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PHYSIOLOGICAL QUALITY OF RICE SEEDS AS A FUNCTION OF DIFFERENT DOSES OF THE INSECTICIDE CIANTRANILIPROLE

João Luis Carricio Viero, Cristina Rossetti, Adilson Jauer, Jonatas Munari, Gabriel Fleck da Rosa, Natalia Pedra Madruga, Andreia da Silva Almeida

Universidade Federal de Pelotas – UFPEL, RS. E-mail: cristinarosseti@yahoo.com.br

Abstract

The seed is one of the main agricultural inputs and its quality is one of the key factors for success in rice cultivation. The objective of this work was to evaluate the physiological quality of rice seeds with different doses of the insecticide ciantraniliprole and its performance during storage of rice seeds. Rice seeds of the cultivar IRGA 424 RI treated at doses 0 (control), 10, 20, 40, 60, 80 and 100 ml of the product for each 100 kg of seeds were used. Evaluations were performed during storage periods 0, 60, 90, 135 and 180 days after treatment. Seed quality was monitored through the germination test, cold test and emergence. Under the conditions in which the study was carried out, we can conclude that: ciantraniliprole at doses of 60, 80 and 100 ml/100kg of seeds provides greater germination when the seeds are not stored, however the dose of 60 ml/100kg showed higher percentages of germination in other storage periods. For the cold test, cyantraniliprole in all doses was superior to the control without treatment and in the doses 60 ml/100kg of seeds it was superior in the storage times 0, 135 and 180 days, already in the storage periods 60 and 90 days the dose of 60 ml/100kg did not differ from the dose of 80 ml/100kg. For the emergence of seedlings, the treatment with the insecticide at a dose of 60 ml/100kg of seeds was superior to the others, except for the storage period of 135 days.

Keywords: *Oryza sativa* L.; chemical control; seed performance.

QUALIDADE FISIOLÓGICA DE SEMENTES DE ARROZ EM FUNÇÃO DE DIFERENTES DOSES DO INSETICIDA CIANTRANILIPROLE

Resumo

A semente é um dos principais insumos da agricultura e sua qualidade é um dos fatores primordiais para o sucesso na cultura do arroz. O objetivo do trabalho foi avaliar a qualidade fisiológica de sementes de arroz com diferentes doses do inseticida ciantraniliprole e seu desempenho durante o armazenamento de sementes de arroz. Utilizaram-se sementes de arroz da cultivar IRGA 424 RI tratadas nas doses 0 (testemunha), 10, 20, 40, 60, 80 e 100 ml do produto para cada 100 kg de sementes. As avaliações foram realizadas durante os períodos de armazenamento 0, 60, 90, 135 e 180 dias após o tratamento. A qualidade das sementes foi monitorada através do teste germinação, teste de frio e emergência. Nas condições de realização do trabalho podemos concluir que: o ciantraniliprole nas doses de 60, 80 e 100 ml/ 100kg de sementes proporciona maior germinação quando as sementes não são armazenadas, no entanto a dose de 60 ml/100kg apresentou maior percentagens de germinação nos demais períodos de armazenamento. Para o teste de frio, o ciantraniliprole em todas as doses foi superior a testemunha sem tratamento e nas doses 60 ml/100kg de sementes mostrou-se superior nas épocas de armazenamento 0, 135 e 180 dias, já nos períodos de armazenamento 60 e 90 dias a dose de 60 ml/100kg não diferiu da dose de 80 ml/100kg. Para a emergência de plântulas o tratamento com o inseticida na dose de 60 ml/100kg de sementes mostrou-se superior aos demais, exceto no período de armazenamento 135 dias.

Palavras-chave: *Oryza sativa* L.; controle químico; desempenho de sementes.

Introduction

The rice (*Oryza sativa* L.) is a relevant crop for the world population, being the second most cultivated cereal in the world (EMBRAPA, 2020). In this sense, the search for new technologies aimed at increasing the productivity of existing cultivars and obtaining seeds of high physiological and sanitary quality is justifiable (EMBRAPA, 2020).

It is characterized as a product of high socioeconomic expression, since, together with beans, it constitutes the basis of the national diet, providing a combination of vegetable protein and carbohydrates (EMBRAPA, 2020). However, the growing need to increase food production in the world, due to population growth, has meant that agricultural frontiers have been substantially increased and/or intensified with new production technologies (MIURA, 2022).

As a result of the constant use of cultivation areas, serious phytosanitary problems have arisen. The occurrence of diseases and insects are one of the biggest limiting factors to production. The rice plant, at any stage of development, is subject to attack by insects that reduce both quality and productivity. Among the direct damages, there is a reduction in the plant stand, stained grains, smaller number and/or grain size and reduction in the productive efficiency of the plants (SOSBAI, 2018).

The technology for protecting irrigated rice plants through the use of insecticides expands every year, as an increase in the occurrence of insects is observed. Among the insects that attack flood-irrigated rice in Brazil, *Oryzophagus oryzae* stands out. The adult insect, commonly known as water weevil, invades rice paddies during flooding, feeding on surface tissues of rice leaves and, when mating and ovipositing mainly in submerged parts of the leaf sheath, gives rise to the larvae known as wormworm. -root, which migrate to the roots, where they feed, and can reduce crop productivity by up to 25% (MARTINS *et al.*, 2019).

Among the *O. oryzae* control methods, the use of chemical insecticides stands out (MARTINS *et al.*, 2016), applied via seed treatment (GRÜTZMACHER *et al.*, 2022). Ciantraniliprole is an insecticide registered for the control of *O. oryzae* in irrigated rice. It is characterized by being an anthranilic diamide, a group of ryanodine receptor modulators. This insecticide acts systemically causing an uncontrolled release of calcium from the insect's muscle cells, leading to paralysis, feeding inhibition and death (CORDOVA *et al.*, 2016). Chemical treatment with insecticides is characterized by being an operation less subject to the action of climatic factors, it also offers less risk to operators, is less aggressive to beneficial soil organisms and leads to reductions in the number or need for complementary applications of pesticides in developing crops. It is a measure of relative low cost, which almost always culminates in significant increases in final production (NASCIMENTO, 2019).

During storage under uncontrolled conditions, seeds are exposed to fluctuations in temperature and relative humidity, pests and storage fungi, which can contribute to a reduction in quality due to the deterioration process. Thus, the treatment of seeds with fungicides and insecticides can contribute to the reduction of these harmful effects and to the maintenance of seed quality during the storage period (BAIL, 2013).

Although it is expected that when treating rice seeds with an insecticide, the physiological quality of the seeds is preserved, Fessel *et al.* (2022) found in maize that certain insecticides when applied to seeds can, in certain situations, cause a reduction in germination percentages. Insecticides and fungicides are usually evaluated for their efficiency in controlling pests and diseases, however some of them can cause effects that are still little known, capable of modifying plant metabolism and morphology (ALMEIDA *et al.*, 2021).

In this context, the present study aimed to evaluate the physiological quality of rice seeds of the cultivar IRGA 424 RI with different doses of the insecticide ciantraniliprole and its performance during storage.

Material and methods

The study was carried out at the Didactic Laboratory of Seed Analysis (LDAS) of the Faculty of Agronomy Eliseu Maciel of the Federal University of Pelotas (UFPel), Pelotas, RS. Rice seeds of the cultivar IRGA 424 RI were used. The treatments are presented in Table 1, the evaluations were carried out during the storage periods 0, 60, 90, 135 and 180 days after treatment.

Table 1. Commercial products, active ingredients, doses for each seed treatment in the rice crop, cultivar IRGA 424 RI.

Treatments	Concentration (g/liter)	g.ia/100kg	mL/100kg of seeds
Witness	-	-	-
Fortenza 600 FS Ciantraniliprole (600 g/l)	600	6	10
Fortenza 600 FS Ciantraniliprole (600 g/l)	600	12	20
Fortenza 600 FS Ciantraniliprole (600 g/l)	600	24	40
Fortenza 600 FS Ciantraniliprole (600 g/l)	600	36	60
Fortenza 600 FS Ciantraniliprole (600 g/l)	600	48	80
Fortenza 600 FS Ciantraniliprole (600 g/l)	600	60	100

The application of the syrup (product + distilled water) was carried out with an industrial seed treatment machine, the volume of syrup used was 0.6 l/100kg of seeds. The effects of the treatments were evaluated using the following evaluations:

Germination Test: five replications were used with six subsamples of 50 seeds for each treatment. The seeds were sown in rolls of germitest® paper, moistened with distilled water, in a proportion of 2.5 times the weight of the dry paper and kept in a germinator set at 25°C. The evaluations were carried out according to the Rules for Seed Analysis (BRASIL, 2009). The count of normal seedlings was performed 5 days after the installation of the test and the results expressed as percentage of normal seedlings.

Cold Test: six replications were used with four subsamples of 50 seeds for each treatment. The seeds were sown in germitest® paper rolls, moistened with distilled water, in a proportion of 2.5 times in relation to the weight of the dry paper, and kept in a refrigerator for seven days at 10°C. After this period, the rolls were transferred to a germinator set at 25°C. The evaluations were carried out according to the Rules for Seed Analysis (BRASIL, 2009). The count of normal seedlings was performed five days after the installation of the test and the results expressed as percentage of normal seedlings.

Emergence in trays: it was carried out by sowing six replicates containing 50 seeds per replicate in trays containing substrate. The evaluation was carried out in a 10-day count, determining the number of normal seedlings and expressing the results in percentage of normal seedlings.

A completely randomized experimental design was used, in a 9 x 5 factorial (9 treatments x 5 repetitions). For the statistical analysis, the Winstat Statistical Analysis System version 1.0 (MACHADO; CONCEIÇÃO, 2003) was used.

Results and discussion

According to Table 2, which shows the germination results as a function of the doses of the insecticide cyantraniliprole, in all evaluated periods, the control presented inferior performance to the other treatments, regardless of the dose. This result can be explained by the fact that some insecticides confer, in addition to the protective effect, physiological effects, helping both in the initial growth and in the development of the plants (DAN *et al.*, 2020).

The fact that the germination of rice seeds is lower at the highest doses (80 and 100 ml/100kg), except in the evaluation without storage, suggests that when storing rice seeds treated with cyantraniliprole there will be a decline in the percentage of germination. This is because this fact is not uncommon, some research results show that certain products, when applied to the seeds of some crops, can, in certain situations, cause a reduction in germination and seedling survival (CRUZ, 2016; 2001). In maize for example, Fessel *et al.* (2003) reported in their study that several insecticides caused a negative effect on their germination and this effect intensified with the extension of the storage period after treatment.

Table 2. Percentage of seedling germination from rice seeds, cultivar IRGA 424 RI treated with different doses of cyantraniliprole, during five storage periods (0; 60; 90; 135 and 180 evaluation periods after seed treatment).

Treatments	**Germination treatments (%)**				
	Evaluation epochs in storage (days)				
	0	**60**	**90**	**135**	**180**
Witness	88 Ca*	89 dA	88 dA	87 dA	86 dB
Ciantraniliprole (10 ml/100 kg)	92 bA	92 cA	91 cA	90 cB	89 cB
Ciantraniliprole (20 ml/100 kg)	92 bA	93 bA	92 bA	90 cB	89 cB
Ciantraniliprole (40 ml/100 kg)	94 bA	93 bA	92 bA	92 bA	91 bB
Ciantraniliprole (60 ml/100 kg)	96 aA	96 aA	95 aA	95 aA	94 aA
Ciantraniliprole (80 ml/100 kg)	95 aA	94 bA	93 bA	93 bA	92 bA
Ciantraniliprole (100 ml/100 kg)	95 aA	93 bA	92 bA	91 cB	91 bB
CV (%)**	1,07				

* Means followed by the same lowercase letters in the columns and uppercase in the row, do not differ from each other by Tukey's test at 5% probability. CV = coefficient of variation **

Bearing in mind that seed treatment is a technique for applying pesticides or the like on seeds in a localized manner in order to carry out phytosanitary control, in this case an insecticide, its primary objective is to control insects. However, as well described by Franco *et al.* (2013) seed treatment will only be successful when the correct dose is applied and if the distribution of the product over the seed surface is homogeneous and does not cause physiological damage to the seed.

The adequacy of the correct dose according to the efficiency of the insecticide in controlling its targets and maintaining the physiological quality of the seeds is a premise when we consider not only the phytotoxicity that these insecticides can cause to seeds and seedlings, but also the environmental impact, due to excess, in addition to the higher cost per kg of treated seed.

According to Grohs *et al.* (2012), it was observed that rice germination with thiamethoxam was 50% higher than the control. Binsfeld *et al.* (2014) studying soybean seeds, found that there was superior performance in germination with the use of products with a bioactivator effect. Thiamethoxam accelerates seed germination by stimulating the activity of enzymes, causing more uniform stands and emergence of seedlings and improvement in initial development (CROSS, 2016).

The treatment of rice seeds with thiamethoxam and lambdacyhalotrin showed an increase in germination, when the test was carried out at temperatures of 10 and 13 ºC the treatment response was more pronounced. Untreated rice seeds show lower germination at low temperatures (ALMEIDA *et al.*, 2021).

In the results of the cold test (Table 3), the treatment with ciantraniliprole at a dose of 60 ml/100 kg of seeds was superior in storage periods of 0, 135 and 180 days, while in storage periods of 60 and 90 days the dose of 60 ml/100 kg did not differ from the dose of 80 ml/100 kg. Regarding the storage period, only the doses of 60 and 100 ml/100kg of seed-maintained germination percentages in the longer storage times (135 and 180 days).

As we can see in Table 3, regardless of the dose of ciantraniliprole, all germination percentages in the cold test were higher in relation to the untreated control, regardless of the storage period. Rice is cultivated in the most diverse environmental conditions, the occurrence of cold is one of the main problems for the cultivation of irrigated rice in the southern region of Brazil, since the vast majority of cultivars in use are of tropical origin. The occurrence of low temperatures, combined with the susceptibility of the materials used, can cause serious damage to the establishment of the crop, reducing the initial stand and consequently favouring the establishment of weeds (MERTZ, 2019).

Resistance to low temperatures is sought in the early stages of the plant (germination/emergence and seedling), with the intention of anticipating sowing and preventing the reproductive stage from coinciding with the onset of cold weather. In this sense, we can consider that the insecticide cyantraniliprole favoured overcoming this stress, something similar to what happens with the insecticide thiamethoxam also in the rice crop (ALMEIDA *et al.*, 2013).

According to Almeida *et al.* (2021), the treatment of seeds with some insecticides activates several physiological reactions, such as the expression of membrane proteins, which interact with several defence mechanisms, allowing the plant to better withstand adverse conditions. Rice seeds treated with thiamethoxam and stored reduced the rate of loss of germination and vigor when compared to untreated seeds.

Table 3. Percentage germination of seedlings from rice seeds, after the cold test, cultivar IRGA 424 RI treated with different doses of cyantraniliprole, during five storage periods (0; 60; 90; 135 and 180 evaluation periods after treatment of seeds).

Treatments	**Cold Test (%)**				
	Evaluation epochs in storage (days)				
	0	**60**	**90**	**135**	**180**
Witness	86 cA*	86 cA	85 cA	84 cB	84 cB
Ciantraniliprole (10 ml/100 kg)	91 bA	91 bA	90 bA	89 bB	90 bA
Ciantraniliprole (20 ml/100 kg)	90 bA	90 bA	90 bA	89 bB	89 bB
Ciantraniliprole (40 ml/100 kg)	91 bA	92 aA	91 aA	90 bB	90 bB
Ciantraniliprole (60 ml/100 kg)	94 aA	93 aA	92 aA	93 aA	93 aA
Ciantraniliprole (80 ml/100 kg)	92 bA	92 aA	91 abA	90 bB	90 bB
Ciantraniliprole (100 ml/100 kg)	91 bA	91 bA	90 bA	90 bA	90 bA
CV (%)**			0,89		

* Means followed by the same lowercase letters in the columns and uppercase in the row do not differ from each other by Tukey's test at 5% probability. CV = coefficient of variation **

For the emergence of seedlings in trays (Table 4), except in the storage period of 135 days where the doses of 60, 80 and 100 ml/100 kg did not differ statistically, in the other four evaluated periods the treatment with the insecticide ciantraniliprole, at the dose of 60 ml/100kg of seeds was superior to the others. And when comparing storage times, treatments with ciantraniliprole at doses 10, 40, 60, 80 and 100ml/100kg of seeds did not differ statistically. These data corroborate Almeida *et al.* (2021), where he showed that seed treatment contributes to a slower loss of seed vigor caused by storage when compared to untreated seeds.

Table 4. Seedling emergence from rice seeds, cultivar IRGA 424 RI treated with different doses of cyantraniliprole, during five storage periods (0; 60; 90; 135 and 180 evaluation periods after seed treatment).

Treatments	Emergency (%)				
	Evaluation epochs in storage (days)				
	0	**60**	**90**	**135**	**180**
Witness	87 dA*	87 dA	86 dA	85 cB	85 cB
Ciantraniliprole (10 mL/100 kg)	90 cA	90 cA	89 cA	89 bA	90 bA
Ciantraniliprole (20 mL/100 kg)	91 bA	91 bA	90 bA	89 bB	89 bB
Ciantraniliprole (40 mL/100 kg)	92 bA	92 bA	91 bA	91 bA	91 bA
Ciantraniliprole (60 mL/100 kg)	94 aA	94 aA	93 aA	93 aA	93 aA
Ciantraniliprole (80 mL/100 kg)	92 bA	92 bA	91 bA	92aA	91 bA
Ciantraniliprole (100 mL/100 kg)	91 bA	91 bA	91 bA	92 aA	91 bA
CV (%)**			1,29		

* Means followed by the same lowercase letters in the columns and uppercase in the row do not differ from each other by Tukey's test at 5% probability. CV = coefficient of variation **

Insecticide treatment, in addition to promoting the control of pathogens and pests, can favour the emergence and development of seedlings when exposed to stress (BALARDIN *et al.*, 2011). Most insecticides used in seed treatment have systemic action on the plant and, when exposed to the soil, are released from the seed due to their low vapor pressure and water solubility. Thus, as the product is absorbed by the roots, its action gives the plant an adequate period of protection against insects (SILVA, 2018).

Conclusion

Treatment with ciantraniliprole regardless of dose and storage period provided better results in germination evaluations, cold test and emergence in relation to untreated seeds. For germination, the dose of 60 ml/100kg of seeds performs better than the others when the seeds are submitted to storage.

Treatment with ciantraniliprole helped to overcome the effect of low temperatures on germination in the cold test. For the emergence of seedlings, the treatment with the insecticide at a dose of 60ml/100kg of seeds was superior to the others, except for the storage period of 135 days.

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