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# The yield and physiological quality of oat seeds subjected to cover with zinc

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**ABSTRACT.** Micronutrients, such as zinc, are important for the metabolic activities that can benefit germination and seed vigor because many soils are deficient in this micronutrient. The objective of this study was to evaluate the influence of coating oat seeds with zinc on the physiological quality and yield of the seeds produced. The experimental design was completely randomized, with a 2 x 5 factorial arrangement of the following, with four replications per treatment: factor A - product 1, 780 g $L^{-1}$ zinc, and product 2, 17 and 600 g $L^{-1}$ nitrogen and zinc, respectively; and factor B - 0, 1, 2, 3 and 4 mL of each product $kg^{-1}$ seed. The results were subjected to an analysis of variance and a means comparison test ($p \leq 0.5$ using Tukey's test). The experimental plots consisted of vases of 30 L situated in the greenhouse of the Plant Science Department, Federal University of Pelotas, Pelotas, Rio Grande do Sul State, Brazil. After harvesting, the yield and physiological quality of the seeds was evaluated based on germination, accelerated aging, cold and field emergence tests. At all of the studied doses, both of the zinc products used to coat the seeds resulted in an increase in the yield and seed germination. The dose of 3 mL of product per kg seed generated the best results.

**Keywords:** *Avena sativa* L., germination, micronutrient, vigor.

## Rendimento e qualidade fisiológica de sementes de aveia branca submetidas ao recobrimento com zinco

**RESUMO.** O experimento foi conduzido em casa de vegetação do Departamento de Fitotecnia, na Universidade Federal de Pelotas, Pelotas, Estado do Rio Grande do Sul, Brasil na safra agrícola 2010. Objetivou-se com o presente trabalho avaliar a influência do recobrimento de sementes de aveia branca com zinco na qualidade fisiológica e no rendimento das sementes produzidas. Os tratamentos consistiram da combinação de dois produtos a base de zinco, em esquema fatorial 2 x 5 (Fator A: produto "A": 780 g $L^{-1}$ de zinco e o produto "B": 17 e 600 g $L^{-1}$ de nitrogênio e zinco, respectivamente; Fator B: níveis de 0, 1, 2, 3 e 4 mL $kg^{-1}$ de semente), totalizando 10 tratamentos, com quatro repetições. O delineamento experimental utilizado foi o completamente casualizado, com quatro repetições. Após a colheita avaliou-se o rendimento e a qualidade fisiológica das sementes produzidas pelos testes de primeira contagem da germinação, germinação, envelhecimento acelerado, teste de frio e emergência em campo. Conclui-se que o zinco fornecido via recobrimento de sementes em aveia branca, em ambos os produtos e doses estudadas, determina aumento de rendimento e de germinação de sementes. A dose de 3 mL de produto $kg^{-1}$ de semente apresenta máximo desempenho.

**Palavras-chave:** *Avena sativa* L., germinação, micronutriente, vigor.

## Introduction

Oat (*Avena sativa* L.), an annual herbaceous plant, is a grain of wide importance because it can be used as food for both humans and animals. Oats have a high economic and social value in the Southern states of Brazil, and the plants are grown during the winter and spring seasons.

Micronutrients are essential elements for plant growth and are required in small quantities (MORTVEDT, 2001). Although the participation of micronutrients in biological processes is not high, the lack of any one element can result in significant reductions in productivity. Such micronutrient problems may occur due to excess phosphorus, promoting zinc and manganese deficiencies, excessive liming, insoluble forms of zinc and manganese, incorporated liming underestimated or inadequately quantity, compromising molybdenum availability, and low levels of soil organic matter, leading to deficiencies of zinc, molybdenum and copper (SFREDO, 2008).

It is estimated that approximately 170 million hectares of soil in Central Brazil, chiefly Cerrado, are deficient in zinc and that approximately 108 million hectares are deficient in boron (LOPES, 1984). Deficiencies were also noted in several other states in Brazil, thus deficiency occurs in Rio Grande do Sul State, in 20.8% of the State land (VOLKWEISS et al., 1983). However, considering that the seed reserve is an important source of zinc, seeds can be treated to correct such deficiencies.

Zinc is important for certain processes relevant to the physiological homeostasis and nutrition of the plant, acting as a structural component or activator of the enzymes that participate in C4 photosynthesis, such as pyruvate carboxylase enzyme. Zinc is also necessary for the production of tryptophan, an amino acid precursor of indole acetic acid, a hormone involved in the plant growth and nitrogen metabolism required to maintain the integrity of biomembranes (MALAVOLTA, 2006).

Nutrients play important roles during the formation, development and maturation of seeds, mainly with regard to the cell membranes and accumulation of lipids, carbohydrates and proteins (SÁ, 1994). Studies involving the use of zinc in oat seeds are emerging in Brazil, and the application of zinc via seeds for winter crops might be a suitable and promising application of micronutrients. Because the amounts of micronutrients required by winter cereals are not high, the difficultly in achieving a uniform application in the field encourages the application via seeds. Such a technique ensures a better uniformity of application and allows the nutrients to be available closer to the root system of the seedlings, promoting greater absorption.

Within the context of these considerations, this study aimed to evaluate the influence of coating oat seeds with zinc on the quality and yield of the seeds produced.

## Material and methods

The study was conducted in the Seed Laboratory and in the greenhouse of the Faculty of Agronomy "Eliseu Maciel", Federal University of Pelotas, Rio Grande do Sul State, Brazil. Seeds from oat cultivar Babarasul were used.

The treatments consisted of two combinations of products based on zinc in a 2 x 5 factorial design (factor A - product "A", 780 g $L^{-1}$ zinc, and product "B", 17 and 600 g $L^{-1}$ of nitrogen and zinc, respectively; Factor B, equal doses at 0, 1, 2, 3 and 4 mL $kg^{-1}$ seed). There were a total of 10 treatments, with four replications. After the application of the products, the seeds were coated with a polymer (Sepiret®) at a dose of 2.5 mL $kg^{-1}$ seed. The proportion of the solution volume was maintained at 8 mL $kg^{-1}$ seed for all of the treatments.

The seeds were treated in the following order of application: nutrients + water and polymer. These products were placed at the bottom of a plastic bag up to a height of approximately 15 cm. Then, 0.20 kg of seeds were placed inside the plastic bag, which was shaken for three minutes; the seeds were dried at room temperature for 24 hours (NUNES, 2005). A total of 12 seeds were placed in each vase (capacity of 15 liters), after emergence, it thinned remaining three plants per vase. The vases were filled with sieved soil that was collected from the A1 horizon of a Haplic Eutrophic Planosol Solodi soil (EMBRAPA, 2006) in Pelotas. The fertilization was based on the results of a soil analysis and the recommendations of the Chemistry and Soil Fertility Committee (CQFS, 2004). Liming was performed thirty days before seeding, and nitrogen, phosphorus and potassium fertilization was performed 14 days before sowing. After seeding, the experimental units were irrigated daily, maintaining the soil near the field capacity.

Manual harvesting was performed during the stage at which two thirds of the spikelets were pale yellow or cream, indicating physiological maturity. The seed quality was evaluated by a germination (G) test performed with four replicates of 50 seeds per experimental unit. The seeds were sown on a paper substrate that was previously soaked in distilled water at a ratio of 2.5 times the mass of dry paper. The paper was rolled and placed in a germination chamber maintained at a temperature of 20°C. The evaluations were conducted at ten days after sowing, according to Regras de Análise de Sementes (BRASIL, 2009), and the results were expressed as the percentage of the normal seedlings. The first count of germination (FCG) was held in conjunction with the germination test and evaluation at five days after sowing. The accelerated aging (AA) test was performed using gerbox-type boxes with wire mesh. A 40 mL aliquot of distilled water was added to the bottom of each box, and the seeds were distributed evenly in a single layer on the screen. The boxes containing the seeds were closed and maintained in an incubator at 41°C for 72 hours. After this period, the seeds were subjected to germination tests and evaluations on the fifth day. A cold test (C) was conducted using four replicates of 50 seeds per experimental unit: seeds sown on rolled paper (as above) were placed in plastic bags, which were then sealed and maintained at a regulated temperature of 10°C for seven days. After this period, the rolled paper units were transferred to a germination chamber and maintained under the same conditions as the germination test and evaluated after five days (CÍCERO; VIEIRA, 1994). We evaluated the percentage of seedling emergence (E) at 21 days after manual sowing at a depth of 2 to 3 cm, with four replications of 50 seeds per experimental unit. The seed yield (SY) was obtained by weighing the harvested seeds, with the seed moisture corrected to 13%. The results were expressed as g plant$^{-1}$.

The experiment consisted of a completely 2 x 5 (products and doses) randomized design, with four replications. The data were subjected to a variance analysis; in presence of significant interaction, have developments needed. The data in percentage form were transformed to the arcsine, and the means were compared using the Tukey test at a 5% probability. WinSTAT - Version 2.0 (MACHADO; CONCEIÇÃO, 2003) was used to perform the statistical analysis.

## Results and discussion

According to the data presented in Table 1, that there was no interaction between the factors “products” and “doses”, as compared to the averages for products “A” and “B” and then compared products averages “A” and “B”. The seeds treated with the products did not differ significantly with regard to the physiological quality, i.e., in first count of germination, germination, accelerated aging, cold and emergence. These results are in agreement with those found by Ohse et al. (2000) who verified that coating rice seeds with zinc did not affect the germination and vigor. Examining rice seeds coated with a zinc source, fungicide and polymer, Funguetto et al. (2010) also did not observe a change in germination. In contrast, Yagi (2006) reported a reduction in the germination percentage of sorghum seeds treated with zinc.

**Table 1.** First count of germination (FCG), germination (G), accelerated aging (AA), cold (C), emergence (E) and seed yield (SY) of oat seeds coated with two doses of zinc.

| Dose (mL kg$^{-1}$) | Product | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A[1] | B[2] | A[1] | B[2] | A[1] | B[2] | A[1] | B[2] | A[1] | B[2] | A[1] | B[2] |
| | FCG (%) | | G (%) | | AA (%) | | C (%) | | E (%) | | SY (g) | |
| 0 | 85 | 84 | 90 | 91 | 81 | 81 | 80 | 81 | 85 | 86 | 23.9 | 20.6 |
| 1 | 86 | 85 | 93 | 92 | 83 | 83 | 83 | 83 | 88 | 87 | 25.5 | 22.3 |
| 2 | 86 | 86 | 95 | 94 | 84 | 83 | 83 | 84 | 89 | 89 | 26.7 | 23.3 |
| 3 | 87 | 87 | 96 | 96 | 85 | 85 | 85 | 85 | 92 | 91 | 28.6 | 24.8 |
| 4 | 83 | 86 | 94 | 94 | 83 | 83 | 82 | 83 | 89 | 89 | 24.8 | 22.5 |
| Average | 85 A* | 85 A | 93 A | 93 A | 83 A | 83 A | 83 A | 83 A | 89 A | 88 A | 25.9 A | 22.7 B |
| VC (%) | 3.9 | | 4.8 | | 4.8 | | 3.9 | | 5.2 | | 16.2 | |

*The means followed by same capital letter in a row in each response variable do not differ by Tukey’s test at a 5% probability. [1]Product 1 “A”: 780 g L$^{-1}$ zinc. [2]Product “B”: 17 and 600 g L$^{-1}$ nitrogen and zinc, respectively.

Product “A”, at 780 g L$^{-1}$ zinc, yielded seeds with a superior performance to product “B”, which has 600 g L$^{-1}$ of zinc; product A has 30% more zinc than product B. Coating the oat seed with product A provided, on average, an increase of 14% in seed yield per plant in comparison to product B.

These results agree with those of Ohse et al. (1999), who observed that the panicle number per rice plant varied depending on the dosage of zinc applied to the seeds, with a maximum estimated number of 5.94 panicles per plant for the optimal dose (0.76 g zinc kg$^{-1}$ seed, equivalent to 114.0 g ha$^{-1}$ of zinc). Conversely, our results disagree with those of Fungueto et al. (2010), who found no difference between doses of zinc for this variable; Orioli Junior et al. (2008) also found no differences in the number of spikelets of wheat after the seeds were treated with zinc.

Based on Figure 1, it appears that there is no interaction between the factors “doses” and “products”.

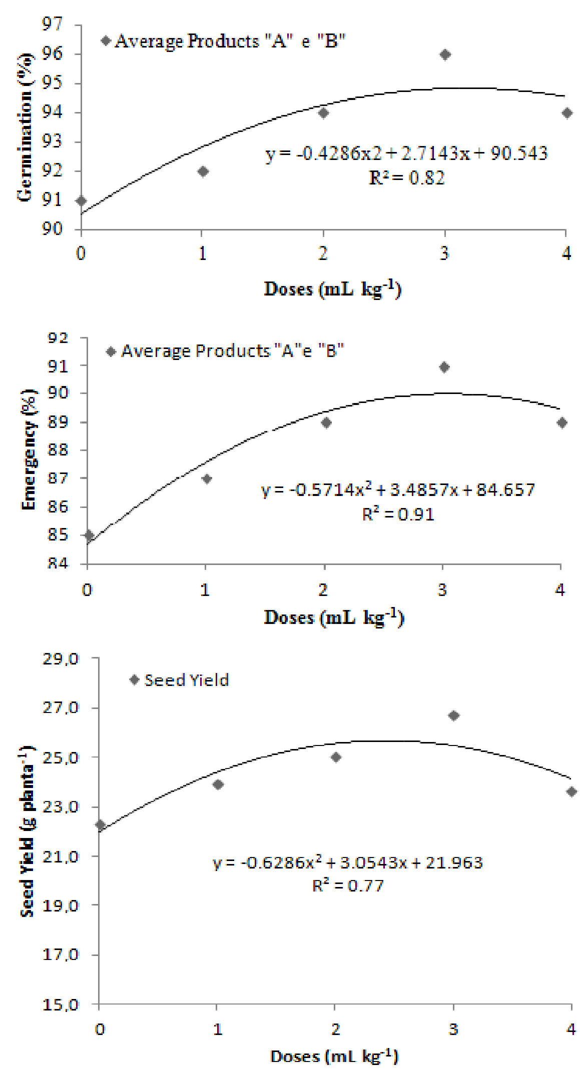


**Figure 1.** Germination, emergency and seed yield of oat seeds treated with two doses of zinc.

However, there was a significant effect of the dose of product "A" and "B" on the germination, emergence and seed yield. It appears that, with an increase in the dose, the germination average of both products up to 4 mL $kg^{-1}$ seed exhibited a quadratic behavior. The control (0 dose) showed an average germination of 91%, whereas the average germination for the 3 mL $kg^{-1}$ doses was approximately 96%. These results indicate that coating the seeds with zinc favored the germination of the seeds. Similar responses were obtained by Slaton et al. (2001) who observed that doses of 1 g zinc $kg^{-1}$ seed (as zinc sulfate) increased the percentage of rice germination by approximately 59% after eight days and approximately 50 % after ten days. The maximum germination was obtained at a dose of 2.8 mL $kg^{-1}$ seed.

In relation to the emergence, a quadratic behavior was observed with a dose of 3 mL $kg^{-1}$ seed, with an increase in the percentage of seedlings emerging by approximately seven percentage points compared to the zero dose. A tendency of a decrease in the emergence was noted at the higher doses, with a maximum emergence obtained at a maximum dose of 3.3 mL $kg^{-1}$ seed.

The seed yield showed a quadratic behavior, and the dose of 3 mL $kg^{-1}$ seed resulted in a superior performance. These data agree with the results of Funguetto et al. (2010) who obtained a linear increase in the number of grains per panicle and grain weight per plant with increasing levels of zinc, showing an increase of 29% in the number of grains per panicle and 21% in the grain weight per plant, at a maximum dose of 0.77 g of zinc $kg^{-1}$ seed (compared to a zero dose). Similarly, Oliveira (2007) found an increase in the yield of soybeans after treatment with Acaplus (8.5% Zn + 7% N) at a dose of 2 mL $kg^{-1}$ seed and an increase in the corn yield when treated with Awaken® at dose of 1.6 mL per 18 kg of seeds. It appears that the maximum seed yield was obtained at the dose 2.4 mL $kg^{-1}$ seed.

## Conclusion

For the products and doses studied, zinc provided via the coating of oat seeds resulted in an increase in the yield and seed germination. The dose of 3 mL product $kg^{-1}$ seed provided the maximum performance.

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