The effect of a fungicide treatment on the physiological potential of rice seeds after storage

Efeito do tratamento com fungicida no potencial fisiológico de sementes de arroz após o armazenamento

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Abstract

The chemical treatment of rice seeds before sowing causes no damage to the seed physiological potential. The objective of this study was to evaluate the physiological potential of three rice seed cultivars treated with fungicide and stored for ten months. Irrigated rice seeds cultivars BR IRGA 409, BRS Pampa and BRS Sinuelo CL produced in the season 2011/2012 treated with the fungicide carboxin + thiram were used. 3.0 kg samples of treated and untreated rice seeds were kept storing for ten months at cold chamber. After this period we assessed the physiological potential through germination, first count of germination, seedling emergence in greenhouse, cold test, length and dry mass of shoots and roots of seedlings in germination and emergence tests. The results showed that BRS Sinuelo CL cultivar was the most sensitive, while a reduction of germination percentage and emergence first count after treatment and storage of seeds. The treatment of irrigated rice seeds with carboxin + thiram fungicide followed by storage of seeds for ten months is detrimental to the physiological potential of cultivar BRS Sinuelo CL. The fungicide applied together with the storage time reduces the emergence of BRS IRGA 409, BRS Pampa and BRS Sinuelo CL, as well as negatively affects the length of the root.

Additional keywords: Oryza sativa L.; phytotoxicity; viability.

Resumo

O tratamento químico de sementes de arroz irrigado alguns dias antes da semeadura não causa nenhum dano ao potencial fisiológico das sementes. Diante do exposto, o presente trabalho teve o objetivo de avaliar a qualidade fisiológica de sementes de três cultivares de arroz irrigado tratadas com fungicida e armazenadas por dez meses. Utilizaram-se sementes de arroz irrigado das cultivares BR IRGA 409, BRS Pampa e BRS Sinuelo CL, produzidas na safra de 2011/2012 e tratadas com o fungicida carboxina + thiram. Amostras de 3.0 kg de sementes tratadas e nãotratadas foram armazenadas por dez meses, em câmara de conservação a 18 °C. Após esse período, avaliaram-se o potencial fisiológico por meio dos testes de germinação, primeira contagem de germinação, emergência de plântulas em casa de vegetação, teste de frio, comprimento e massa secas da parte aérea e raiz das plântulas obtidas nos testes de germinação e emergência. As sementes da cultivar BRS Sinuelo CL foram as mais sensíveis, ocorrendo redução da percentagem de germinação e primeira contagem de germinação após o tratamento químico e armazenamento. O tratamento de sementes de arroz irrigado com carboxin + thiram, seguido de armazenamento por dez meses, é prejudicial para o potencial fisiológico de sementes da cultivar BRS Sinuelo CL. O fungicida aplicado em conjunto com o tempo de armazenamento reduz a emergência das cultivares BRS IRGA 409, BRS pampa e BRS Sinuelo CL, bem como afecta negativamente o comprimento da raiz.

Palavras-chave adicionais: fitotóxicidade; Oryza sativa L.; viabilidade.
Introduction

The Brazil ranks ninth among the largest rice producers in the world, achieve a production of about 12 million tonnes in the 2014/2015 crop, about 3.5% higher than the previous harvest. The Rio Grande do Sul stands out how state that more produces and presents average yield above 7 t ha⁻¹ (CONAB, 2015).

It is known that the establishment of proper plant population since the crop emergence is essential so that every kind of crop may be able to express their productive potential. This condition is associated with a group of cultural practices, such as proper soil management, proper sowing season, efficient control of weeds and well-regulated sowing. However, it is worth to mention that the use of seeds with good physical, physiological and sanitary quality is necessary to obtain proper plant population in crops (Franco & Magalhães, 2011).

From the sanitary point of view, the ideal seed is that free of any undesirable microorganism, but this is not always possible because the sanitary quality of seeds is influenced by edaphoclimatic conditions in which they had been produced, as well as storage conditions. Thus, as a security measure and in aim to reduce the incidence of fungi at low levels, the rice producer, in order to advance the sowing time, it has adopted seed treatment (Gomes et al., 2004).

The treatment of seeds is an operation in which they apply fungicides or insecticides on the seed surface in order to control fungi and pests during both germination and the initial period of seedlings development (Gomes et al., 2004). However, seed treatment before to storage may be beneficial or can be prejudicial to seeds.

In experiment with sunflower seeds treated with insecticide it was verified a reduction in germination and emergence speed index due to the toxic effect of the product on the physiological potential of the same after 30 days of storage (Dan et al., 2012). Study of cowpea seeds treated with insecticide and fungicides showed a reduction of the vigor to 180 days of storage, this reduction was more pronounced for emergence testing of seedlings and the germination speed index (Oliveira et al., 2015). High humidity associated with fungicide treatment accelerates the reduction of the physiological potential of the rice seeds stored in sealed environments for 240 days (Silva et al., 2011).

Regarding the storage of treated seeds, Moraes et al. (2001) found that soybean seeds treated with carboxin + thiram 180 days before sowing did not alter the physiological quality. Marcos Filho (2005) found that soybean seeds treated with fungicides (thiram and thiophanate methyl + thiram) before storage benefited as to vigor. In cotton seeds, the treatment with fungicides, insecticides and polymers provided seeds with higher germination percentage over 9 months storage (Karnataka, 2007).

Lately, some farmers have preferred irrigated rice seeds from Rio Grande do Sul State due to the chemical treatment of seeds a couple of days before sowing which, according to the literature, causes no damage to the physiological potential of seeds (Sosbai, 2012).

The Rio Grande do Sul state has been highlighted by the use of seed treatment, especially with fungicides and insecticides (Fanco et al., 2013).

Therefore, this work aimed to assess the physiological quality of seeds from three irrigated rice cultivars treated with fungicides and stored for ten months.

Material and methods

Irrigated rice seeds cultivars BR IRGA 409, BRS Pampa and BRS Sinuelo CL harvested in the area of seed production at ETB season 2011/2012 were used. Seeds were classified, and 6 kg samples from each cultivar were taken, wherein 3 kg treated with 9 mL carboxin + thiram (carboxin – carboxanilide + thiram – dimethyldithiocarbamate) fungicide; 60 g i.a. 100 kg⁻¹ seeds 200 SC and 3 kg untreated. Seeds were subsequently stored in cold chamber (50% humidity and 18 °C average temperature) for 10 months. After storage, the physiological potential of seeds was measured with the following tests:

Germination and first count – four replicates of 100 seeds from each treatment, sowed in germination paper rolls moistened with distilled water equivalent to 2.5-fold their dry mass. Seeds were kept in a regulated germinator at 25 °C. Evaluations were performed at 5 and 14 days after the beginning of the test (Brasil, 2009), and results expressed in normal seedlings percentage.

Emergence of seedlings in greenhouse – four replicates of 100 seeds from each treatment sowed in plastic trays with soil from irrigated rice crops, determining the percentage of seedling emergence after 21 days.

Length of shoots and roots of seedlings – determined together with both the emergence and germination tests, after 21 and 14 days, respectively (Nakagawa, 1999). Average length of shoots and roots of seedlings were obtained by dividing the sum of the measurements taken from subsamples by the number of measured seedlings, results expressed in cm seedling⁻¹.

Dry mass of roots and shoots of seedlings – obtained from seedlings from germination and emergence tests used to determine the length of roots and shoots. Each sample was packed in paper bags and kept in an oven with forced air circulation at 70 °C temperature until reaching constant mass. Dry-mass of seedlings was determined with a precision scale ± 0.001 g (Nakagawa, 1999) and results expressed in g seedlings⁻¹.

Cold test – four replicates of 100 seeds from each treatment distributed in germitest paper rolls moistened with water equivalent to 2.5-fold their dry-substrate mass. Seeds covered with sieved soil from rice crop and covered with a paper towel sheet. Rolls...
were packed in plastic bags, sealed and kept in regulated chamber at 10 °C for 7 days. After this period, rolls were transferred into a germinator at 25 °C temperature for another 7 days (Cicero & Vieira, 1994). Results expressed in percentage of normal seedlings.

The experiment was performed in a completely randomized design in a 2x3 factorial (treated and untreated seeds from three cultivars) with four replicates. Data subjected to analysis of variance and means compared by Tukey test at 5% probability. Statistical software WinStat version 2.0 was used (Machado & Conceição, 2003).

**Results and discussions**

The results showed that there was an interaction between the seed treatment and cultivars for most of analyzed variables, i.e., the performance of treated and untreated seeds varied after storage depending on the cultivar. According to the germination test results, the treatment of seeds with carboxin + thiram fungicide was damaged only to the quality of seeds of BRS Sinu elo CL cultivar, since it did not affect the performance of seeds of BR IRGA 409 and BRS Pampa cultivars (Table 1).

Despite, even after the treatment with fungicide, the germination of seeds from all evaluated cultivars remained within the country standard required for seed commercialization which is supposed to be 80% (Brasil, 2013) (Table 1). Similarly, germination of rice seeds treated with Vitavax-Thiram and Mancozeb remained over 80% after six months storage (Van Nghiep & Gaur, 2005).

Film-coated soybean seeds treated with thiabendazole + thiram fungicide stored for six months exhibited germination percentage above 80% (Pereira et al. 2011a). However, Silva et al. (2011) verified that rice seeds treated with fungicides and stored for 8 months in airtight containers had the germination reduced to values below 80%. In maize seeds subjected to phytosanitary treatment and stored for six months exhibited lower normal seedlings number, indicating a possible phytotoxic effect of the treatment (Pereira et al., 2005).

Grohs et al. (2012) observed that of rice seeds germination treated with thiamethoxam was 50% higher than the witness. In another study, it was observed that rice seeds treated with thiamethoxam presented accelerated germination (Clavijo, 2008). The first count of the germination test is a trait of seed liveliness, enabling an estimation of seed performance under adverse field conditions (Franco & Magalhães, 2011). Data obtained in this study have also showed that only seeds of BRS Sinu elo CL cultivar were negatively affected by the treatment of seeds with fungicide, exhibiting 77% normal seedlings at the first count of germination test after treatment and 91% for untreated seeds (Table 1), supporting the higher sensitiveness of this cultivar seeds regarding their germination after treatment with fungicide followed by storage. Similarly, Avelar et al. (2011) reported that soybean seeds stored for six months with no treatment exhibited higher performance in comparison to treated seeds. In experiment with rice seed treated with Thi amethoxam was observed stimulus the first count, cultivar IRGA 425 obtained higher percentage compared to the control (Grohs et al., 2012).

The cold test aims the assessment of seed performance after exposition to low temperature, higher moisture level of substrate and activity of potential pathogens (Marcos Filho, 2005). Therefore, results obtained in this test indicate that there was no significant difference between the performance of seeds subjected to treatment and untreated seeds, and there was no difference between the performance of seeds of different cultivars after treatment (Table 1). As well as Hossen et al. (2014) did not observe significant differences in treated wheat seeds and not treated with fungicides in the cold test.

The treatment of seeds with fungicide followed by storage for ten months reduced significantly the emergence of seedlings in greenhouse conditions for all evaluated cultivars (Table 1). Dan et al. (2012) in experiments with sunflower seeds treated with imidacloprid + Thiodicarb found a reduction in emergency due to toxic effects of the product on the physiological potential of the same.

However, Grisi et al. (2009) not observed statistical difference in the emergence of sunflower seeds treated with thiamethoxam and fipronil. By contrast, Almeida et al. (2011) found that treatment with thiamethoxam positively favors the emergence of seeds of rice IRGA 410 and 424 IRGA. Pereira et al. (2011a) observed that soybean seeds treated with thiabendazole + thiram and carbenzadzin + thiram stored for six months exhibited higher vigor in comparison to untreated seeds. In this case, it is likely that higher vigor of seeds treated with fungicides may have been a result of the high protection of seeds provided by fungicides.

The main objective of the length test of roots and seedlings is to estimate the relative liveliness of a seed lot. It is important to mention this because the determination of normal seedling average length is carried out given that samples expressing higher values are more liveliness (Nakagawa, 1999). In the present study, the results obtained for shoot length of seedlings from the germination test did not emphasize any effect of seed treatment for three evaluated cultivars (Table 2). Although, the root length of seedlings obtained in this test was hampered by seed treatment with fungicide, where there was lower growth in treated seeds in all cultivars (Table 2). Probably this reduction at length test of roots occurred because generally the radicle is the first point formed by in growth seed, besides being the site of synthesis and release of plant hormones (Coll et al., 1992). Their growth and development faster than the hypocotyl probably is what gives you the facility to interact more with the product applied to the seed (Vieira, 2005).
Table 1 - Germination, first count of germination (FCG), emergence and cold test in seeds of three irrigated rice cultivars both untreated and treated with carboxin + thiram after ten months storage (Pelotas, RS, 2013/2014).

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>FCG (%)</th>
<th>Germination (%)</th>
<th>Emergence (%)</th>
<th>Cold (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Untreated</td>
<td>Treated</td>
<td>Untreated</td>
<td>Treated</td>
</tr>
<tr>
<td>BR IRGA 409</td>
<td>89 Aa</td>
<td>85 Aa</td>
<td>91 Aa</td>
<td>88 Aa</td>
</tr>
<tr>
<td>BRS Pampa</td>
<td>81 Ab</td>
<td>79 Ab</td>
<td>84 Ab</td>
<td>81 Ab</td>
</tr>
<tr>
<td>BRS Sinuelo CL</td>
<td>91 Aa</td>
<td>77 Bb</td>
<td>93 Aa</td>
<td>80 Bb</td>
</tr>
<tr>
<td>CV (%)</td>
<td>3.38</td>
<td>3.39</td>
<td>10.35</td>
<td>6.62</td>
</tr>
</tbody>
</table>

Means followed by the same upper case letter in line and lower case in column do not differ according to Tukey test at 5% probability.

Table 2 - Length (L) of shoots and roots of three irrigated rice cultivars, from either treated or untreated seeds in germination test after ten months storage (Pelotas, RS, 2013/2014).

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Shoots (cm)</th>
<th>Roots (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Untreated</td>
<td>Treated</td>
</tr>
<tr>
<td>BR IRGA 409</td>
<td>10.66 Aa</td>
<td>10.57 Aa</td>
</tr>
<tr>
<td>BRS Pampa</td>
<td>9.84 Aab</td>
<td>10.04 Aab</td>
</tr>
<tr>
<td>BRS Sinuelo CL</td>
<td>8.95 Ab</td>
<td>9.55 Ab</td>
</tr>
<tr>
<td>CV (%)</td>
<td>5.20</td>
<td>8.01</td>
</tr>
</tbody>
</table>

Means followed by the same upper case letter in line and lower case in column do not differ according to Tukey test at 5% probability.

Regarding the performance of seedlings from the emergence test, it was found that the seed treatment with carboxin + thiram fungicide followed by seed storage for ten months influenced only the root length of seedlings of BRS Sinuelo CL cultivar, which was higher in comparison to the others. For the other cultivars, there was no treatment effect related to shoot or root length (Table 3). Avelar et al. (2011) detected a better performance of seedlings for seeds treated with polymer and stored for six months, which exhibited a reduction in seedling length of only 0.4 cm per month and 0.8 cm for seedlings of seeds with no polymer. In the treatments with polymer, there was also a better performance for root length with a reduction of only 0.5 cm per month in comparison to 0.7 cm in treatment with no polymer.

Table 3 - Means of shoot and root length of seedlings of three irrigated rice cultivars, from treated and untreated seeds in the emergence test in greenhouse conditions after ten months storage (Pelotas, RS, 2013/2014).

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Shoot (cm)</th>
<th>Root (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Untreated</td>
<td>Treated</td>
</tr>
<tr>
<td>BR IRGA 409</td>
<td>30.91 Aa</td>
<td>32.33 Aa</td>
</tr>
<tr>
<td>BRS Pampa</td>
<td>32.32 Aa</td>
<td>32.46 Aa</td>
</tr>
<tr>
<td>BRS Sinuelo CL</td>
<td>29.89 Ab</td>
<td>29.58 Aa</td>
</tr>
<tr>
<td>CV (%)</td>
<td>6.31</td>
<td>12.37</td>
</tr>
</tbody>
</table>

Means followed by the same upper case letter in line and lower case in column do not differ according to Tukey test at 5% probability.

According to Carvalho & Nakagawa (2000), the determination of the seedling dry mass enables the estimation of the transference rate of seed reserves to the embryo, which is an indicative of liveliness. Data from shoot dry-mass of seedlings obtained in tests of germination and seedling emergence from treated and untreated seeds did not exhibit significant difference between cultivars BR IRGA 409 and BRS Pampa. The treated seeds of BRS Sinuelo CL cultivar presented root dry mass large in relation to untreated seeds, because BRS Sinuelo CL obtained the highest root length compared the other two cultivars (Tables 4 and 5).

The untreated seeds of the cultivars BRS IRGA 409, BRS Pampa and BRS Sinuelo presented 34.00, 36.20, and 31.00 g of dry matter respectively. Treated seeds with fungicide carboxin + thiram obtained 33.00, 32.00 and 38.20 g dry mass to cultivars BR IRGA 409, BRS and BRS Sinuelo Pampa. The root dry mass of seedlings from the emergence test did not exhibit significant difference between treated and untreated seeds in all evaluated cultivars (Table 5). However, in studies with wheat seeds cultivar Pampeano treated with carboxin + thiram, best dry mass performance was observed compared to untreated seeds (Hossen et al., 2014).
As observed in the present study only BRS Sinuelo cultivar demonstrated a higher sensitivity to the treatment of the seed with Dickey storage time, resulting in a loss of viability as seen in the germination and emergence test. However, according to Bittencourt et al. (2007), fungicides (carboxin + thiram) provides greater protection to the seed, against the microorganisms present in the soil and the seed itself, especially when exposed to unfavorable conditions for their development, and also during storage.

Table 4 - Dry-mass of shoots and roots of three irrigated rice cultivars, from treated and untreated seeds in the germination test after ten months storage (Pelotas, RS, 2013/2014).

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Shoot dry mass (g)</th>
<th>Root dry mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Untreated</td>
<td>Treated</td>
</tr>
<tr>
<td>BR IRGA 409</td>
<td>55.50 Aa</td>
<td>57.25 Ab</td>
</tr>
<tr>
<td>BRS Pampa</td>
<td>56.00 Aa</td>
<td>54.75 Ab</td>
</tr>
<tr>
<td>BRS Sinuelo CL</td>
<td>43.25 Bb</td>
<td>65.00 Aa</td>
</tr>
<tr>
<td>CV (%)</td>
<td>6.57</td>
<td>12.81</td>
</tr>
</tbody>
</table>

Means followed by the same upper case letter in line and lower case in column do not differ according to Tukey test at 5% probability.

Table 5 - Dry-mass of shoots and roots of three irrigated rice cultivars, from treated and untreated seeds from the emergence test in greenhouse conditions after ten months storage (Pelotas, RS, 2013/2014).

<table>
<thead>
<tr>
<th>Cultivars</th>
<th>Shoot dry mass (g)</th>
<th>Root dry mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Untreated</td>
<td>Treated</td>
</tr>
<tr>
<td>BR IRGA 409</td>
<td>414.5 Aa</td>
<td>406.0 Aa</td>
</tr>
<tr>
<td>BRS Pampa</td>
<td>497.5 Aa</td>
<td>469.0 Aa</td>
</tr>
<tr>
<td>BRS Sinuelo CL</td>
<td>391.2 Ba</td>
<td>498.2 Aa</td>
</tr>
<tr>
<td>CV (%)</td>
<td>14.19</td>
<td>24.10</td>
</tr>
</tbody>
</table>

Means followed by the same upper case letter in line and lower case in column do not differ according to Tukey test at 5% probability.

Conclusions

The treatment of irrigated rice seeds with carboxin + thiram fungicide followed by storage of seeds for ten months is detrimental to the physiological potential of cultivar BRS Sinuelo CL. The fungicide applied together with the storage time reduces the emergence of BRS IRGA 409, BRS Pampa and BRS Sinuelo CL, as well as negatively affects the root length.

References


