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Germination test in carioca bean seeds chemically treated with the use of alternative substrates

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Abstract
The use of quality seeds is a key element for the success of carioca bean (*Phaseolus vulgaris* L.) cultivation. To avoid or reduce various problems of importance to the crop, it facilitates the achievement of the cultivar's productive potential and the reduction of production costs. Thus, the objective of this work is to identify which conditions are suitable for evaluating germination in bean seeds using different substrates. The treatments were subjected to a temperature of 25 °C analyzing five substrates (germitest® paper; germitest® paper + sand; germitest® paper + soil; germitest® paper + charcoal and germitest® paper + vermiculite). The chemicals used were: Cruiser 350 FS, Fortenza 600 FS, Standak Top and Avicta complete. The most suitable substrate for installing the germination test in beans depends on the type of product and active ingredient of the seed treatment. Emphasizing the substrates germitest® + vermiculite and germitest®+soil, those that best performed positive characteristics when in contact with the chemical treatment.
Keywords: Physiological quality, TSI, *Phaseolus vulgaris* L., productivity.

Teste de germinação em sementes de feijão carioca tratadas quimicamente com uso de substratos alternativos

Resumo: O uso de sementes de qualidade é um elemento chave para o sucesso dos cultivos do feijão carioca (*Phaseolus vulgaris* L.). Por ser uma forma de evitar ou reduzir problemas diversos de importância para a cultura, facilita a obtenção do potencial produtivo da cultivar e a redução de custos de produção. Tendo assim, como objetivo esse trabalho identificar quais as condições adequadas para avaliação da germinação em sementes de feijão através da utilização de diferentes substratos. Os tratamentos foram submetidos a temperatura de 25 °C analisando cinco substratos (papel germitest®; papel germitest® + areia; papel germitest® +solo; papel germitest® + carvão e papel germitest® + vermiculita). Os produtos químicos utilizados foram: Cruiser 350 FS, Fortenza 600 FS, Standak Top e Avicta completo. O substrato mais indicado para instalação do teste de germinação em feijão depende do tipo de produto e ingrediente ativo do tratamento de sementes. Destacando os substratos germitest® + vermiculita e germitest®+solo, os que melhor desempenharam características positivas quando em contato com o tratamento químico.
Palavras-chave: Qualidade fisiológica, TSI, *Phaseolus vulgaris* L., produtividade.

Introduction

Beans (*Phaseolus vulgaris* L.) are one of the most produced crops in Brazil and in the world. Its importance to the main agricultural holdings is due to the food and nutritional safety factor based on the high protein content of its grains, which makes it one of the main sources of protein in the human diet. In addition to presenting cultural relevance in the cuisine of different countries and cultures (Toledo *et al.*, 2019; Barbosa; Gonzaga, 2017).

Beans are a food rich in nutrients, such as carbohydrates, proteins, and fats and when combined with other nutritional sources, it

becomes an important ally for the diet (FARIAS *et al.*, 2017). In Brazil, traditional food is based on rice and beans and mixtures that include other vegetables and animal derivatives such as meat, eggs, and cheese (FERREIRA *et al.*, 2017).

The consumption of this legume is part of the cultural identity of Brazilians, its cultivation is widespread, and its agronomic characteristics mutually studied, although beans vary in sizes, flavors and colors depending on the region (FERREIRA *et al.*, 2017).

According to Conab (2020), the planted area of common bean (*P. vulgaris* L.) in Brazil, in 2019, had a setback in relation to the 2017/2018 harvest, reaching only 2.86 million tons, a reduction of little more. of 11.4% compared to the previous crop, impacted by the drought in the main producing regions.

The seed stands out for being the most significant input in the context of productivity and for it to be considered of high quality it must have adequate sanitary, physical, genetic, and physiological characteristics (FRANCE NETO *et al.,* 2016). These characteristics are essential for plants to express their full potential and increase the final yield of the crop.

For both untreated and treated seeds, the standardized quality test required by the Ministry of Agriculture, Livestock and Supply (MAPA) for the seed trade is germination. However, the germination test is carried out under ideal conditions of humidity, temperature, substrate, light and oxygen, a fact that does not match the field reality. It is a standardized test, as it has a wide possibility of repeating results, within reasonable tolerance levels, if the instructions established in the national Seed Analysis Rules (BRAZIL, 2009) are followed, as well as international ones, such as ISTA and AOSA.

The use of certain substrates has a great influence, because, depending on the type of material used, factors such as structure, aeration, water retention capacity and degree of pathogen infestation can vary from one to the other. Thus, differences may occur between the results if there is no standardization of the methodology in relation to the substrate, considering the level of seed vigor and the presence of some chemical treatment (GALLO *et al.,* 2018).

In this context, there are still doubts about the correct way to evaluate the germination of the species, since the results obtained with the traditional methodology are not always reproducible, therefore, the present study aimed to identify the appropriate conditions for evaluating the germination in bean seeds with different substrates.

Material and Methods

This work was carried out at the Seed Analysis Didactic Laboratory “Flavio Rocha” at Faem/UFPEL. Conducted using a completely randomized design, in a 5x5 factorial scheme (five substrates and five treatments). The means obtained were subjected to analysis of variance (MACHADO; CONCEIÇÃO, 2005) and the statistical analysis was performed with the aid of the statistical package WinStat, the mean test was given by the Tukey test, at a 5% significance level ($p \leq 0.05$).

Carioca bean seeds of the cultivar IPR Siriri were used, the seeds were industrially treated with the following products: Cruiser 350 FS, Fortenza 600 FS, Standak Top and complete Avicta according to table 1.

Table 1. Commercial products, doses, and volumes of final syrup for each seed treatment in the carioca bean crop. FAEM/UFPel. Capão do Leão, RS, 2020.

Treatments	*Commercial name*	*Active ingredient*	*Product type*	*Commercial Product Dose*	*Dose (mL/100 kg of seeds)*
1	Witness	-	-	-	-
2	Cruiser 350 FS	Tiometoxam	Insecticide	200 g.i.a/L	300 ml
3	Fortenza 600 FS	Ciantraniliprole	Insecticide	60 g.i.a/L	500 ml
4	Standak Top	Estrobilurinas (Piraclostrobina), Benzimidazol (Tiofanato Metílico) e Pirazol (Fipronil).	Insecticideand Fungicide	-	200 ml
5	Avicta Completo	Abamectina	Insecticideand Nematicide	-	500 ml

Substrates were used (germitest® paper; germitest® paper + sand; germitest® paper + soil; germitest® paper + charcoal and germitest® + vermiculite). The total amount of seeds per treatment was 200 distributed in four subsamples of 50 seeds.

The germination test was carried out using four replicates of each treatment, containing four subsamples of 50 seeds, only on moistened germitest® type paper rolls with distilled water in the proportion of 2.5 times the weight of the paper. The rollers were placed in germinators at a temperature of 25 °C.

To the treatments that include sand and soil, 17 g of these materials were added homogeneously on the substrate paper of each roll for each treatment. The treatment performed with germitest® paper + charcoal was added 10 g of material, evenly on the substrate paper of each roll for each treatment.

The germination evaluation was carried out at 5 days in the first count and at 9 days as the final count, in which the percentage of normal and abnormal seedlings and non-germinated seeds (hard, dormant, or dead) was determined, obtaining the germination result accordingly, with the Rules for Seed Analysis (BRASIL, 2009).

As for the emergency test, this was performed by sowing 50 seeds per repetition, thus totaling 200 seeds per treatment, these being handled in trays containing sand substrate. The evaluation was carried out at 9 days and 21 days after sowing, determining the number of normal seedlings and expressing the results in percentage.

For the soil emergence test, this was carried out in construction sites, in a Solodic Eutrophic Planosol established in the Centro Agropecuário da Palma, located on the banks of BR 116 near Pelotas-RS. The evaluation was carried out at 9 days and 21 days after sowing.

Results and Discussion

In general, bean seeds showed variable performance, regarding germination, when different substrates were used (Table 2), these being basic components for the germination test. Mainly for treated seeds, the use of substrate together with the preparation of the test is important, as it allows obtaining reliable results, since this test does or does not add value to the seeds in the commercialization stage.

Table 2. Results of the germination test for bean seeds using different substrates. FAEM/UFPel. Capão do Leão, RS, 2020.

TREATMENTS	Germitest®	Germitest® + sand	Germiest® + charcoal	Germitest® + vermiculite	Germitest® + soil
Witness	82 b	85 b	86 b	86 b	87 b
Cruiser 350 FS	84 a	87 a	88 a	90 a	91 a
Fortenza 600 FS	84 a	86 a	87 a	90 a	90 a
Standak Top	85 a	87 a	88 a	90 a	90 a
Avicta completo	82 b	85 b	86 b	89 a	89 a
CV (%)	1.1	1.2	1.1	1.2	1.3

Means followed by the same letter in the column do not differ statistically from each other by the Tukey test for the substrates used at 5% probability.

The treatment with complete Avicta provided the lowest percentage of germination when in contact with the substrates germitest®, germitest® + sand and germitest® + charcoal. Seed treatment can cause degenerative changes in metabolism, as well as trigger a process of restructuring seed cell membranes, causing a reduction in physiological quality (PICCININ *et al.*, 2013).

The substrate germitest® + sand, presented a lower index of dead seeds, but higher for abnormal plants, when compared to the germitest® + vermiculite. When observing the relationship between the use of alternative substrates along with chemical treatment, it is observed that the substrates germitest® + vermiculite and germitest® + soil were the ones that best performed a positive result when in contact with the treated seeds.

According to Figliola (2016), vermiculite is a substrate used with satisfactory results for the germination of bean seeds, as it presents characteristics such as lightness, easy handling, and good water absorption capacity. This substrate does not require daily wetting and thus provides good germination performance of the seeds.

The germitest® + charcoal substrate showed the best performance regarding the initial development of the seedlings. This fact occurs because coal is a by-product rich in potassium. Potassium, unlike nitrogen and phosphorus, does not enter into the formation of any organic compounds in the plant. Its main function is linked to the metabolism of the plant and because of that, it allows the plants to develop faster (MALAVOLTA, 2006).

The use of charcoal substrate in the germination test should be studied, as substrate moisture varies depending on environmental conditions and the presence of nutrients from wood positively affects seedling growth (TOBE *et al.*, 2018). Therefore, as stated by Figliolia (2016), performing analyzes on seeds is of paramount importance for providing information that expresses their physical and physiological quality, and this information can be used for sowing and storage purposes.

For the evaluation of emergence with soil and sand substrates, tested separately (Table 3), it can be observed that both emergences both in tray and in bed showed high performance of the emerged seedlings, with no phytotoxicity or the presence of seedling abnormalities being observed.

Table 3. Results of the emergence test for bean seeds comparing different substrates and chemical treatments. FAEM/UFPel. Capão do Leão, RS, 2020.

TRATAMENTS	Germitest®	Germination in sand (trays)	Emergency on the ground
Witness	82 b	85 b	84 b
Cruiser 350 FS	84 a	87 a	86 a
Fortenza 600 FS	84 a	86 a	87 a
Standak Top	85 a	87 a	87 a
Avicta completo	82 b	85 b	86 a
CV (%)	1.1	1.3	1.5

Means followed by the same letter in the column do not differ statistically from each other by the Tukey test for the substrates used at 5% probability.

For the emergency parameter, the highest values were observed for the seeds tested with the Standak Top chemical treatment, with no significant differences (p>0.05) between the substrates. It was observed in seeds treated with complete Avicta, when testing in trays and in a controlled environment, a greater presence of abnormal seedlings was observed, this fact may have occurred due to excess water, since the irregularity of irrigation can affect some of the most critical phenological stages in production of common bean, such as germination and seedling emergence (DUTRA *et al.*, 2019).

When comparing the substrates tested in different environments, it is possible to observe that the performance of the test in a tray with sand and controlled temperature or in beds at room temperature did not obtain significant differences (p>0.05) when compared to the tests performed with germitest® paper.

Conclusions

The most suitable substrate for installing the germination test in beans depends on the type of product and active ingredient of the seed treatment.

Emphasizing the substrates germitest® + vermiculite and germitest® + soil, the ones that best performed positive characteristics when in contact with the chemical treatment.

As for the emergency test, it can be carried out in trays with sand or in beds in ambient conditions.

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