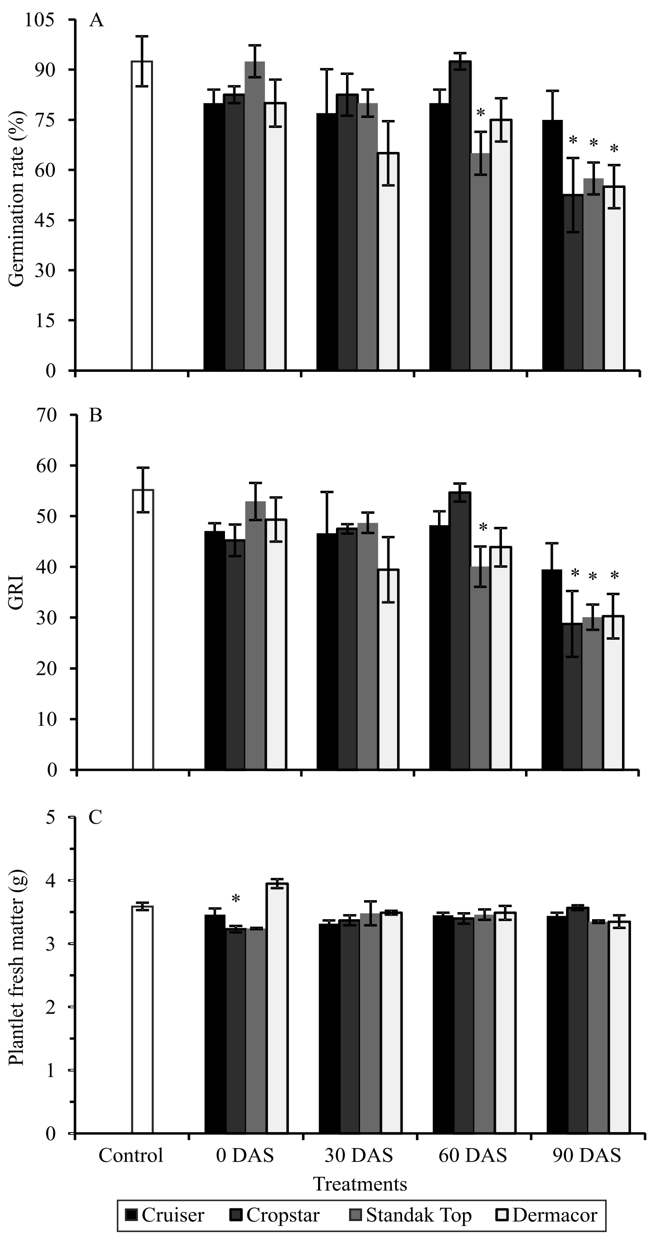

Figure 1. Germination rate (A), germination rate index (GRI) (B), and plantlet fresh matter (C) of soybean (*Glycine max*) seeds, at 90 days of storage (DAS), treated with four agrochemicals: Cruiser, CropStar, Standak Top, and Dermacor, when compared with the control. *Means were compared by Dunnett's test, at 5% probability. The bars indicate the standard error of the mean.

The results obtained for seed germination and the GRI indicated that all pesticides, except thiamethoxam, significantly reduced seed germination during storage of '97Y07RR' soybean seeds, in comparison with the control. However, Dan et al. (2013) reported that thiamethoxam, applied at 90 days of storage, reduced seed vigor of 'Anta 82 RR' soybean. This shows that the tolerance of the genotype to the insecticide at different storage times is an intrinsic factor for seed vigor.

The use of other agrochemicals significantly reduced germination and the GRI, especially after 60 days of storage. This may be due to the type of formulation used, to the period of contact with the product and its application conditions, as well as to the different crop species studied and to the cultivar's tolerance to phytotoxicity (Stevens et al., 2008).

The seeds began their degenerative process during storage, and, therefore, reduced their physiological performance for all treatments. It was observed that, at 60 days, the treated seeds can be stored without significant losses, when compared with the control treatment; however, the storage time of treated seeds should not be extended for more than 90 days.

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