(DOI): 10.5935/PAeT.V7.N2.03
This article is presented in English with abstracts in Spanish and Portuguese
Brazilian Journal of Applied Technology for Agricultural Science, Guarapuava-PR, v.7, n.2, p.25-32, 2014

Cientific Paper

Effect of biostimulants and sowing depth on the emergence of seedlings and initial growth of the Guarani cultivar of castor beans

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Abstract

The aim of this study was to evaluate the effect of two biostimulants and the sowing depth over the germination of seeds, emergence of seedlings and initial growth of the cultivar Guarani of castor bean. On the experiment of biostimulants effect, the treatments were constituted by two biostimulants (Bioradicante and Ecormon) and 5 evaluation seasons (35, 40, 45, 50 and 55 days after the sowing), with 3 repetitions. In order to evaluate the effect of sowing depth we used 4 sowing depths, with four repetitions. On the effect experiment of biostimulants, we observed that the seeds treated with Bioradicante and Ecormon obtained lower germination percentage of seeds in comparison to control. On the effect experiment of sowing depth, the sowing depths of 2 and 4 cm led to higher germination percentages, 80.55% and 69.44%, respectively. The sowing depth of 2 cm presented greater emergence speed rate and a higher germination percentage of seeds, for the Guarani cultivar.

Keywords: *Ricinus communis*; biostimulants; sowing depth

Efecto de bioestimulantes y de la profundidad de siembra en la emergencia de las plántulas y crecimiento inicial de ricino cultivar Guaraní

Resumen

El objetivo de lo estudio fue evaluar el efecto de dos bioestimulantes y de la profundidad de siembra en la germinación de semillas, emergencia de las plántulas y el crecimiento inicial dela cultivar de ricino Guaraní. En el experimento los tratamientos fueran constituidos de dos bioestimulantes (Bioradicante y Ecormon) y cinco momentos de evaluación (35, 40, 45, 50 y 55 días después de la siembra) con 3 repeticiones. La profundidad de siembra fue evaluada en cuatro profundidades y con cuatro repeticiones. Para evaluar el efecto de la profundidad de siembra de 4 profundidades de siembra se utilizaron, con cuatro repeticiones. En el experimento se observó que las semillas tratadas con Bioradicante y Ecormon obtuvieran maior porcentaje de germinación de las semillas en comparación con el control. En el experimento del efecto de la profundidad de siembra, la siembra en profundidade de 2 y 4 cm, propiciaran porcentajes de germinación mas elevado, 80,55% y 69,44%, respectivamente. La profundidad de siembra de 2 cm mostró una mayor tasa de velocidad de emergencia y un mayor porcentaje de germinación de las semillas, para el cultivar Guarani.

Palabras clave: *Ricinus communis*; bioestimulantes; profundidad de siembra

Efeito de bioestimulantes e da profundidade de semeadura na emergência de plântulas e crescimento inicial da mamoneira da cultivar Guarani

Resumo

O objetivo deste trabalho foi avaliar o efeito de dois bioestimulantes e da profundidade de semeadura sobre a germinação de sementes, emergência das plântulas e o crescimento inicial da cultivar Guarani da mamoneira. No experimento os tratamentos foram constituídos por dois bioestimulantes (Bioradicante e Ecormon) e 5 épocas de avaliação (35, 40, 45, 50 e 55 dias após semeadura), com 3 repetições. A siembra fue evaluda da cuatro profundiades a profundiade de semeadrua foi

Recived at: 11/02/14. Aceppted for publication: 30/07/14.

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avaliada em quatro profundidades e com com quatro repetições. Observou-se que as sementes tratadas com Bioradicante e Ecormon obtiveram menor porcentagem de germinação das sementes em comparação com a testemunha. No experimento efeito da profundidade de semeadura, as profundidades de de 2 e 4 cm, propiciaram maiores porcentagens de germinação, 80,55% e 69,44%, respectivamente. A profundidade de semeadura de 2 cm apresentou maior índice de velocidade de emergência e uma maior porcentagem de germinação de sementes, para a cultivar Guarani.

Palavras-chave: *Ricinus communis*; bioestimulantes; profundidade de semeadura

Introduction

The castor bean (*Ricinus communis* L.), belonging to the family *Euphorbiaceae*, is an oilseed of high socioeconomic value that has gained prominence due to its rusticity and good adaptation to adverse conditions of soil and climate, elevated production and high content of oil in its seeds (RIBEIRO et al., 2009; SANTOS et al., 2011). Currently, the castor bean cultivation has attracted the interest of governments and researchers in projects that seek its rational cultivation, aiming the utilization of the oil extracted from the seed on the industry, which has a great chemical versatility (DINIZ et al., 2009).

Despite the socioeconomic importance that the castor bean cultivation represents, it still presents a slow germination process of seeds and seedling development, which can be influenced by a series of factors such as the agronomic cultivar and edaphoclimatic conditions. The germination can be slow, surpassing three weeks, which leads to higher susceptibility to pathogens and stresses caused by the environment. Thus, it becomes relevant to study alternative methods that favor a more uniform and faster germination (MENDES et al., 2009).

A cultivation practice that could be used for improving the performance of castor bean crops is the application of biostimulant products. The biostimulants are products that can reduce the fertilizer use and increase the plant's production and the resistance to stresses caused by temperature and water deficit (CASTRO and VIEIRA, 2001; ABRANTES et al., 2011).

Another factor that can interfere on the castor germination is the sowing depth. The sowing must be done at a depth enough to facilitate the nutrient absorption and the plant sustention, providing a fast and uniform germination, with minimum reserve expenses and periods of susceptibility to pathogens, during the emergence of seedlings. The sowing made too deep hinders the seedling emergence and increases the period of susceptibility to pathogens. On the other hand, shallow sowing can facilitate the attack of predators or damages derived from irrigation (MARCOS FILHO, 2005).

Considering the need for cultivation practices that favor the seedling emergence and the initial growth of castor bean, this study aimed to evaluate the effect of application of two biostimulants and of different sowing depths over the seed germination, seedling emergence and initial growth of the Guarani castor bean cultivar.

Material and Methods

The experiments were set on the experimental station at the Federal University of Tocantins, University Campus of Gurupi (11º43'45"S; 49°04'07"W; and average altitude of 300 m). The soil used in the experiment was classified as dystrophic red-yellow Latosol of medium texture. The chemical analysis of the soil presented the following composition: pH (H_2O) = 5.5; $H^+ + Al^{3+}$ = 4.0 $cmol_c\,dm^{-3}$; Ca^{2+} = 0.6 $cmol_c\,dm^{-3}$; Mg^{2+} = 0.1 $cmol_c\,dm^{-3}$; P (extrator Mehlich 1) = 0.9 mg dm^{-3}; K^+ = 0.04 mg dm^{-3}; organic matter = 15 g Kg^{-1}; CTC = 4.74 $cmol_c\,dm^{-3}$ and V% = 16.4%.

Effect of biostimulants on the seedling emergence and initial growth of the Guarani cultivar

The sowing was conducted in polyethylene sacks with volume of 800 cm^3 and as substrate we used a mixture of soil and cattle manure, on the proportion of 2:1. The experimental design used was in randomized blocks, in factorial scheme. The treatments consisted in two biostimulants (Bioradicante e Ecormon) and 5 evaluation seasons (35, 40, 45, 50 and 55 days after the sowing), with 3 replicates.

The biostimulants were applied directly over the seeds before the planting. The seeds stayed in contact with the products during a period of 1 hour. We used a dosage of 100 mL of each biostimulant for 50 Kg of seeds. Five seeds per bag were sown and the thinning was conducted after 21 days of the sowing (DAS), leaving one plant per bag.

We used two biostimulants (Bioradicante and Ecormon). The Bioradicante is an organomineral fertilizer stimulant of the root system and the plant shoot; its composition contains amino acids, manganese and zinc sulfates, boric acid, ammonium molybdate and iron citrate. The Ecormon is an organomineral fertilizer formulated based on seaweed extract (*Ascophyllum nodosum*), molybdenum and phosphorous acid. The Ecormon stimulates the fruit development and corrects molybdenum deficiency. The seaweed extract is composed by natural phytohormones such as auxins, cytokinins and gibberellins.

We evaluated the characteristics of germination percentage, plant height, stem diameter, foliar area, stem fresh mass, leaf fresh mass, leaf dry mass, stem dry mass and root dry mass. The stem diameter was measured at 2 cm of the soil surface with a steel digital caliper rule. The foliar area was calculated through the equation: $AF = 0.2439 \times (P + T)^{2,0898}$; where AF, P and T correspond to foliar area (cm²), main vein length and average of the side vein length, respectively. For determining the dry mass of the leaf, stem and root, a sample was placed in a greenhouse of forced circulation at 70ºC, until constant mass.

Effect of the sowing depth on the seedling emergence and initial growth of the Guarani cultivar

The castor seeds of Guarani cultivar were planted in polyethylene sacks with volume of 800 cm³. The experimental design used was of randomized blocks in four sowing depths (2, 4, 6 and 8 cm), with 4 replicates. We made the thinning 21 days after the planting, leaving one plant per vessel.

The following characteristics were evaluated at 75 days after the sowing: germination percentage, emergence speed rate, foliar area, plant height, stem diameter, leaf fresh mass, stem fresh mass, leaf dry mass, stem dry mass and root dry mass. For the calculus of emergence speed rate (IVE) we conducted daily observations of the number of germinated plants until its number became constant. For this calculus we used the following formula: (MAGUIRE, 1962); where IVE = emergence speed rate; E_i = number of emergences that occurred each day; and T_i = time (days). The foliar area, the stem diameter, fresh and dry mass were calculated using the methods described earlier.

Statistical analysis

The data were subjected to variance analysis and regression analysis. In the qualitative factor we applied the Tukey test and in the quantitative factor we adjusted regression equations. The statistical analysis was performed with the aid of the computational system SAEG (System for Statistical and Genetic Analyses) (RIBEIRO JÚNIOR and MELO, 2009).

Results and Discussion

Effect of biostimulants on the seedling emergence and initial growth of the Guarani cultivar

The germination percentage of the seeds was reduced with the use of biostimulants Bioradicante and Ecormon (60%) and, thus, the use of biostimulants did not favor the seed germination of the Guarani cultivar of castor. In the control treatment the germination percentage of the seeds was of 70%. FERREIRA et al. (2007) evaluated the effect of the biostimulant Stimulate, on the development of *Passiflora edulis* seedlings, concluding that the biostimulant applied on the seeds promoted significant increases on the emergence percentage and on the seedling development.

We verified that there was difference between the treatments only on the foliar area characteristics, stem fresh mass and leaf dry mass, on the last season of sample (Table 1)

On the variable of foliar area, we found that the biostimulant applications provoked a reduction of the foliar area in the Guarani cultivar of castor, on the last season of evaluation. On the treatment with the Bioradicante biostimulant, we adjusted the quadratic model and on the others we adjusted the linear regression model. According to the adjusted model on control, we obtained a foliar area increment rate of 4.5393 $cm^2\ day^{-1}$, reaching, on the last evaluation season, 171.33 $cm^2\ plant^{-1}$ (Table 1).

As for the leaf fresh mass variable, we observed, with the Bioradicante biostimulant, the major growth rate, 0.0796 $g\ day^{-1}$, which turned into 4.55 $g\ plant^{-1}$, 55 days after the sowing (Table 1).

Regarding the variables of stem fresh mass and leaf dry mass, we observed that in the treatment with Bioradicante, we obtained a significantly inferior value to the control, and the Ecormon, on the last sampling season (Table 1).

On the stem fresh mass variable, in all treatments, we adjusted the linear regression model. On control treatment, we obtained the highest rate of accumulation in the stem fresh mass (0.0973 $g\ dia^{-1}$), reaching, on the last sampling season, 2.77 $g\ planta^{-1}$ (Table 1).

As for the root dry mass variable, we observed higher growth rate with the biostimulant Ecormon, 0.0636 g day^{-1} (Table 1). SILVA et al. (2009), working with the use of the biostimulants Stimulate and Forth Seed, associated with phosphorus doses on bean cultivation, verified that the biostimulants caused a reduction in the final dry mass of bean plants.

COSTA et al. (2008) evaluated the use of biostimulants on the production of watermelon seedlings and found, based on the evaluated characteristics (seedling height, dry mass of the shoot, root dry mass and root length), that the biostimulant Fertiactyl GZ promoted higher seedling growth. LIMA et al. (2006) evaluated the foliar application of biostimulant on cotton crop and verified that

Table 1. Average values, regression equations and determination coefficients of two biostimulants (Bioradicante- B, Ecormon- E and control- T), on five sampling season, of the Guarani castor cultivar. Gurupi-TO.

	Sampling season (days after sowing)						
	35	**40**	**45**	**50**	**55**	**Regression equations**	**r^2**
				Height			
B	5.41a	5.58a	8.08a	8.58a	8.50a	Y = -1.0017 + 0.1833 EP	0.83
E	6.16a	7.16a	7.91a	7.25a	9.42a	Y = 1.6583 + 0.1317 EP	0.75
T	5.75a	6.41a	6.91a	8.33a	9.75a	Y = -1.4917 + 0.1983 EP**	0.95
				Stem diameter			
B	0.50a	0.58a	0.56a	0.62a	0.63a	Y = 0.2433 + 0.0073 EP	0.79
E	0.45a	0.50a	0.53a	0.63a	0.68a	Y = 0.020 + 0.012 EP**	0.97
T	0.50a	0.53a	0.53a	0.60a	0.62a	Y = 0.2867 + 0.006 EP**	0.92
				Foliar area			
B	105.90a	107.57a	118.60a	136.80a	117.23b	Y =-128.835+ 10.1227EP - 0.1009EP2	0.59
E	86.75a	109.12a	119.64a	135.67a	150.62ab	Y = - 18.4859 + 3.0856 EP**	0.99
T	92.31a	94.71a	108.76a	161.48a	172.23a	Y = -78.3296 + 4.5393 EP**	0.89
				Leaf fresh mass			
B	3.09a	3.11a	3.95a	3.95a	4.66a	Y = 0.1730 + 0.0796 EP	0.90
E	2.79a	3.47a	4.19a	4.20a	4.40a	Y = 0.2851 + 0.0785 EP	0.86
T	3.04a	3.17a	3.,60ª	3.61a	4.33a	Y = 0.8459 + 0.0602 EP	0.89
				Stem fresh mass			
B	0.89a	1.41a	1.67ª	1.68a	1.73b	Y = - 0.2709 + 0.0389 EP	0.77
E	0.83a	1.38a	1.69ª	1.70a	1.80a	Y = -0.5433 + 0.045 EP**	0.81
T	0.95a	1.23a	1.51ª	2.60a	2.70a	Y = -2.5796 + 0.0973 EP**	0.92
				Leaf dry mass			
B	0.54a	0.64a	0.85ª	1.00a	0.76b	Y = - 4.,2194+0.2104 EP – 0.0022 EP2	0.81
E	0.41a	0.69a	0.88ª	1.13a	1.30a	Y = -1.0995+ 0.0441 EP	0.99
T	0.52a	0.63a	0.82ª	1.18a	1.26a	Y = -0.9397 + 0.0406 EP	0.95
				Stem dry mass			
B	0.15a	0.19a	0.28ª	0.37a	0.40a	Y = - 0.3436 + 0.0138 EP	0.98
E	0.10a	0.20a	0.26ª	0.36a	0.42a	Y = -0.4563 + 0.0161 EP	0.99
T	0.40a	0.17a	0.25ª	0.38a	0.50a	Y = 4.0164 – 0.1764 EP + 0.0021EP2	0.85
				Root dry mass			
B	0.85a	0.88a	1.33ª	1.52ª	1.63a	Y = - 0.7314 + 0.0439 EP	0.93
E	0.67a	0.90a	1.41ª	1.61a	1.90a	Y = -1.5638 + 0.0636 EP	0.98
T	0.81a	0.79a	1.06ª	1.67a	1.83a	Y = -1.3944 + 0.0584 EP	0.90
				Specific foliar area			
B	194.87a	166.11a	137.90a	136.50a	153.32a	Y = 259.179 – 2.2542 EP	0.55
E	218.96a	158.19a	137.87a	119.70a	116.13a	Y = 369.917 – 4.8833 EP	0.85
T	176.41a	149.00a	133.72a	138.33a	141.23a	Y = 220.661 – 1.6205 EP	0.57

Averages followed by the same letter on the column in each variable do not differ between them by the Tukey test (P > 0.05).

the biostimulant did not influence on the cotton production neither did it interact with the nitrogen fertilization.

The Specific Foliar Area (AFE) is the morphological and anatomical component of the leaf area ratio (RAF), because it relates the surface with the own mass of dry matter of the leaf. At the growth beginning, the leaves constitute strong drains and receive great part of the substances derived from the photosynthesis. However, with the plants having their heights defined, the assimilatory system tends to stabilize and the dry mass continues to grow, this way, it occurs a decrease of the AFE with the plant's ontogeny. Plants that present low RAF have a more active drain for its products of assimilation and, thus, higher photosynthesis rate (CASTRO et al., 1999; BENINCASA, 2003; RADIN et al. 2004).

The AFE decreased continuously during the experiment period in all treatments. The highest decrease rate of the AFE was found with the biostimulant Ecormon, - 4.8833 $cm^2 g^{-1}$, moving from 199.00 $cm^2 g^{-1}$ 35 days after the sowing to 101.34 $cm^2 g^{-1}$ 55 days after the sowing (Table 1).

Since we found positive results in other cultures with the application of biostimulants, the use of biostimulants on the castor cultivation must be better evaluated with the conduction of further experiments, aiming to propitiate a faster initial development of castor plants.

Effect of the sowing depth on the seedling emergence and initial growth of the Guarani cultivar

We verified that with the increase of the sowing depth occurred a reduction of the germination percentage of seeds and of the speed emergence rate. We observed that the increase of the sowing depth raised the number of days for the emergence, which interfered on the characteristics evaluated in this study.

We also found that the sowing depths of 2 and 4 cm propitiated higher germination percentages, 80.55% and 69.44%, respectively. The sowing depths of 6 and 8 cm propitiated lower germination percentages, 38.89% and 36.10%, respectively. The seedling emergence depends not only on the energy contained in the endosperm or the cotyledon, but also on the sowing depth (HACKBART and CORDAZZO, 2003).

The sowing depth of 2 cm provided the highest speed emergence rate (1.32), when compared with the other depths of 4, 6 and 8 cm, which obtained speed emergence rates of 1.10, 0.61 and 0.59, respectively. The increase of the physical barrier provided by the deeper layers (6 and 8 cm) was probably crucial for the increase of average time of emergence and, consequently, for the decrease of the emergence speed rate.

The germination speed is a good index for evaluating the establishment of a species in a certain environment, since the fast germination is a species characteristic, whose strategy is to establish itself on the environment as fast as possible, availing favorable environmental conditions. The emergence speed is associated with the temperature fluctuations at day and night, which favor, mainly, the seeds sowed on lower depths (MARTINS et al., 1999; MAIA et al., 2004).

On the variable of seedling height, we observed a tendency of reduction of the seedling height with the increase of the sowing depth. According to the adjusted model, we found, at the depth of 2 cm, a 18.23 cm height, turning into 14.60 cm at the depth of 8 cm (Table 2).

In relation to the variable of foliar area, we found that there was an increase on the foliar area, as we increased the sowing depth, and on the depth of 8 cm the plants reached 167.67 cm^2 $plant^{-1}$ (Table 2).

As for the variables of leaf fresh mass, leaf dry mass and root dry mass, we observed the same increase tendency on the values of these variables with the increase of the sowing depth. According to the model adjusted on the MFF variable, the lowest value found in this variable was on the depth of 4.28 cm (3.22 g) and the highest value on the depth of 8 cm (4.41 g) (Table 2). The fact that the plants present higher values in these variables, when sowed in deeper pits, can be attributed to the fact that probably on biggest depths the soil presents higher humidity, which is an essential factor to the plant growth.

Other studies also evaluated the sowing depth on the development of different cultures. SOUSA et al. (2007) worked with seeds of *Moringa oleifera* and concluded that the lowest planting depth provided the seedlings a better response for the emergence percentage, IVE and seedling height. GROTTA et al. (2008) evaluated the influence of the sowing depth and soil compaction over peanut productivity, concluding that the lowest depths were more favorable to the culture's development of peanut.

Table 2. Regression equations and determination coefficient of the variables of plant height (ALT), stem diameter (DC), foliar area (AF), leaf fresh mass (MFF), stem fresh mass (MFC), leaf dry mass (MSF), stem dry mass (MSC) and root dry mass (MSR), in function of four sowing depths. Gurupi-TO.

Variables	Regression equations	r^2
ALT (cm)	Y = 19.435 – 0.604 PR	0.71
DC (cm)	Y = 0.515 + 0.014 PR	0.74
AF(cm2)	Y = 129.52 + 4.769 PR	0.92
MFF(g)	Y = 4.7825 – 0.7318 PR + 0.0856 PR2	0.96
MFC (g)	Y = 3.6925 + 0.2488 PR – 0.0306 PR2	0.93
MSF(g)	Y = 0.565 + 0.031 PR	0.84
MSC(g)	Y = 0.4575 + 0.0468 PR – 0.0056 PR2	0.73
MSR(g)	Y = 0.615 + 0.0685 PR	0.78

Conclusions

The germination percentage of seeds was reduced with the application of the biostimulants Bioradicante and Ecormon. The application of the biostimulants Bioradicante and Ecormon in seeds of the Guarani cultivar of castor provided greater growth rate on the variables of stem diameter, leaf fresh mass and root dry mass. It is recommended to evaluate the effect of biostimulants during the complete cycle of the Guarani cultivar and the economic viability of biostimulants application.

The sowing depth of 2 cm presented greater emergence speed rate and a higher germination speed of seeds of the Guarani cultivar. On the variables of stem diameter, foliar area, leaf fresh mass, leaf dry mass and root dry mass, we observed an increase tendency on the values of these variables, with the increase of the sowing depth; this fact can be related to the higher humidity in deeper pits.

Acknowledgments

To the National Council of Scientific and Technological Development (CNPq), and the Coordination of Personnel Improvement of Higher Education (CAPES) for the research fellowship and financial support.

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