

*Full Length Research Paper*

## Physiological quality of bean genotypes seeds peanut and xamego treated with fungicides and insecticides

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**Bean is one of the most important crops because it is a staple food. In order to control diseases and pests, the use of fungicides and insecticides in the seed treatment are efficient methods. In this sense, the aim of this study was to evaluate the effect of fungicides and insecticides on physiological quality of bean seeds. The experiment was conducted in a laboratory and greenhouse, and seeds of two genotypes of common bean (Peanut and Xamego) were used. The seeds were treated with the following fungicides: Captan, Fluazinam, Metioram and insecticides: Acefate, Imidacloprid and Thiametoxan. The experiment was arranged in a completely randomized design, with replications and seven treatments. Not treated seeds were utilized as control. The bean seeds treatment of the genotype Peanut and Xamego using insecticide and fungicide did not affect the physiological quality of the seeds. Xamego genotypes shows greater vigor in the laboratory, while the Peanut genotype in the greenhouse, and the treatments do not interfere in the initial growth of the plants.**

**Key words:** *Phaseolus vulgaris* L, germination, phytosanitary treatment, seedling emergence, vigor.

### INTRODUCTION

Bean (*Phaseolus vulgaris* L.) is one of the most important crops in Brazil, which stands out as one of the largest

producers in the world with production in 2016 of 3,328.1 tons, equivalent to an increase of 6.8% in relation to 2014

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**Table 1.** Fungicides, insecticides and dosages used in the treatments of the genotypes of bean seeds.

Treatments	Doses in seeds (g)
Fungicides	
Captan	3.2
Fluazinam	1.0
Metiram	3.0
Insecticides	
Acefate	10.0
Imidacloprid	10.5
Thiametoxan	7.0
Control	0.0

to 2015 harvest while from 2013 to 2014, harvest was 3,302.1 tons which has a planted area of approximately 4,380 hectares (Conab, 2016).

In bean crop, countless pests and diseases negatively interfere in production. Pest and diseases control in seeds, insecticides and fungicides are usually used, some of which may present physiological activity with a tendency to establish vigorous growth and to improve production (Castro et al., 2008). The active ingredients Thiametoxan and Imidacloprid, belonging to the chemical group of neonicotinoids, are systemic substances of insecticidal action (Ávila and Duarte, 2012). The insecticide Acefate belongs to the chemical group of organophosphorus and also presents systemic action.

The insecticides used for seed treatment is an alternative to avoid possible losses due to the soil and aerial plant part pests, which damage young seeds and seedlings (Martins et al., 2009). Therefore, seed treatment protects them against the initial attack of specific pests, being important in the rational use of effective products and prolonged residual action, guaranteeing seedlings stand and initial establishment. Insecticides in most cases can reduce the number of applications after crop emergence (Marchi et al., 2011) which can have protective and physiological effects, helping both the initial growth and the plant development (Dan et al., 2012).

Among the insect pests in stored common bean seeds, the weevil, *Zabrotes subfasciatus* whose eggs are deposited on the grains surface and larvae develops inside the grain, causing cotyledon weight loss, reducing the germination capacity of seed and commercial devaluation (Costa et al., 2014). In addition to controlling insects in the seeds, it is necessary to control fungi. The action of chemical fungicides in the physiological quality of the seed can increase or decrease the seeds germination and vigor (Pereira et al., 2007).

The active ingredient Captan belonging to the chemical

group dicarboximide, Fluazinam to the phenylpyridinylamine group and Metiram to dithiocarbamate are systemic fungicidal substances. Some of the results of the present study have shown the efficiency of seed treatment with fungicides applied in the crops (Cardillo et al., 2017; Oliveira et al., 2016). The main storage fungi, *Aspergillus* sp and *Penicillium* sp, contaminate bean seeds, which cause germination losses, produce toxins and reduce the dry weight of the seeds (Torres and Bringel, 2005). With the absence of initial seed control, it is easier to introduce the fungus in the crop area, consequently, causing losses to the farmer.

Thus, the objective was to evaluate the physiological quality of bean seeds due to fungicide and insecticide treatment.

## MATERIALS AND METHODS

The experiment was carried out in the Laboratory of Seed Analysis (LAS) and in a greenhouse located at the Center of Agrarian Sciences and Engineering of the Federal University of *Espirito Santo* (CCAUE-UFES), in *Alegre-ES*.

Seeds of bean genotypes of the Peanut group and black group (Xamego) from the region's farmers were planted at the *Barro Branco* site in *Rive, Alegre-ES* district. The seeds were harvested in July 2017 and immediately under phytosanitary treatment. They were treated with fungicides and insecticides according to the manufacturers recommendations, with the application of the doses presented in Table 1, followed by homogenization.

Each product was added to the bottom of a plastic bag and scattered to a height of approximately 15 cm. Thereafter, 0.20 kg of seeds were added and shaken for 5 min. Seeds were allowed to dry at room temperature for 24 h. Meanwhile, seeds that were not treated chemically were used as control. In the laboratory the following were analyzed:

**Germination (%):** This was carried out with four replicates in 25 seeds, seeded in a germitest type paper roll, moistened with distilled water three times the mass of the dry paper and kept in growth room at 25°C. The evaluations were performed after five and nine days of sowing, calculating the percentage of normal seedlings (Brasil, 2009) and the results were expressed in percentage of germination.

**Abnormal seedlings (%) and germination speed index:** This involves concomitant determination using the germination test, alongside counting daily the number of seeds with primary root protrusion  $\geq 2$  mm (Maguire, 1962).

**Length of the shoot of seedlings and root length (cm):** They were determined after 9 days of sowing, measuring from the last leaf neck to the apex and from the neck to the tip of the largest root, respectively.

**Total dry matter (mg):** of the seedling, total dry matter were evaluated nine days after sowing, in an analytical balance (0.0001 g), obtaining dry mass and placing seedlings in paper bags, and putting inside a convection oven at 72°C for 72 h. The results were expressed as mg seedling<sup>-1</sup>.

**Table 2.** Germination (%), abnormal seedlings (%), germination speed index of bean seeds of the genotypes Peanut (P) and Xamego (X) treated with fungicides and insecticides under laboratory conditions.

Treatments	Germination (%)		Abnormal seedlings (%)		Germination speed index	
	P	X	P	X	P	X
Captan	96 <sup>bB(1)</sup>	100 <sup>aA</sup>	4 <sup>cdB</sup>	10 <sup>bcA</sup>	11.48 <sup>bB</sup>	17.54 <sup>bA</sup>
Fluazinam	100 <sup>aA</sup>	100 <sup>aA</sup>	6 <sup>bcB</sup>	9 <sup>cA</sup>	22.65 <sup>aB</sup>	24.68 <sup>aA</sup>
Metiram	100 <sup>aA</sup>	100 <sup>aA</sup>	7 <sup>abB</sup>	12 <sup>bA</sup>	23.83 <sup>aA</sup>	24.50 <sup>aA</sup>
Acefate	96 <sup>bB</sup>	100 <sup>aA</sup>	10 <sup>aA</sup>	8 <sup>cB</sup>	23.08 <sup>aA</sup>	24.25 <sup>aA</sup>
Imidacloprid	100 <sup>aA</sup>	100 <sup>aA</sup>	5 <sup>bcB</sup>	10 <sup>bcA</sup>	23.38 <sup>aB</sup>	24.75 <sup>aA</sup>
Thiametoxam	100 <sup>aA</sup>	100 <sup>aA</sup>	9 <sup>aB</sup>	17 <sup>aA</sup>	11.64 <sup>bB</sup>	18.91 <sup>bA</sup>
Control	100 <sup>aA</sup>	100 <sup>aA</sup>	2 <sup>dA</sup>	3 <sup>dA</sup>	12.52 <sup>bA</sup>	13.62 <sup>cA</sup>
CV (%)	0.1		15.19		4.55	

<sup>(1)</sup>Means followed by the same lowercase letters in the column and uppercase in the row did not differ statistically by the Tukey test at 5% probability for each variable.

In the greenhouse the following were analyzed:

Emergence (%): was analyzed and placed in tubes of 53 cm<sup>3</sup> with commercial substrate Mercplant® sowed in 2.5 cm depth, being watered daily according to the crop needs. Evaluations were carried out daily, counting the emerged seedlings and the results were expressed as emergence percentage.

Emergence speed index: this was determined according to Maguire (1962); height (cm), stem diameter (mm), length of the shoot of seedlings and root length (cm) and total dry mass (mg) of the seedlings were obtained after nine days of sowing.

The obtained data were submitted as a test for normality and homogeneity of variance. The analysis of variance and the means were compared to the Tukey test at a 5% probability level. For all analyzes, the statistical program R was used with the ExpDes package (R Core Team, 2017).

## RESULTS AND DISCUSSION

There was a significant interaction between fungicide and insecticides treatments and common bean genotypes (Table 2). The Xamego genotype presented higher values of germination, abnormal seedlings and germination speed index in relation to the Peanut genotype.

Higher germination values were observed for the treatments Fluazinam, Metiram, Imidacloprid, Thiametoxan and control presenting 100% for the Peanut genotype. Fungicides and insecticides did not affect seed germination of the Xamego genotype presenting 100%. Increased number of abnormal seedlings was found for the Xamego genotype (17%) in the treatment with the fungicide Thiametoxan. For germination speed index, higher values were observed for Fluazinam, Metiram, Acefate and Imidacloprid for both genotypes.

These results are important for the use of fungicides and insecticides via seed, since it is a technique capable of eradicating the pathogen from the seed surface and protecting them during germination, especially in infected soils, with decreasing responses as the seeds quality of increases.

In soybean seeds, treatment with Imidacloprid and Thiametoxan insecticides did not affect germination (Tavares et al., 2007; Castro et al., 2008), and in sorghum seeds, there was no reduction in the seed vigor (Vanin et al., 2011). However, in rice seeds with low physiological quality, the seed treatment with rhizobacteria or Thiametoxan increased their physiological potential (Soares et al., 2012). Free radicals provide membrane lipid peroxidation, protein oxidation, and DNA damage. Reactive oxygen species are formed upon the metabolism of xenobiotics to one or more of their reactive intermediates (Delgado, 2006).

The seed treatment using Thiametoxan can favor the absorption and stomatal resistance to lose water, and act as a bioactivator, determining the increase in the percentage of germination, in the emergence, root length and aerial part length, in the dry phytomass; due to transporting through the cells which triggers biochemical reactions. This can significantly improve the seedlings performance under adverse conditions, such as water deficit, soil acidity and salinity, phytotoxic effects of elevated levels of aluminum and temperature, in addition to determining the increase of protein levels and plant enzyme (Almeida et al., 2011; Almeida et al., 2012).

In studies carried out by Castellanos et al. (2017), in bean seeds treated with Thiametoxan during storage, it was verified that doses of the insecticide between 200 and 300 mL 100 kg<sup>-1</sup> showed that seeds obtained good germination and satisfactory vigor expression, with the

**Table 3.** Length of the shoot of seedlings (cm), root length (cm) and total dry mass (mg) of bean seeds of genotypes Peanut (P) and Xamego (X) treated with fungicides and insecticides under laboratory and greenhouse conditions.

Treatments	Length of the shoot of seedlings (cm)		Root length (cm)		Total dry mass (mg)	
	P	X	P	X	P	X
Captan	14.52 <sup>cA(1)</sup>	14.21 <sup>dA</sup>	15.82 <sup>aA</sup>	13.08 <sup>aB</sup>	221.13 <sup>dA</sup>	105.06 <sup>cB</sup>
Fluazinam	15.25 <sup>bcB</sup>	16.82 <sup>bA</sup>	11.58 <sup>bA</sup>	13.05 <sup>aA</sup>	242.51 <sup>aA</sup>	110.29 <sup>bB</sup>
Metiram	13.31 <sup>dA</sup>	13.25 <sup>dA</sup>	11.41 <sup>bB</sup>	13.95 <sup>aA</sup>	225.92 <sup>cA</sup>	102.37 <sup>cB</sup>
Acefate	16.16 <sup>bB</sup>	19.60 <sup>aA</sup>	11.51 <sup>bA</sup>	13.90 <sup>aA</sup>	217.25 <sup>eA</sup>	110.76 <sup>bB</sup>
Imidacloprid	17.96 <sup>aA</sup>	17.20 <sup>bB</sup>	10.75 <sup>bB</sup>	14.85 <sup>aA</sup>	207.15 <sup>fA</sup>	125.60 <sup>aB</sup>
Thiametoxan	12.21 <sup>eB</sup>	14.15 <sup>dA</sup>	16.11 <sup>aA</sup>	13.27 <sup>aB</sup>	236.62 <sup>bA</sup>	109.88 <sup>bB</sup>
Control	15.08 <sup>cA</sup>	15.32 <sup>cA</sup>	17.95 <sup>aA</sup>	12.06 <sup>aB</sup>	208.16 <sup>fA</sup>	110.20 <sup>bB</sup>
CV (%)	3.19		13.14		0.93	

<sup>(1)</sup>Means followed by the same lowercase letters in the column and uppercase in the row did not differ statistically by Tukey test at 5% probability.

potential to be stored under controlled conditions, reducing the germination rate loss over time. This result corroborates with the results found in the present study, in which the insecticides used do not negatively affect seed potential. The occurrence of abnormal seedlings is related to increased seed deterioration (Marcos Filho, 2015). Seeds treated with insecticides and fungicides may be related to deterioration during storage, as well as, the phytotoxic effect of the insecticide product, either applied alone or with fungicide.

The Peanut genotype presented higher values of total dry mass in relation to the Xamego genotype (Table 3). Higher length of shoot of seedlings values of the Peanut genotype were observed for the treatment Imidacloprid (17.96 cm) in relation to the other treatments and Xamego genotype. The Xamego genotype showed a higher value of length of the shoot of seedlings (19.60 cm) for Acefate in relation to the other treatments and Peanut genotype. Larger root lengths were found for Peanut genotype (17.95, 16.11 and 15.82 cm) for the control, Thiametoxan and Captan treatments, respectively, in relation to the other treatments and Xamego genotype. For total dry matter, higher values were observed for Fluazinam for the Peanut genotype (242.51 mg) and Xamego genotype.

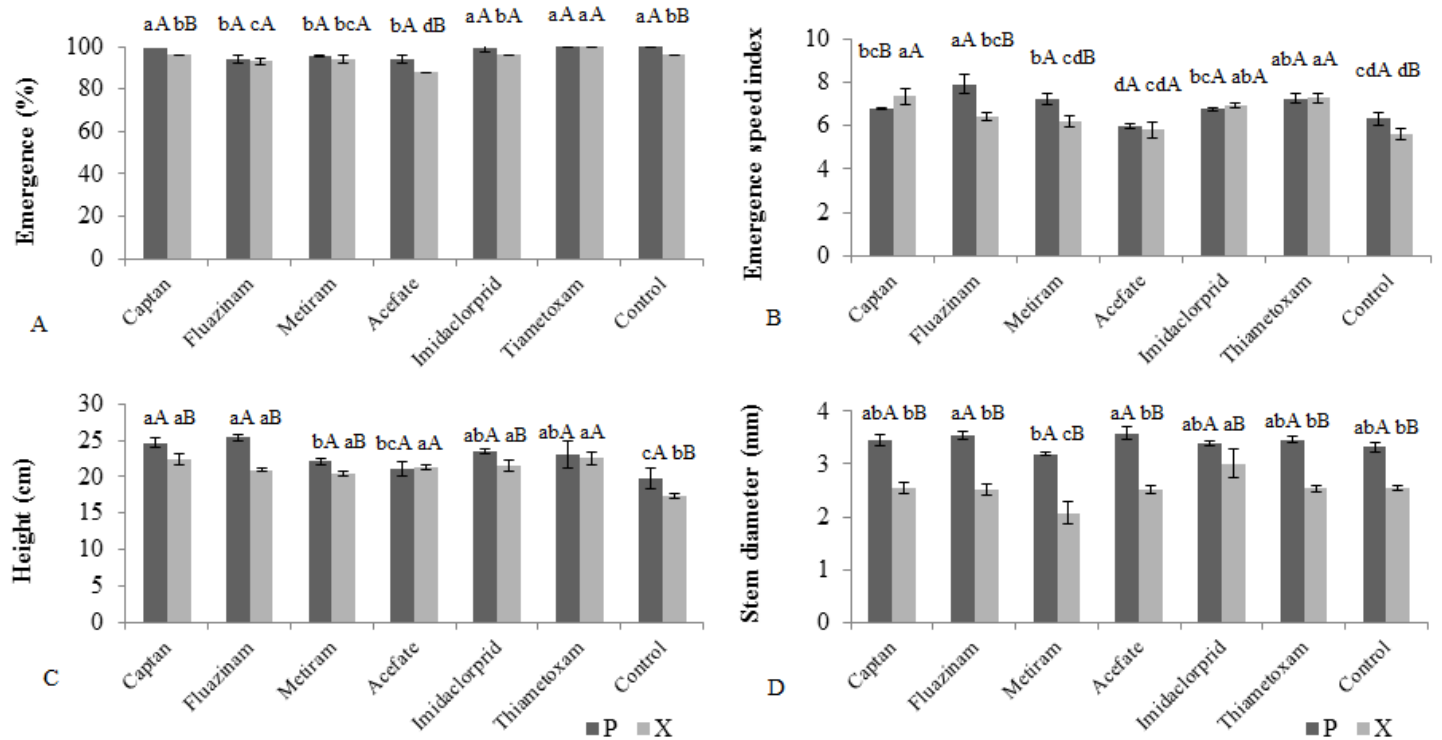
The increase in the length of the shoot of seedlings with the use of Thiametoxan can increase depending on the applied dose and the absorption and stomatal resistance to water loss, according to Castro et al. (2007), therefore favoring metabolism and increasing stress resistance. It can also increase, according to Castro and Pereira (2008), the efficiency in the absorption, transport and assimilation of nutrients.

Considering the growth and accumulation of total dry mass, there was a higher accumulation of dry masses in

Peanut seedlings, and the products did not interfere with the physiological quality. These phases are associated with an increase in organic synthesis, rubisco activity, the amount of chlorophyll and hormones, leading to increase in the photosynthetic capacity in plants (Taiz and Zeiger, 2017). These results can improve the seedlings development due to the seed treatment, and Thiametoxan acting as a bioactivator in providing a larger aerial plant part (Acevedo and Clavijo, 2008; Lauxen et al., 2010). Pyraclostrobin + Metiram applied in tomatoes promoted an increase in the weight and volume (Guimarães et al., 2014).

The fungicide used in the seed treatment may influence in its physiological quality, and vary depending on the chemical used, causing an increase or decrease in the germination and treated seeds vigor (Pereira et al., 2007). However, Silva et al. (2013) verified positive effects on cowpea beans vigor treated with fungicide. In the insecticide treatment, the group carbamates and organophosphates may have a decrease in the physiological potential, due to the formation of free radicals, and exogenous stress produced by insecticides (Soares and Machado, 2007).

There was a significant interaction (treatments x genotypes) for emergence, emergence speed index, height and stem diameter (Figure 1). The Peanut genotype presented higher values of emergence, emergence speed index, height and stem diameter in relation to the Xamego genotype. Behavior checked when seeds were treated with Captan (100%), Imidacloprid (99%), Thiametoxan (100%) and control (100%) were compared to the other treatments. For the emergency speed index, higher Peanut values were observed for Captan (6.78), Fluazinam (7.92) and Thiametoxan (7.25).



**Figure 1.** Emergence (%-A), emergence speed index (B), height (cm-C) and stem diameter (mm-D) of bean seeds of the genotypes Peanut (P) and Xamego (X) treated with fungicides and insecticides under greenhouse conditions. Means followed by the same lowercase letters (fungicide and insecticide treatments) and uppercase (seeds of bean genotypes) did not differ statistically by the Tukey test at 5% probability for each variable.

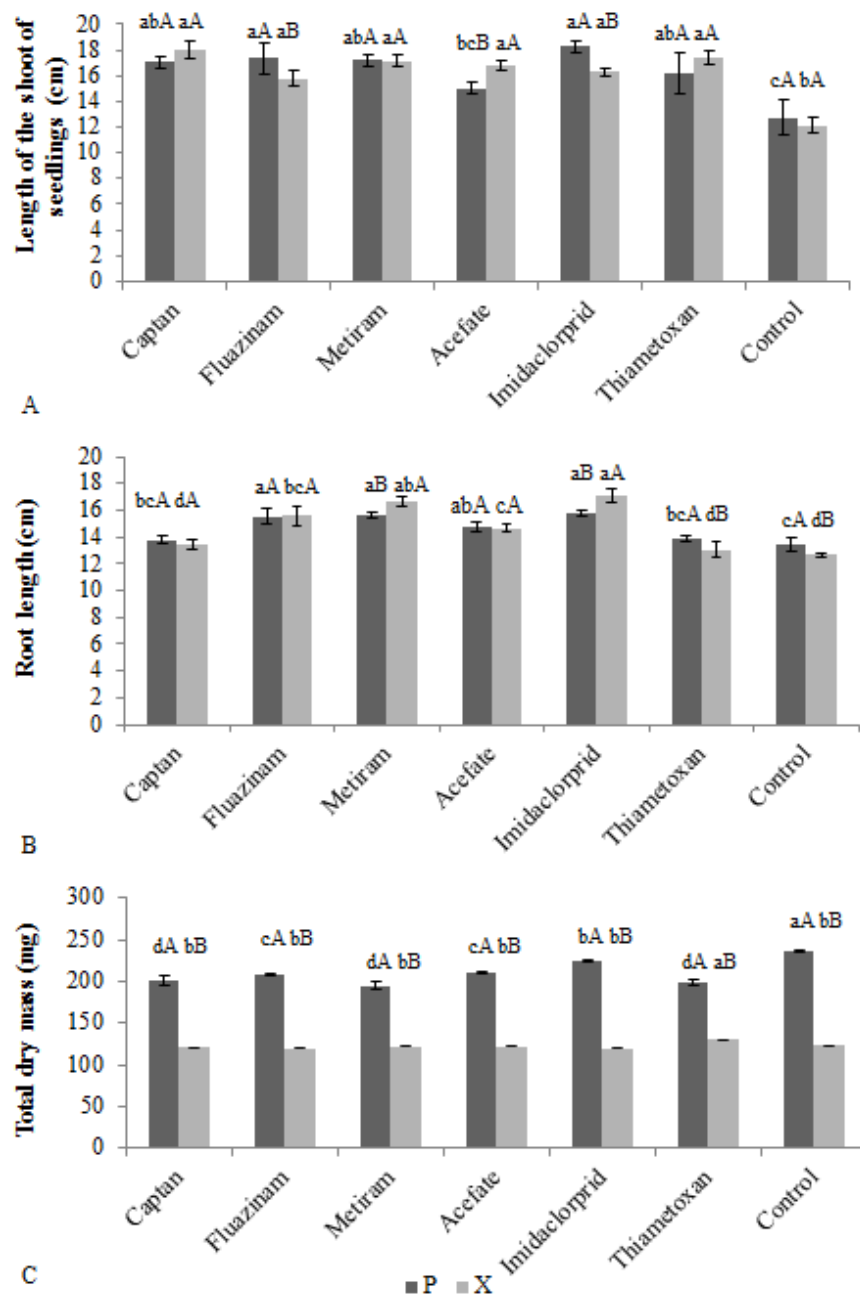
The Xamego genotype presented higher values of emergency and emergence speed index for the treatment Thiametoxan (100%, 7.27, respectively) in relation to the other treatments. The effect of Thiametoxan that presents the neonicotinoid chemical group acts on the germination of the seed producing plants, with greater number of fasciculated roots and of greater extension, at the same time in which a bigger growth of the aerial part is observed, seen in the work that the phytosanitary treatments do not affect the physiological quality of the seeds (Nunes, 2006).

However, seed treatment seeks to control fungi that may potentially cause soil seed deterioration or seedling death, such as *Phytophthora* spp., *Pythium* spp., *Fusarium* spp. and *Aspergillus* spp. (Henning et al., 2010). Bean genotypes showed higher heights for fungicide and insecticides treatments in relation to control. For the stem diameter, the Peanut genotype showed higher values for Fluazinam (3.54 mm) and Acefate (3.58 mm) in relation to the other treatments. Several pesticides, such as organophosphates (Acefate), may exert toxic effects with the induction of oxidative stress (imbalance between production and catalysis of

free radicals) and alteration of the antioxidant system (Braguini, 2005).

The Peanut genotype presented higher values of length of the shoot of seedlings, root length and total dry mass in relation to the Xamego genotype (Figure 2). The Peanut genotype presented higher values of length of the shoot of seedlings for the treatments Fluazinam (17.33 cm) and Imidacloprid (18.26 cm) in relation to the other treatments. For root length, higher values of Peanut bean were observed for Fluazinam (15.56 cm), Metiram (15.65 cm) and Imidacloprid (15.78 cm). The Xamego genotype showed higher root length values for the Imidacloprid treatment (17.09 cm) in relation to the other treatments. The Peanut genotype presented the highest values for the control (237.30 mg) and the Xamego genotype for Thiametoxan (130.10 mg) in relation to the other treatments.

For two groups of bean plants in the treatment with Imidacloprid, insecticide presented higher values for the root length, which according to Horii et al. (2007), may be due to the increase of the energy availability from the hydrolysis via pentose phosphate, for the germination and emergence process. Similarly, there was a better



**Figure 2.** Length of the shoot of seedlings (cm - A), root length (cm - B) and total dry mass (mg - C) of bean seeds of the genotypes Peanut (P) and Xamego (X) treated with fungicides and insecticides under greenhouse conditions. Means followed by the same lowercase letters (fungicide and insecticide treatments) and uppercase (seeds of bean genotypes) did not differ statistically by the Tukey test at 5% probability for each variable.

physiological performance of rice seeds (Almeida et al., 2011), and cotton seeds (Lauxen et al., 2010), when treated with 35 g of active L<sup>-1</sup> ingredient.

The phytosanitary treatments did not interfere in the physiological quality of the seeds, because the quality of the seeds is related to the capacity of the same to

perform its vital functions, such as longevity, germination and vigor. Therefore, the effects on seed quality are generally translated by the increase in the percentage of germination, normal seedlings and vigor, as observed in the work (Kappes et al., 2012).

## Conclusions

The bean seeds treatment of the genotype Peanut and Xamego using insecticide and fungicide did not affect the physiological quality of the seeds. Xamego genotypes shows greater vigor in the laboratory, while the peanut genotype in the greenhouse, and the treatments do not interfere in the initial growth of the plants.

## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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