Original Research Article

Germination and early development of corn seeds under the influence of plant growth regulator

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ABSTRACT

The corn crop has been cultivated throughout the country, with increasing productivity with the help of technology products. There is greater demand and greater use of improved seeds, associated with treatments of fungicides, insecticides and bioregulators. It is believed that the use of biostimulant can improve many plant characteristics, one of which is productivity. The present work had as objective to evaluate the effect of the use of biostimulant applied in the treatment of seeds on the germinability and initial development of maize plants. The biostimulants used in the experiment were the Haf-Plus from the Inesta group, which is an organomineral stimulant and Stromler's Stimulate from Brazil which is a hormonal biostimulant. The experimental design was completely randomized, in a 2 x 4 factorial scheme, with two biostimulants (Stimulate and Haf Plus) in 4 doses (Stimulate: control, 0.5 mL of Stimulate + 1 mL of water, 1.0 mL of Stimulate + 0.5 mL of water, 1.5 mL of Stimulate, and for Haf Plus: control, 0.125 mL + 0.375 mL of distilled water, 0.25 mL of Haf Plus + 0.25 mL of water and 0.5 mL of Haf Plus), with 4 replicates of 10 seeds each. The Stimulate biostimulant was efficient in increasing the root system and aerial part volume.

Keywords: Stimullate, Haf-plus, plant hormone, seed treatment

1. INTRODUCTION

The corn plays a key role in the Brazilian and world agricultural production systems and is considered one of the most important cereals grown and consumed in the world, due to its high production potential, its chemical composition and nutritional value (Dourado Neto et al., 2004).

Seed treatment is a practice used to increase seed performance, especially of high value species such as maize hybrids, as it protects the crop during the early stages of the cycle (Pereira et al., 2008). These gains can be obtained by applying various products to the seeds, such as: fungicide, insecticide, micronutrients and growth stimulators or vegetable bioregulators.

Among the most promising technologies to perform at this stage of the crop is the use of growth regulators, which make the plants more tolerant to stress factors and, consequently, can develop more vigorously in conditions that are not ideal, allowing better chances of to reach their genetic potential of productivity (Castro et al, 2008).

The biostimulants are defined by many authors, such as natural or synthetic substances arising from the mixing of two or more plant bioregulators or of these with other substances (amino acids, vitamins and nutrients), which can be applied directly to the plant or seed treatment (Kiahold et al., 2006). It is sought, therefore, to obtain greater productions and better in the quality of the seeds. Many of these products increase the water and nutrient uptake by plants, as well as their resistance to water stresses and the residual effects of herbicides on the soil, making their use in agriculture increasing (Vasconcelos, 2006).

For better development of the root system, seeking an increase in productivity, there are plant growth regulators and bio-stimulants that stimulate the growth and elongation of the root system, and proved that the density and depth of the roots are fundamental aspects of plant productivity, for good root system is directly related to increased production (Vieira and Santos, 2005). In addition, biostimulants promote greater tolerance to abiotic stresses by producing responses in plant development. These hormones send chemical messages that stimulate plant growth, acting primarily on roots, shoot, and adapt better to their environment (Long, 2006).

The effects on the use of the biostimulant in agriculture are still quite divergent, which shows the need for new research to better evaluate the effects of these products on the cultivation of different crops, since the responses of the plants vary according to the environmental conditions during the development.

Thus, the purpose of this work was to evaluate the germinability of seeds and the initial development of corn plantain after the treatment of the seeds with the bioregulators.

2. MATERIAL AND METHODS

The experiment was conducted at the Laboratory of Seed Technology and Mathematics (LaSeM) of the State University of Mato Grosso - UNEMAT, Alta Floresta Campus – MT. Brazil.

The experiment was organized in a completely randomized design, and the effect of two biostimulants at different germination and initial development stages of a maize cultivar was studied.

The work was organized in a 2 x 4 factorial scheme, and the treatments were composed by the combination of two biostimulants (Stimulate and Haf Plus) in 4 doses, with 4 replicates. Stimulate consists of 0.005% indolebutyric acid, kinetin) 0.009% and gibberellic acid 0.005% and Haf Plus is a fertilizer composed of boron (0.2% or 2.4 g L^{-1}), organic carbon (14% or 168 g L^{-1}), cobalt (0.02% or 0.6 g L^{-1}), copper (0.05% or 0.6 g L^{-1}), iron (0.1% or 1.2 g L^{-1}), manganese (25% or 300 g L^{-1}), molybdenum (0.2% or 2.4 g L^{-1}), nitrogen (5% soluble) and organic matter (25% or 300 g L^{-1}).

The seeds of each treatment with the biostimulants were homogenously mixed with the products in the respective doses of each treatment as shown in Table 1. The biostimulant mixture with the seeds was given in the following proportion: Stimulate - 100 grams of seed for each dosage (D0): without mixing, 0.5 mL of Stimulate plus 1 mL of distilled water (D1), 1 mL of Stimulate + 0.5 mL of distilled water (D2), 1.5 mL of pure Stimulate (D0) D3) (Table 1). And for Haf Plus - 100 grams of seeds for each dosage, being as follows; (D0), dose 0.125 mL + 0.375 mL distilled water (D1), 0.25 mL Haf Plus + 0.25 mL distilled water (D2), and 0.5 mL Haf Plus pure D3).

After the seeds were treated, they were placed on two sheets of germitest paper and covered with another, previously moistened (distilled water) with the ratio of 2.5 times the dry weight. After being rolled, these were identified and taken to Mangelsdorff germination chamber with temperature controlled at 25 °C for 7 days (Brazil, 2009). The counting was not performed at 4 days, in order to avoid any damage or damage of the seedlings formed, considering only the evaluation performed after one week of assembly of the experiment.

After this period, germination%, number of abnormal seedlings, root and aerial system length were evaluated. In addition, the root and aerial area of corn seedlings were determined using the LICOR leaf area meter model LI3100 Area meter.

Table 1. Scheme of the doses and products applied in the treatments.

Doses	Product	
	Stimulate (mL) + water	Haf Plus (mL) + water
D0	0,00	0,00
D1	0,50 + 1,00	O,125+0,375
D2	1,00+0,50	0,25+0,25
D3	1,50 pure	0,50 pure

The data were submitted to analysis of variance and the means were compared by Tukey test at 5% probability, with the help of Sisvar software (Ferreira, 2011).

3. RESULTS AND DISCUSSION

For the variable germination, abnormal seedlings and shoot length, no difference was observed between biostimulants and doses of the products, either in isolation or for interaction between them (Table 2).

Thus, it is possible to verify that both Stimulate and Haf-Plus did not interfere in the germination, number of normal seedlings and length of the aerial part of the corn seeds. Lavezo (2012) also did not verify the effect of the same bioestimulates on the germinative capacity of soybean cultivars. However, the biostimulants provide a significant increase in the number of leaves in the cotton crop, and this fact was attributed to the plant regulators present in the applied product, where the growth of the aerial part was observed, through increased cell division, expansion and differentiation cellular (Sampaio, 1998).

Scarpellini et al. (2003) evaluated biostimulants in the treatment of soybean seeds and did not show an increase in the percentage of germination of the seeds. No results were also observed regarding plant height, plant weight and productivity.

Almeida et al. (2009) reported that biostimulants have the ability to allow greater expression of seed germination potential, with accelerated root growth, increasing nutrient and water uptake by plants.

Table 2. Mean square values % of germination (G%), abnormal seedlings (AP) and aerial part length (CA) of corn seeds submitted to treatments with biostimulants at different doses

Font of Variation	G%	PA	CA
Product (P)	28,1250ns	0,1250ns	51.2578ns
DOSE (D)	11,4583ns	0,0833ns	92.0703ns
P * D	11,4583ns	0,7083ns	313.7370ns
Error	34,3750	0,4583	147.7110ns
C.V. (%)	6,07	18,32	17,24

*** and * significant at 1 and 5% probability respectively by the F. ns test: not significant.*

Regarding the root length of maize seedlings (Table 3), significant interaction between the factors studied was observed (Table 3).

For Stimulate it is noted that doses 3 and 2 were higher than dose 1 and the control, indicating beneficial effect of the product at higher doses. No differences were observed between the doses for root length for the Haf-Plus biostimulant.

Similarly, Vieira et al. (2001) found that the stimulate biostimulant applied through seed treatment showed higher root system growth and total root length for sisal, bean and rice crops and also observed that the application of these products did not obtain significant results regarding phytotoxicity for these cultures.

The Stimulate product has as a special feature to promote greater rooting by the presence of three synthetic hormones, which provide greater cell division, increasing and improving the formation of the root and aerial system, giving greater photosynthetic capacity and greater absorption of water and nutrients. (Stoller, 1998).

When comparing the two products, it is possible to verify that at dose 2 there was a significant difference between the products, where the upper Stimulate, demonstrating its ability to promote root lengthening.

Table 3. Root length of maize seedlings submitted to treatment with biostimulants at different concentrations.

Dose	**Product**	
	Stimulate	**Haf-Plus**
0	119,75 A b	130,50 A a
1	117,00 A b	129,00 A a
2	142,00 A a	111,00 B a
3	147,50 A a	126,50 A a
CV (%)	12,26	

Means followed by the same capital letter in the row and lowercase in the column, do not differ among themselves by the Tukey test at 5% probability.

Regarding the total root area of maize, a significant interaction between the factors was observed (Table 4). For Stimulate, the lower dose applied (D1) caused a decrease in the radicle area of the plants, indicating a negative effect of the product. However, the larger doses D2 and D3 stimulated the root development, however not differing from the control without application of the product. With respect to Haf-Plus, the highest mean was observed at the lowest dose (D1), which differed only from the D2 dose, indicating that the product did not cause a significant increase in the root area of the plants compared to the control without application. In the comparison between the two products, the superiority of the Stimulate from the D2 dose is perceived, indicating, therefore, the superiority of the same in the stimulation to the initial root development of the maize plants.

Table 4. Total area occupied by the root portion of maize seedlings submitted to treatment with biostimulants at different concentrations.

dose	**Product**	
	Stimulate	**Haf-Plus**
0	27,35 A ab	22,55 A ab
1	22,60 A b	29,33 A a
2	36,85 A a	18,53 B b
3	33,83 A a	24,03 B ab
c.v (%)	18,64	

Means followed by the same capital letter in the row and lowercase in the column, do not differ among themselves by the Tukey test at 5% probability.

Ferreira et al. (2007) found a difference in root length of maize cultivars in an evaluation made with four biostimulants, applied through seed treatment, where it obtained a significant difference in root dry mass production. Klahold et al. (2005) did not find significant difference in evaluation with dosages of the same biostimulant for root volume in relation to the control treatments.

Vieira et al. (2001) also found in the research that the biostimulants applied through seed treatment provided greater growth of the root system, as well as in the total root area. Sanders et al. (2001) evaluated the effect of the application of five biostimulants on carrot development (*Daucus carota* L.) and found a significant increase in the number of roots.

For the leaf aerial, there was a significant interaction among the factors, where for the Stimulate, the higher doses (D2 and D3) provided an increase in the leaf area of the plants. Regarding Haf-Plus, no significant difference was observed between doses. The Stimulate proportion increased leaf area development relative to Haf-Plus only at the highest dose (D3), again providing further development.

According to Ferreira et al. (2007), the use of biostimulants via seed treatment and foliar via in maize cultivation leads to an increase in dry root mass and total root system volume, as well as the height of ear insertion, and grain yield, Dario and Baltierri et al. (1998) in one study, observed the efficacy of plant regulators in the maize crop, where the total volume of the root system was positive.

Table 5. Total area occupied by aerial part of maize seedlings submitted to treatment with biostimulants at different concentrations.

Dose	Product	
	Stimulate	**Haf-plus**
0	22,25 A b	19,73 A a
1	20,05 A b	24,80 A a
2	26,15 A ab	21,05 A a
3	30,25 A a	19,18 B a
c.v(%)	17,68	

Means followed by the same capital letter in the row and lowercase in the column, do not differ among themselves by the Tukey test at 5% probability.

According to Vieira and Castro (2004) the product Stimulate had the power to stimulate a greater root development, increasing the nutrients and water absorption by the roots and thus allowing a greater hormonal balance.

Santos and Vieira (2005) verified in their research that the Stimulate product used for treatment of cotton seeds, provided more vigorous seedlings, with greater volume of leaf area and height of the plants, being indicated to obtain higher productivity yield.

4. CONCLUSION

The Stimulate biostimulant at doses D2 and D3 promoted root growth, aerial and total area of maize seedlings.

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