Chemical treatment, different conditions and storage periods on the physiological quality of rice seeds

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ABSTRACT

Seed is considered as the main input in agriculture, which must have physiological quality to reach its maximum productive potential. In addition, the germination test is one of the parameters to analyze the viability and represent the emergence in the field when sowing is carried out in ideal soil conditions. Therefore, this work aims to evaluate the germination percentage of rice seeds (Oryza sativa) cultivar IRGA 431 CL from the year 2021 with and without seed treatment, stored for different periods in prototypes of vertical silos and big bags. The experiment was carried out at the Post-Harvest Laboratory of the Federal University of Pampa – Alegrete Campus, where they remained for 6 (six) months. The germination tests were set up every 30 (thirty) days throughout the storage period, in the laboratory of the Cooperativa Agroindustrial de Alegrete LTDA. The design to be used was completely randomized (DIC), three-factorial (2 x 2 x 6) for the factors seed treatment levels, type of storage and storage period. There are twenty-four treatments, each with four replications, totaling ninety-six experimental units + initial analysis + final analysis (composed of 4 replications for the use or not of seed treatment). The factors were composed of two seed treatments (T1: with seed treatment; T2: no seed treatment), two storage levels (A1: prototype mini silo; A2: prototype big bag) and six different storage periods (P1: thirty days; P2: sixty days; P3: ninety days; P4: one hundred and twenty days; P5: one hundred and fifty days and P6: one hundred and eighty days). After setting up the germination tests, the counts were performed on the fifth and fourteenth day after insertion in the incubator. The results indicated that there was a reduction in the percentage of vigor and germination throughout the storage period, under the presence of seed treatment, regardless of the type of storage used. Storage in impermeable packaging is less harmful to the physiological quality of the seeds, and the percentage of germination was higher than 80% in all treatments, in accordance with Normative Instruction No. 45 of 2013 for commercialization. From the first 30 days, the portion of treated seeds started to have a decrease in the physiological quality of rice seeds.

Keywords: Germination, Post Harvest, Agricultural Inputs, Store.

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INTRODUCTION

The seed is considered the input with the highest added value, as it carries genetic technology of the varieties, being produced within strict quality standards that provide greater performance in the field, maximizing the action of other inputs, such as fertilizers and pesticides (EMBRAPA, 2021).

The maximum yield potential is a direct result of the physiological quality of seeds, and one of the main parameters for its verification is through the analysis of viability and vigor according to the instructions of the Rules for Seed Analysis – RAS (BRASIL, 2009).

Viability, determined by the germination test, seeks to evaluate the maximum germination of the seed, showing the development of the essential structures of the embryo, demonstrating its aptitude to produce a normal plant under favorable field conditions (BRASIL, 2009). On the other hand, vigor comprises a set of characteristics that determine the physiological potential of seeds, being influenced by the environmental and management conditions during the pre- and post-harvest stages (VIEIRA & CARVALHO, 1994).

In the field, as an alternative to protect the seed in the early stages of the crop, from sowing to seedling emergence, the use of seed treatment has increased due to the greater occurrence of attack by microorganisms and soil pests in the last harvests. Seed treatment is the technique of applying an agricultural pesticide, nutrients (micro/macro) or inoculant on the seeds, with the objective of carrying out phytosanitary control (EMBRAPA, 2013).

The action of insects is one of the main factors that affect rice crops (MARTINS et al., 2004), since the losses caused by them vary between 10 and 35% of production (BENTO, 1999; MARTINS et al., 2000; MARTINS et al., 2004). In addition, according to Costa Lima, in 1936 one of the most harmful insects before the entry of water into the crop is the "rice root worm" or rice weevil (*Oryzophagusoryzae*). As a preventive control measure, rice seed treatment is used.

Although the ambient conditions of the warehouse can be artificially controlled, the cost for such control in large storage areas is generally not economic, which means that almost the entire volume of seeds produced in Brazil is stored at ambient temperature and relative humidity (RAZERA et al. 1986).

The type of packaging used in the packaging of seeds during storage is also of relevant importance to maintain their viability and vigor, seeds preserved in packages that allow exchanges of water vapor with atmospheric air can absorb water under high relative humidity of the air, deteriorating easily (CROCHEMORE, 1993). Therefore, the longevity of stored seeds is also influenced by the type of packaging used for their packaging (POPINIGIS, 1985; WARHAM, 1986).

In this context, the objective of this study was to evaluate the germination and vigor of rice seeds (*Oryza sativa*) from the year 2021 with and without seed treatment, stored for 180 days in prototypes of vertical silos and big bags.

METHODOLOGY

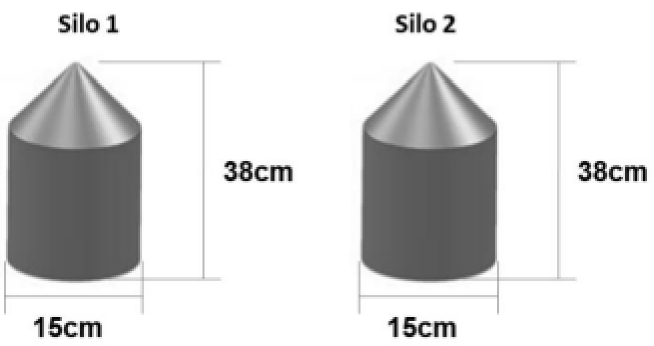
The experiment was carried out at the Post-Harvest Laboratory of the Federal University of Pampa – Alegrete Campus, where they remained for 6 (six) months. According to Köppen and Geiger, the climate of the region is classified as Cfa (humid subtropical climate). The temperature here averages 19.6 °C. The laboratory is located at geographical coordinates 29o 47' latitude, 55o 46' longitude and 95 m altitude.

The design was completely randomized (DIC), tri-factorial (2 x 2 x 6) for the factors seed treatment levels, type of storage and storage period. Twenty-four treatments were used, each with four replications, totaling ninety-six experimental units + initial analysis + final analysis (composed of 4 replicates for the use or not of seed treatment).

The factors were composed of two seed treatments (T1: with seed treatment; T2: no seed treatment), two storage levels (A1: prototype mini silo; A2: prototype big bag) and six different storage periods (P1: thirty days; P2: sixty days; P3: ninety days; P4: one hundred and twenty days; P5: one hundred and fifty days and P6: one hundred and eighty days). The cultivar used for rice seeds (*Oryza sativa*) from the year 2021, used is IRGA 431 CL.

Seed storage was carried out in vertical silo prototypes and big bag prototypes. In the prototypes of vertical silos, the seeds were separated into two batches each weighing 13.5kg (Figure 1). In addition, in Silo 1 lot 1 was packed with seed treatment and in Silo 2 lot 2 without seed treatment.

Figure 1 - Dimensions of vertical silo prototypes.



Source: Adapted from Dubal (2021).

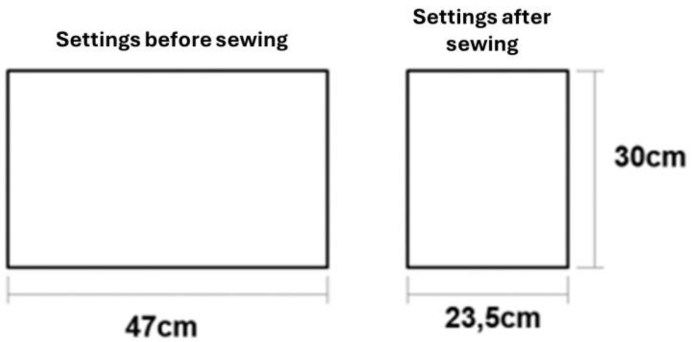
Throughout the time in which the seeds were stored in the prototype vertical silos, temperature and relative humidity readings were taken once a day between 10:30 am and 2:00 pm, every day until the end of the experiment.

For this verification, the MAX-MIN THERMO HYGRO digital hygrometer with an extension cable inserted between the grain mass was used. The device records the minimum and maximum temperature and relative humidity automatically with Accuracy: ± 1 °C (or ± 2 °F) or 5%.

In the big bag prototypes, the seeds were separated into six lots of 1kg each corresponding to each period in which the analyses were performed. Thus, a total of 12 big bag prototypes were obtained between the batch with and without seed treatment.

To make the big bag prototypes, 1 big bag 120x90x90cm with a closed base (raffia) was used, in which 12 pieces of 30x47cm were removed and then sewn (Figure 2). The material of the big bag prototype was prolipropyland with a grammage of 190g/m2.

Figure 2 - Dimensions used to make the big bag prototypes.



Source: Authors.

Seed treatment was carried out as recommended by the package insert of the available chemicals: Permit Star = 0.625 at 1 L/100kg of seeds; Cruiser Opti = 0.625 to 1 L/100kg of seeds. An intermediate value of 0.8125 L/100 kg of seeds was adopted, thus, for 20 kg of treated seeds 0.1625 or 162.5 ml. In this way, for

The seed treatment was carried out in two stages, where each 10kg will be used 0.08125 liters or 81.25ml for each of the products.

The estimated syrup for each 10kg of seed was 200 ml, of which 37.5 ml was composed of water for a better coating of the seeds.

The germination tests were set up every 30 (thirty) days throughout the storage period, in the laboratory of the Cooperativa Agroindustrial de Alegrete LTDA.

For the germination test, an initial analysis was carried out, based on the following evaluations. Thus, 1kg of seed was taken for each factor, homogenized and quartered, obtaining a representative sample of work.

The following analyses were performed every 30 days for each treatment on 400 seeds, divided into 4 sub-samples of 100 seeds, for each replication with a total of 16 mounted tests per analysis. The seeds were distributed on germitest paper and moistened with the equivalent of 2.5 times the mass of the paper, then to reduce evaporation, the tests were inserted into plastic bags and, later, directed to the BOD incubator for germination at a temperature of 25 oC.

The seedlings considered normal were evaluated 14 calendar days after the assembly of the test and the results were expressed in %, according to the recommendations of the Rules for Seed Analysis (BRASIL, 2009). The result was expressed as a percentage made by the average of the four subsamples of 100 seeds.

For vigor, the seedlings considered normal were counted, evaluated at 5 calendar days after the assembly of the test, and the results were expressed as percentages, according to the recommendations of the Rules for Seed Analysis (BRASIL, 2009). The result was expressed as a percentage made by the average of the four subsamples of 100 seeds.

The results were analyzed using the Sisvar 4.0 software. Analysis of variance was performed at 5% probability. Subsequently, a joint analysis was performed to identify the presence of interaction between the treatments. Treatments that showed significant interactions were analyzed using Tukey's test.

RESULTS AND DISCUSSION

Table 1 shows the results of the analysis of variance with F-test values for the physiological quality variables of the rice grains examined. The results obtained indicate statistical significance at 5% probability, with coefficients of variation of 5.54% and 3.24%, respectively, for vigor and germination. Thus, it is possible to observe that there was low variability of the statistical data, characterizing their homogeneity.

Table 1 - Analysis of variance for physiological quality of stored grains.

FV	GL	Medium Square	
		SAW	**GE**
Treatment (trat)	1	26766,76*	900,37*
Storage (arm)	1	133,01ns	2,04ns
Período (for)	5	391,18*	46,61*
trat*arm	1	55,51ns	3,37ns
trat*per	5	477,23*	61,60*
arm*per	5	111,43*	40,86*
trat*arm*per	5	76,63*	24,35*
Repetition	3	8,42	30,29*
Error	69	18,06	8,85
CV (%)		**5,54**	**3,24**

*Significant at 5% probability; NS - not significant; VF – variation factor; CV – coefficient of variation; Gl – degrees of freedom; VI – vigor; GE – germination.

Source: Authors.

Table 2 shows the results of the percentages of vigor of rice seeds over 180 days in the different treatments.

Table 2 - Vigor of rice seeds stored for 180 days in prototype silo and big bag, submitted or not to seed treatment. Alegrete, 2023.

Period Stored	**With seed treatment**		**No seed treatment**	
	Silo	Big Bag	Silo	Big Bag
Initial	74,75 B a α	74,75 B a α	91.25 A to α	91.25 A to α
30	69,25 B a α	66,00 B a βα	95.50 A to α	93.25 A to α
60	57,75 B a β	57,75 B a β	92.00 A to α	90.25 A to α
90	42,75 B to Ø	40,75 B to Ø	94.75 A to α	96,00 A to α
120	67.50 B to α	71.75 B to α	90.50 A to α	96,00 A to α
150	65,00 B a βα	67.25 B to α	92.75 A to α	93.50 A to α
180	46,50 B b Ø	68,50 B to α	92.75 A to α	94.25 A to α
Final	53.25 B to β	53.25 B to β	95.40 A to α	95.40 A to α

Means followed by the same letter do not differ statistically from each other by Tukey's test at 5% probability of error, uppercase letter in the line compares the type of treatment within each type of storage over the stored period, lowercase letters in the line compare the types of storage as a function of the type of seed treatment over the stored period, and, Greek letters in the column compare the periods stored for each type of seed treatment within each type of storage.
Source: Authors.

Analyzing the average results of physiological quality of the grains when comparing the percentages of vigor, analyzing the type of seed treatment (with or without) within the type of storage over the 180 days stored, it can be noted that the treated seeds presented the lowest averages when compared to those without seed treatment.

Statistically for Silo Prototype, the differences were significant, where treated seeds presented averages between 42.75 and 74.75%, while untreated seeds presented higher values in the range of 90.5 to 95.5%.

Similar to the previous results, in the Big Bag Prototype, the differences were also significant, where treated seeds presented averages between 40.75 and 74.75 %, while untreated seeds presented higher values in the range of 90.25 to 96%.

When observing the averages for the breakdown of the type of storage as a function of the seed treatment over the stored period, in both storages only the seeds with storage treatment showed a difference at 180 days, with vigor percentages of 46.5 and 68.5%, respectively for Silo Prototype and Big Bag Prototype.

The seeds stored in the silo prototype obtained lower oscillations throughout storage, and there was no significant difference between the vigor percentages. Krüger et al. 2013, studying the physiological quality of seeds for 10 years, noticed that storage in impermeable packaging is less harmful to the physiological quality of seeds, keeping germination values within the standards required for seed commercialization. Therefore, the longevity of the seeds

stored packaging is also influenced by the type of packaging used for its packaging (POPINIGIS, 1985; WARHAM, 1986).

When analyzing the stored period in relation to the type of treatment as a function of the type of storage, only treated seeds showed statistical differences for both storages, and the variations observed may have been influenced by the non-homogenization portion of the seed lot when the tests were set up and also a possible mixture of seed lots with different physiological quality.

Although it is considered one of the most efficient methods to ensure the good establishment of the initial seedling stand, research results show that the use of seed treatment can cause a reduction in physiological quality as a function of the time stored (ROCHA et al. 2017).

For Dan et al. (2010), in a study with soybean seeds treated with carbofuran and acephate insecticides for a period of 45 days, they observed that the reduction in the physiological quality of the seeds, conditioned by the insecticides, increases over the storage period of the treated seeds, suggesting that the insecticidal treatment of the seeds be carried out as close as possible to sowing.

In another study developed by Dan et al. (2011), using different insecticides for the treatment of soybean seeds, they showed that there are losses in the physiological quality according to the stored period, reaffirming results already obtained in other studies.

Table 3 shows the results of the germination percentages of rice seeds over 180 days in the different treatments.

Table 3 - Germination of rice seeds stored for 180 days in prototype silo and big bag, submitted or not to seed treatment. Alegrete, 2023.

Period Stored	**With seed treatment**		**No seed treatment**	
	Silo	Big Bag	Silo	Big Bag
Initial	94.25 A to α	94.25 A to α	93.75 A to α	93.75 A to α
30	94.25 A to α	86,75 B b ab	96.00 A to α	93.50 A to α
60	91,50 B a α	91.75 A to α	95.75 A to α	94.00 A to α
90	89,50 B a α	91,25 B a α	95.00 A to α	96.75 A to α
120	92.50 A to α	90,75 B a α	90.75 A to α	96.75 A to α
150	83,00 B a β	82,50 B a β	95.50 A to α	94.75 A to α
180	92,50 B b β	89.75 B to α	94.75 A to α	96,00 A to α
Final	86,25 B a αβ	86,25 B a αβ	95.50 A to α	95.50 A to α

Means followed by the same letter do not differ statistically from each other by Tukey's test at 5% probability of error, uppercase letter in the line compares the type of treatment within each type of storage over the stored period, lowercase letters in the line compare the types of storage as a function of the type of seed treatment over the stored period, and, Greek letters in the column compare the periods stored for each type of seed treatment within each type of storage.
Source: Authors.

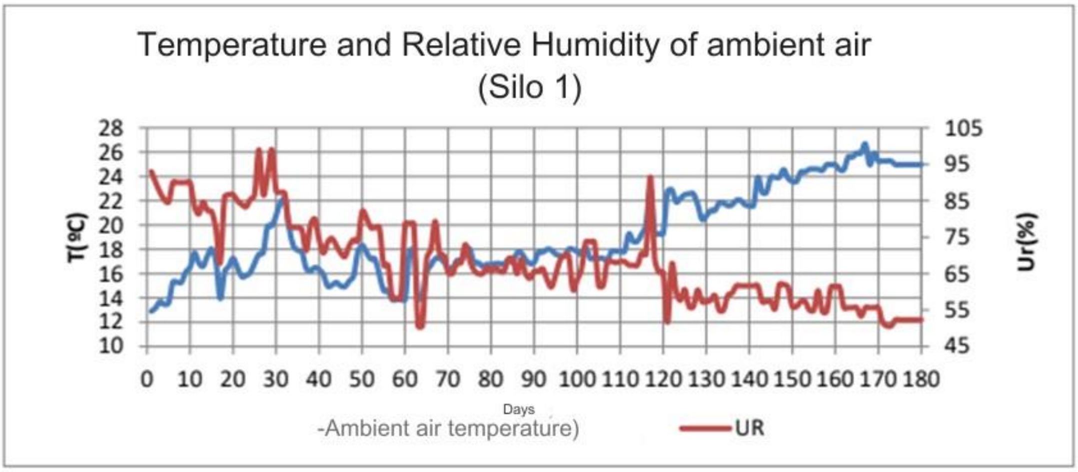
As well as the data obtained for vigor, in germination the averages differed only when the seed treatment was used. However, even with its use, germination averaged above 80% in all treatments. Thus, it is possible to affirm that these seeds germinate in accordance with the provisions of Normative Instruction No. 45 of 2013. In other words, the lot of rice seeds of the 431CL variety is of high quality, which is indispensable to ensure good productivity of the crop in which it will be sown.

In a study, Carraro (2001) showed that the greater the use of certified seeds, the higher the productivity over the years. In addition, according to Embrapa (2013), the guarantee of productivity is a direct result of the genetic, physical, physiological and sanitary quality of the seed.

An example of this, the Seed Analysis Laboratory (LAS) of UDESC in a study analyzed the physiological quality of a total of 81 rice lots produced in Santa Catarina, in the certified and self-use categories, where certified seeds represented 94% of the evaluated lots (CAREGNATO, E. et al. 2019).

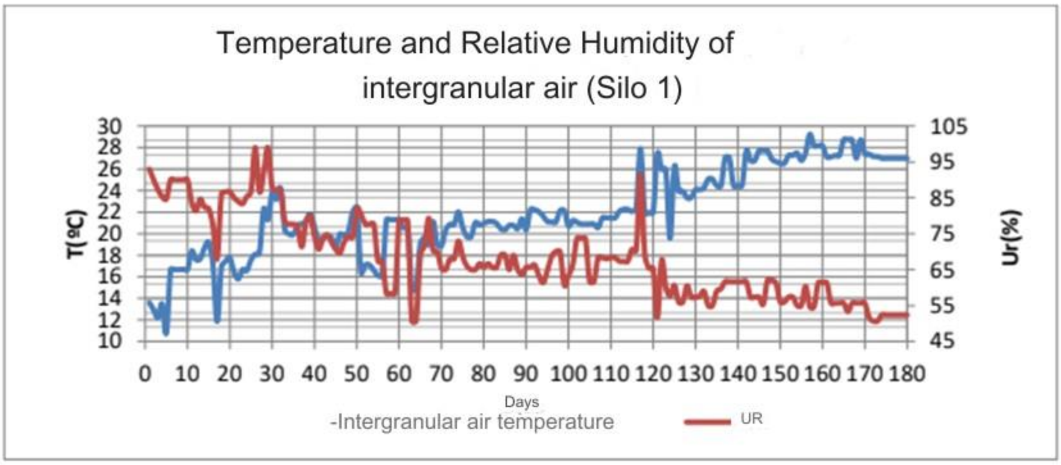
Figures 3, 4, 5 and 6 show the monitoring of the temperature and relative humidity of the ambient air and the intergranular air of the silo 1 and 2 prototypes.

Figure 3 - Monitoring of ambient air temperature and relative humidity Silo Prototype 1.



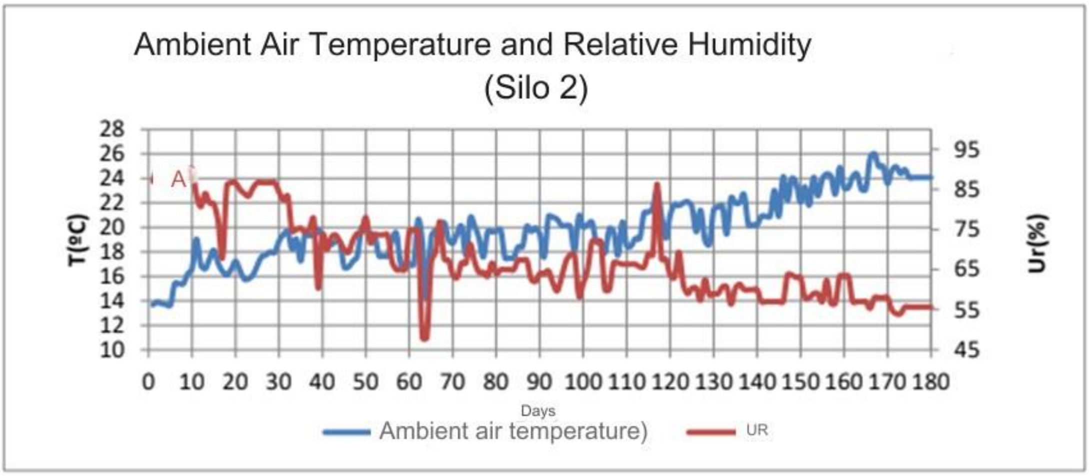
Source: Authors.

Figure 4 - Monitoring of intergranular air temperature and relative humidity Silo Prototype 1.



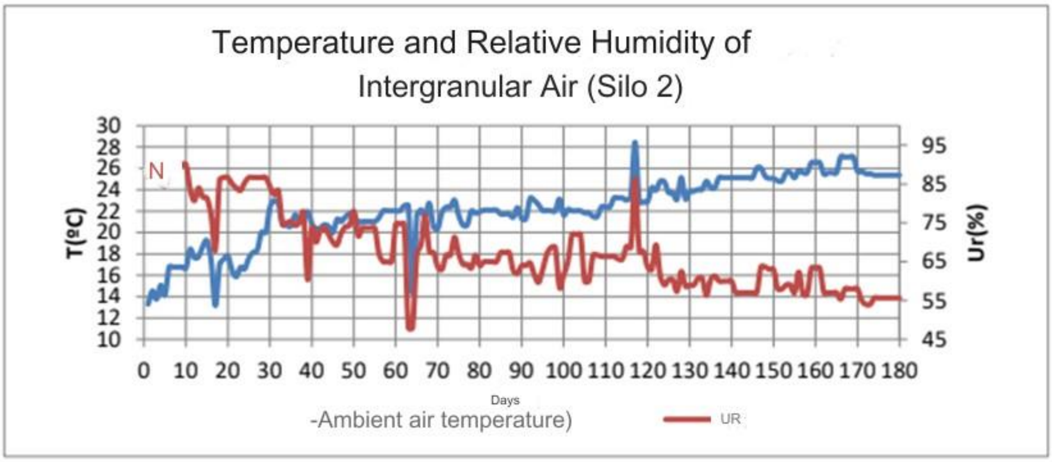
Source: Authors.

Figure 5 - Monitoring of the temperature and relative humidity of the ambient air Silo 2 Prototype.



Source: Authors.

Figure 6 - Monitoring of intergranular air temperature and relative humidity Silo 2 Prototype.



Source: Authors.

In the results obtained, variations in temperature and relative humidity of the ambient air were observed, which influenced the intergranular air conditions. Throughout the storage time, there was an increase in the ambient temperature, which influenced the intergranular temperature, as well as a decrease in the relative humidity, since the two factors have proportionality between them. In addition, such behavior is due to the characterization of the summer season where the experiment was installed, which according to Köppen and Geiger the climate of the region is classified as Cfa (humid subtropical climate) for Alegrete.

Studies indicate that temperature influences the viability and vigor of the seed, interfering with the respiratory process. (MENDES et al., 2009). Thus, Madruga (2010), evaluating the respiratory activity of seeds and enzymatic activity of rice seedlings cultivar BRS 7 Taim subjected to different temperatures for 24 hours, observed that the seeds showed better physiological quality when exposed to 25oC.

According to the results obtained by Nunes (2019), seeking to determine the appropriate conditions to ensure the physiological quality during the storage of soybean seeds, stored for a period of 180 days at temperatures of 15, 25 and 35 °C and packed in different packages, concluded that the temperature of 25 °C kept the germination percentages above the standard, however, it presented lower strength results for all storage systems.

In addition, Marini et al. (2013) studying the changes caused in the physiological quality of rice seeds subjected to different temperatures, relating to seed deterioration, were able to conclude that temperatures higher than 25oC depreciate the physiological quality of rice seeds cultivar Pelota. However, this fact was not observed throughout this experiment, where even with temperatures higher than 25oC there was no significant decrease in vigor and germination percentages.

CONCLUSION

Rice seeds of cultivar 431 CL showed a reduction in the percentage of vigor and germination over the storage period, under the presence of seed treatment regardless of the type of storage used.

Storage in impermeable packaging is less harmful to the physiological quality of the seeds, making it possible to maintain germination within the standards required for seed commercialization.

The seed lot has germination in accordance with the provisions of Normative Instruction No. 45 of 2013, as all the independent averages of the tying presented a value higher than 80%, the minimum percentage required for commercialization.

From the first 30 days, the portion of treated seeds started to have a decrease in the physiological quality of rice seeds.

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