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Cientific Paper

Effect of biostimulants and seed treatment with fungicide on the germination and vigor of soybean seedlings

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Abstract

Exogenous vegetal biostimulants have been used on soy cultivation with the aim of increasing productivity. The objective of this study was to assess the germination and vigor of soy seeds under the action of biostimulants, with the presence and absence of fungicide. We used soy seeds of the cultivars MSoy 8527 RR and Anta 82 RR, treated with and without fungicide (carbendazim+thiram) and three concentrations (250, 500 e 750 mL 100 kg^{-1} of seeds) of the biostimulant Stimulate®, plus the control treatment. The treatments were arranged in factorial scheme 2x2x4, on completely randomized design with four replicates. In laboratory, we assessed the germination parameters, seedling length, dry matter mass of seedlings. In greenhouse, we evaluated the emergence on sand and speed germination rate. There was quadratic effect of the biostimulant dose for the seed germination of the cultivar Anta 82 RR, when treated with fungicide. The maximum responsive dose was 281.69 mL 100 kg^{-1} of seeds, when 91.06% of the seeds germinated. Crescent doses of biostimulant did not influence the biomass production of seedlings; however, they can increase the germination and vigor of seeds, depending on the cultivar.

Key words: *Glycine max*, seeds, germination, vigor.

Efecto de bioestimulantes y tratamiento de semillas con fungicida en la germinación y el vigor de las plántulas de soja

Resumen

Bioestimulantes vegetales exógenas han sido utilizados en el cultivo de soja con el objetivo de aumentar la productividad. El objetivo de este estudio fue evaluar la germinación y el vigor de las semillas de soja bajo la acción de bioestimulantes, con la presencia y ausencia de fungicida. Se utilizó semillas de soja de las cultivares MSoy 8527 RR y 82 Anta RR, tratada con y sin fungicida (carbendazim + tiram) y tres concentraciones de bioestimulante Stimulate® (250, 500 y 750 ml 100 kg^{-1} de semillas), además del tratamiento de control. Los tratamientos fueron dispuestos en esquema factorial 2x2x4, en diseño completamente al azar con cuatro repeticiones. En laboratorio fueran evaluados los parámetros de la germinación, la longitud de las plántulas y materia seca de plántulas. En invernadero se evaluó la emergencia en la arena y la velocidad de germinación. Hubo efecto cuadrático de la dosis bioestimulante para la germinación de las semillas de Anta 82 RR, cuando tratados con fungicida. La dosis máxima de respuesta fue 281,69 ml 100 kg^{-1} de semillas, Cuando 91,06% de las semillas germinaran. Dosis crecientes de bioestimulante no influyó en la producción de biomasa de las plántulas; Sin embargo, pueden aumentar la germinación y el vigor de las semillas, dependiendo del cultivar.

Palabras clave: *Glycine max*, semillas, germinación, vigor.

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Efeito da bioestimulantes e tratamento de sementes com fungicidas na germinação e vigor de plântulas de soja

Resumo

Bioestimulantes vegetais exógenas têm sido utilizados no cultivo da soja com o objetivo de aumentar a produtividade. O objetivo deste estudo foi avaliar a germinação e a vigor de sementes de soja sob a ação de bioestimulantes, com a presença e ausência de fungicida. Foram utilizadas sementes de soja das cultivares MSoy 8527 RR e Anta 82 RR, tratados com e sem fungicida (carbendazim + thiram) em três concentrações do bioestimulante Stimulate®(250, 500 e 750 mL 100 kg^{-1} de sementes), além do tratamento de controle. Os tratamentos foram dispostos em esquema fatorial 2x2x4, no delineamento experimental inteiramente casualizado, com quatro repetições. Em laboratório, foram avaliados os parâmetros de germinação, comprimento de plântula, massa da matéria seca das mudas. Em casa de vegetação, avaliou-se a emergência em areia e velocidade de germinação. Houve efeito quadrático da dose de bioestimulante para a germinação das sementes da cultivar Anta 82 RR, quando tratados com fungicida. A dose de máxima resposta foi de 281.69 100 mL kg^{-1} de sementes, quando 91,06% das sementes germinaram. Doses crescentes de bioestimulante não influenciaram a produção de biomassa de mudas; no entanto, podem aumentar a germinação e vigor das sementes, dependendo do cultivar.

Palavras chave: *Glycine max*, sementes, germinação, vigor.

Introduction

The employment of exogenous vegetal biostimulants has been used on the soybean cultivation, aiming to increase productivity. The vegetal bioregulators are synthetic substances that, applied exogenously, have similar actions to the group of known vegetal regulators (cytokinins, gibberellins, auxin, abscisic acid and ethylene) (VIEIRA and CASTRO, 2002). The mixture of two or more bioregulators or of bioregulators with other substances (amino acids, nutrients, seaweed and vitamins) yields a biostimulant or vegetal stimulant (CASTRO and VIEIRA, 2001; VIEIRA, 2002).

The biostimulants regulate, for example, the photosynthesis processes, the absorption and transport of water and nutrients, the movement of the stomata, and provide the increase of the plant resistance to biotic and abiotic stresses. The effect of biostimulants over the plants is the result of the influence over their metabolisms. They stimulate the synthesis of natural hormones, sometimes increase their activity, facilitate the absorption of nutrients from the soil, stimulate the root growth, contribute for a better yield and, frequently, contribute for the quality improvement (BASAK, 2008).

Several researches about the soy culture prove the functionality of the bioregulators (KLAHOLD et al., 2006; CAMPOS et al., 2008; MOTERLE et al., 2008; CAMPOS et al., 2009). However, techno-scientific positioning is predominant, but yet to be consolidated in face of its employment in species such as the soybean, which already reached an elevated technological level. In the cases where there was a positive response to these products, their effect happened, mostly, on production components. In this aspect, the number of pods per plant and the grain mass were what most responded positively to the application of bioregulators (BERTOLIN et al., 2010; ALBRECTH et al., 2011).

Expressive results of the use of bioregulators were found by BERTOLIN et al., (2010), when assessing the effect of commercial bioregulator applied on the treatment of seeds at the stage R5. In that occasion, they obtained a productivity of 4987 kg ha^{-1}. In this study, the biostimulant application resulted in productivity increase in relation to the control treatment, without restrictions regarding the form of application, that is, via seed or leaf. PICCININ et al. (2011) obtained 5007 kg ha^{-1} with the application of bioregulator in the seed treatment at the stage R1, along with the application of fungicide. Despite the fact that these studies show significant gains with the employment of bioregulators, it is also common to find reports of unsuccessful attempts in this scenario (DARIO et al., 2005; CASTRO et al., 2008).

In relation to effects over the seed germination and vigor, as well as the initial performance of the seedlings, the results are also contradictory. VIEIRA and CASTRO (2001) verified that it is possible to obtain a greater number of normal seedlings, greater dry matter of seedlings and higher root growth. Although MORTELE et al. (2011) did not obtain increase on germination and dry matter of seedlings, they concluded that it is possible to increase vigor, depending on the cultivar.

Despite the controversial results, the biostimulant application can be considered a promising practice for the soybean culture, even facing the lack of results that justify this adoption as an agricultural practice. Presently, a small number of studies has been approaching physiological aspects on soy plants, mainly when the application is conducted along with other operations, like in the seed treatment. Information about the effects of these chemical products on soy could provide essential subsidies for further studies of the agricultural use of growth regulators. Thereby, we aimed to assess the germination and vigor of soy seeds under the action of biostimulants, with the presence and absence of fungicide.

Material and Methods

The study was conducted in the year of 2013, at the Routine Laboratory of soy seeds, Department of Phytotechny at the Federal University of Viçosa. We used soy seeds of the cultivars MSoy 8527 RR and Anta 82 RR, treated with or without fungicide (carbendazim+thiram, 30 and 70 g kg^{-1} of seeds, respectively) and the biostimulant composed by 0.009% of kinetin, 0.005% of gibberellic acid and 0.005% of indolebutyric acid, in the concentrations of 250, 500 and 750 mL of the commercial product (p.c.) per 100 kg^{-1} of seeds, plus the control treatment with 350 mL of distilled water per 100 kg^{-1} of seeds. The treatments were arranged in factorial scheme 2x2x4 (two cultivars, presence and absence of fungicide and levels of biostimulant) with completely randomized design with four replicates. With the aim of assessing the effects of biostimulants over the seeds and seedlings, we installed tests of seed germination and seedling vigor.

The biostimulant was applied directly over the seeds, conditioned in plastic bags with capacity of 1.0 kg, with the aid of a graduated pipette. After the application, the set was stirred during one minute, aiming to standardize the treatments about the seed mass. After 30 minutes, the seeds of the treatments with fungicide received the application of the product, with stirring for another minute, in order to obtain a good coverage of the seeds. The tests were installed right after the fungicide application.

Germination: we used as substrate paper towels Germitest type, with four subsamples of 50 seeds, for each treatment. We set up rolls wrapped in plastic bags, in germination chamber, at 25ºC, for eight days, with results expressed in percentage (BRASIL, 2009).

Seedling length: determined with the employment of four replicates with 10 seeds per treatment, disposed over the lines traced in the upper third of the paper, in the longitudinal direction. The substrates, Germitest paper rolls, were moistened with water volume equivalent to 2.5 times the weight of dry substrate. After the sowing, the rolls were maintained at 25ºC. The evaluation was performed at the eighth day after the sowing, with the separation of the plant shoot from the root of the normal seedlings; the results were expressed in centimeters (BRASIL, 2009).

Dry matter mass of seedlings: determined using the seedlings obtained at the final test of length. The seedlings of each treatment were separated into plant shoot and root. Subsequently, the samples were conditioned in paper bags and taken to the greenhouse, with forced air circulation, maintained at the temperature of 65 ºC, remaining there for 72 hours. After the cooling, each replicate was weighed on a scale with precision of 0.01 g (NAKAGAWA, 1999) and the results were expressed in grams per seedling.

At the same time, in a greenhouse, we conducted the following tests:

Emergence of seedlings in sand: we took four subsamples of 50 seeds per treatment. These were sowed in the depth of three centimeters, in plastic trays (42 x 28 x 10 cm) containing washed sand. The counting of the emerged seedlings was conducted twelve days after the sowing, according to NAKAGAWA (1999).

Emergence speed rate: we determined along with the emergence test. Daily, the emerged seedlings were counted until the establishment of the stand, at the twelfth day after the installing of the test. The emergence speed rate of seedlings was calculated according to MAGUIRE (1962).

The percentage data were subjected to the normality tests (LILLIEFORS). When that was not verified, the values were transformed into arcsine ($\sqrt{x/100}$). We processed a variance analyses (ANAVA). For the developing of the factor of biostimulants levels, we used the regression analysis, while the others were compared by the Tukey test at 5% probability. The statistical analysis of the data was processed through the app GENES (CRUZ, 2013).

Results and Discussion

In Table 1 are the averages of the cultivars, treatment with fungicides and biostimulant doses for the germination, length of the plant shoot and root; and dry matter of the plant shoot and root. We verified an interaction of third order ($p<0.05$) for the seed germination, emergence in sand and germination speed rate. For the germination, all sources of variance tested were significant, except the interaction between treatment of seeds and biostimulant. On the other hand, there was interaction ($p<0.05$) between treatment of seeds x biostimulant dose for the dry matter of shoot and root. We also found an interaction between the cultivar and the dose of biostimulant for length and dry matter of the root. In relation to the shoot length, there was a general effect of seed treatment with biostimulant. The absence of fungicide favored the development of the seedling shoot (Table 1). In relation to the doses of biostimulant, though insignificant, did not adjust to the regression models, the results being equal to the average (11.09 cm).

The seed germination of the cultivar MSoy 8527 RR, with and without seed treatment, within each level of biostimulant was not different among them (Table 2). However, for the cultivar Anta 82 RR, we verified a difference between the presence and absence of fungicide under the doses of zero and 500 mL of biostimulant per 100 kg^{-1} of seeds. We also found that for these doses of biostimulant, the absence of fungicide provided less seed germination.

Table 1. Averages of the variables of germination **(G)**, length of shoot **(CPA)** and root **(CPR)**, dry matter of the shoot **(MSPA)** and root **(MSR)** of two soy cultivars, treated with or without fungicide, with four doses of biostimulant.

	G (%)[1/]	CPA (cm)	CR (cm)[3/]	MSPA (g)[2/]	MSR (g)[2/]	EA (%)	IVE
Msoy 8527RR	94.59 a	10.61 a	11.57 a	0.61 a	0.13 a	89.63 a	9.31 a
Anta 82 RR	82.53 b	11.58 a	11.76 a	0.63 a	0.07 b	70.75 b	5.86 b
Without	87.40 b	11.64 a	11.66 a	0.60 a	0.10 a	65.06 b	6.14 a
With	89.71 a	10.54 b	11.66 a	0.64 a	0.10 a	95.31 a	9.04 b
0	89.00 a	10.72 ab	11.76 ab	0.65 a	0.09 a	76.63 a	7.32 a
250	90.05 a	10.26 b	10.43 b	0.68 a	0.10 a	82.81 a	7.87 a
500	90.50 a	10.85 ab	12.23 a	0.60 a	0.11 a	79.19 a	7.45 a
750	84.25 b	12.54 a	12.24 a	0.55 a	0.09 a	82.13 a	7.70 a

Averages followed by different letter in the columns are different among them ($p<0,05$) by the Tukey test; [1]/Interaction cultivar x seed treatment x significant dose of biostimulant; [2]/Interaction seed treatment x significant dose of biostimulant; 3/Interaction cultivar x significant dose of biostimulant.

Table 2. Germination of two soy cultivars in the absence and presence of seed treatment with fungicide, subjected to four doses of biostimulant.

Dose (mL 100 kg^{-1})	MSoy 8527 RR		Anta 82 RR	
	Without	With	Without	With
	Germination (%)			
0	97.0 Aa	95.5 Aa	76.5 Bb	87.0 Ab
250	96.0 Aa	93.4 Aa	86.0 Ab	86.5 Ab
500	94.8 Aa	94.0 Aa	80.5 Bb	92.8 Aa
750	92.0 Aa	94.0 Aa	76.5 Ab	74.5 Ab
RL	ns	ns	ns	**
RQ	ns	ns	Ns	**

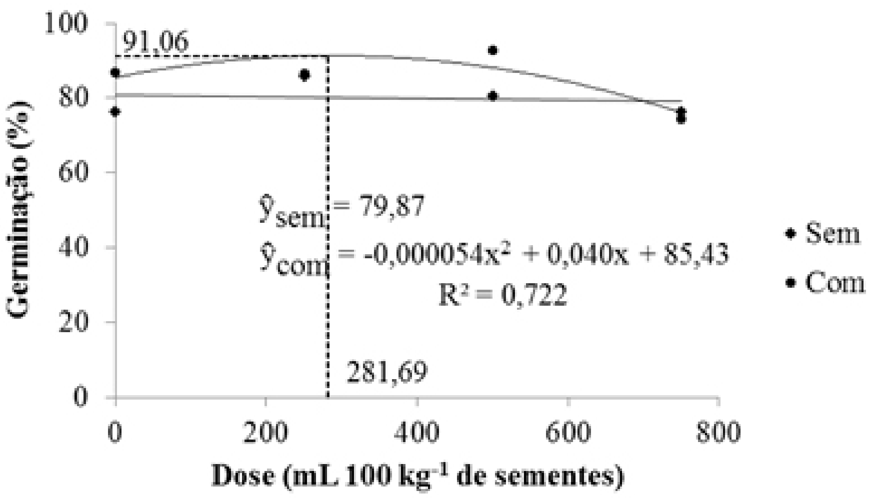
***RL** = linear regression; **RQ** = quadratic regression; **ns** = non-significant; ** = significant ($p<0,01$); Same capital letters in the line, between with and without seed treatment, within each cultivar, and same lower case letters in the line, between cultivars and within each seed treatment, did not differ among them ($p<0,05$) by the Tukey test.*

In the absence of seed treatment, the cultivar MSoy 8527 RR exceeded the Anta 82 RR on all levels of biostimulant. The same result was observed with the presence of seed treatment, except on the dose of 500 mL of biostimulant per 100 kg^{-1} of seeds.

The results reinforce the importance of seed treatment with fungicide in order to guarantee the seed germination, mainly in lots of seeds that are less vigorous, such as the Anta 82 RR. According to MENTEN and MORAES (2011), the seed treatment, besides controlling the pathogens associated with the seeds, it also controls the inhabitants/invaders of the soil, storage fungi and initial foliar pathogens. The chemical treatment can act against the four ways through which the pathogens cause damage; the physical treatment has no residual effect, acting only over the seed pathogens. The seed treatment can yet ensure the adequate stand, vigorous plants, delay of the initial of epidemics and increase in yield. It also presents immediate benefits (the cost of the process is lower than the gain in yield) and at medium/long term (balanced production system).

In Figure 1, we can see the response pattern of seed germination of the cultivar Anta 82 RR, treated and not treated with fungicide, in function of the biostimulant doses. The absence of seed treatment did not influence the germination, which did not adjust to any regression model. With the seed treatment, we can observe a quadratic adjustment (R^2 = 0.72) in function of the doses, with maximum germination obtained at the dose of 281.69 mL 100 kg^{-1} of seeds. The major part of the treatments presented germination values superior to 80%, a minimum value referenced by Brasil (2005), which characterizes the absence of harmful effects over this parameter.

The results obtained in this study are contrary to what had already been reported by VIEIRA and CASTRO (2001), who obtained the effect of biostimulant over the germination of soy seeds (cv. IAC-8-2). In the occasion, the authors verified that the concentration of 3.5 mL of biostimulant per 0.5 kg^{-1} of seeds provided the maximum number of normal seedlings, with increase of 51.9% in relation to the control treatment. On the other hand, it corroborates with other results found in the literature. DÁRIO et al., (2005) and MORTELE et al. (2011), after applying crescent doses of the same biostimulant, observed that there was no significant influence over the percentage increase of the plants germination. BINSFELD et al. (2014) verified that the application of biostimulant in a lot of low vigor increased the percentage of seed germination. However, when it was applied in a lot of high vigor, there was no improvement in the germination.



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(vertical: Germination (%); With, Without | horizontal: Dose (mL 100 kg^{-1} of seeds)

Figure 1. Seed germination of the cultivar Anta 82 RR, with and without seed treatment, subjected to four doses of biostimulant.

According to MORTELE et al. (2011), the application of phytohormones in the seeds of some cultivars can have an inhibitory effect in the germination speed. The phytohormones, in this case, could have modeled negatively the synthesis or expression of some important enzymes in the process of seed germination. Besides, the authors highlight that it is necessary to consider the morphogenetic differences and, or, absorption rates that are different from the bioregulator between cultivars.

Considering the effect of the seed treatment within each level of biostimulant dose for the dry matter mass of the plant shoot and root, there was a difference only in the dose of 750 mL kg 100 kg^{-1} of seeds (p.c.). The seed treatment provided greater dry matter of the plant shoot and root of the seedlings (Table 3). The increment in the dose of biostimulant in the seeds not treated with the fungicide presented a reduction tendency of the two variables, while in the seeds treated with fungicide there was an increase tendency of the dry matter. However, in both treatments there was no regression adjustment. VIEIRA and CASTRO (2001) obtained the maximum value of dry mass of soy seedlings when applied 820 mL 100 kg^{-1} of seeds (p.c.), surpassing in 55.3% the control concentration.

Similar to the results of this study, MORTELE et al., (2011) reported the inexistence of influence of crescent bioregulator doses over the dry matter biomass of soy seedlings. BINSFELD et al. (2014) did not observe a difference in the total dry matter of soy seedlings, from a lot of low vigor when applied 600 mL 100 kg^{-1} of seeds (p.c.) of the biostimulant. However, when the same dose was applied in a lot of high vigor, they obtained an increase in the total dry matter.

The developing of the interaction cultivar x biostimulant dose for the dry matter mass of the root demonstrated that there was no influence over the cultivar MSoy 8527 RR (Table 4). For the cultivar Anta 82 RR, we obtained an adjustment of (R^2= 60.2%) to the model of quadratic regression, with a maximum responsive dose of 142.86 mL 100 kg^{-1} of seeds (p.c.) of biostimulant, with seedlings reaching 0.078 g of root dry matter. Results obtained by VIEIRA and CASTRO (2001) demonstrated a contrary behavior.

Table 4. Summary of the regression analysis of dry matter of the root (MSR) and root length (CR) of two soy cultivars subjected to four doses of biostimulant.

Variable	Cultivar	Estimated equation ($\hat{Y}$)	R^2(%)	Critical points	
				X (dose)	($\hat{Y}$)
MSR (g)	MSoy 8527 RR	$= -7E-08x^2 + 2E-05x + 0,0756$	60.2	142.86	0.078 (max.)
	Anta 82 RR	$\hat{Y}=\ddot{Y}=0,1325$			
CR (cm)	MSoy 8527 RR	$= 0.003x + 10.20$	68.6		
	Anta 82 RR	$= 0,00000916x^2 - 0,0078x + 12.72$	69.7	430.95	11.02 (min.)

Table 5. Emergence in sand and emergence speed rate of two soy cultivars, with and without seed treatment and four doses of biostimulant.

Dose	Emergence in sand (%)				Emergence speed rate			
	MSoy 8527 RR		Anta 82 RR		MSoy 8527 RR		Anta 82 RR	
	Without	With	Without	With	Without	With	Without	With
0	85.0 Ba	97.0 Aa	28.0 Bb	96.5 Aa	8.8 Aa	9.8 Aa	2.1 Bb	8.5 Aa
250	82.0 Ba	94.5 Aa	63.3 Bb	91.5 Aa	8.6 Aa	10.2 Aa	4.6 Bb	8.1 Ab
500	83.2 Ba	99.2 Aa	41.0 Bb	93.3 Ab	8.7 Aa	10.3 Aa	3.5 Bb	7.3 Ab
750	76.7 Ba	99.5 Aa	61.3 Bb	91.3 Ab	7.8 Ba	10.1 Aa	4,8 Bb	8.0 Ab
Média	81.5 Ba	97.6 Aa	48.4 Bb	93.2 Ab	8.5 Aa	10.1 Aa	3.8 Bb	7.9 Aa
RL	ns	ns	ns	ns	ns	ns	ns	ns
RQ	ns	ns	ns	ns	ns	ns	ns	ns

RL = *linear regression;* **RQ** = *quadratic regression; ns = non-significant;*

Same capital letters in the line between with and without seed treatment, within each cultivar, and same lowercase letters between cultivars, within each seed treatment, do not differ among them by the Tukey test (p<0.05).

The concentration of 4.1 mL of the product in soy incremented 55.3% on the values of dry matter mass of seedlings. However, LEITE et al. (2003) observed that the addition of exogenous gibberellins and cytokinins has not contributed for the increase of dry matter of soy plant roots and that the association of gibberellin and cytokinin tended to decrease the effects of the gibberellins.

The root length presented a different behavior between cultivars in function of the biostimulant dose, as we can see in Table 4. With the cultivar Msoy 8527 RR we could observe a linear behavior, with acceptable adjustment degree (R^2= 68.6%). As for the cultivar Anta 82 RR, the behavior was quadratic, with decrease of the plant length until the maximum dose of 430.95 ml 100 kg^{-1} of seeds (p.c.).

The result of this study counterpoints CASTRO et al. (2008), concluding that the seed treatment with biostimulant do not provide greater root growth. VIEIRA and CASTRO (2001) verified that the application of biostimulant promoted greater vertical growth of the root system of soy plants, under the concentrations between the interval (260 – 1000 mL 100 kg^{-1} of seeds), while under the concentration of 260 mL the vertical root system reached the maximum value in relation to the control treatment. BINSFELD et al. (2014) obtained an increase of root length only in the lot where the seeds had high vigor. According to MORTELE et al. (2011), the differential response of the cultivars to the bioregulator application over the length of seedlings can be attributed to the different sensibility degrees between the cultivars and even the interaction between the hormones present in the product.

The emergence of seedlings in sand, when the seeds were not treated, was inferior to the emergence observed with the presence of fungicide, to both cultivars and biostimulant levels (Table 5). We also observed a lower seedling emergence of the cultivar Anta 82 RR in relation to the MSoy 8527 RR, in the absence of seed treatment. The seed treatment provided higher seedling emergence on both cultivars, mainly the cultivar MSoy 8527 RR, whose seeds were more vigorous. Moreover, comparing the seedling emergence between cultivars, in the presence of seed treatment and biostimulant doses, we verified a difference for the doses of 500 and 750 ml 100 kg^{-1} of seeds (p.c.). The low emergence of the cultivar Anta 82 RR is due to the low initial vigor of the seed lot. The results of this study are in accordance to those reported by MERTZ et al. (2009), where they found the efficiency of the seed treatment with the fungicide carbendazim+thiram, for providing greater seed germination and seedling emergence.

DÁRIO et al. (2005) report that the application of biostimulant in the doses of 0.25, 0.50, 0.75 L ha^{-1} (p.c.) did not present significant influence over the germination percentage of soy seedlings. BINSFIELD et al. (2014) applied the biostimulant in two seed lots, with low and high vigor, respectively. The authors also came to the conclusion that the biostimulant do not improve the seedling emergence.

The emergence speed rate did not differ with the cultivar MSoy 8527 RR, considering the absence and presence of seed treatment, except when combined with the dose of 750 mL 100 kg^{-1} of seeds of the biostimulant (Table 5). A different result was observed with the cultivar Anta 82 RR, where seedlings from seeds that were not treated presented lower emergence rate. Between cultivars, we verified a difference only in the absence of seed treatment with fungicide. Similarly to the germination, we did not find an effect of the biostimulant levels over the emergence speed rate, corroborating with the results reported by BINSFELD et al. (2014).

According to other studies, the fact that many cultivars do not respond positively to the application of crescent doses of bioregulators for the assessed characteristics can be attributed to the genetic characteristic of the used cultivars and the different metabolic processes, which require efficiency of these mechanisms during the initial phase of development. We must also consider the differences on the contact surface of the seeds and the sensibility of the plasmatic membranes, which could have compromised the bioregulator efficiency.

Conclusions

The seed treatment with fungicide increased the germination percentage of the seeds and emergence of seedlings in sand. However, it did not result in increment on the length of the plant shoot. Crescent doses of biostimulant did not influence the production of biomass in seedlings, though they increased the germination and vigor of the seeds, depending on the cultivar.

References

ALBRECHT, L.P.; BRACCINI, A.L.; SCAPIM, C.A.; ÁVILA, MR; ALBRECHT, A.J.P.; RICCI, T.T.Manejo de biorregulador nos componentes de produção e desempenho das plantas de soja. Bioscience Journal, v.27, n.6, p.865-876, 2011.

BASAK, A. Bioestimulators: definitions, classification and legislation. In: GAWRONSKA, H (Ed.).Biostimulators in modern agriculture: general aspects. Warsaw: Editorial House Wie Jutra, 2008 p.7-17.

BERTOLIN, D.C.; SÁ, M.E.; ARF, O.; FURLANI JUNIOR, E.; COLOMBO, A.S.; CARVALHO, F.L.B.M. Aumento da produtividade de soja com a aplicação de bioestimulantes. Bragantia, v.69, n.2, p.339-347, 2010.

BRASIL, Ministério da Agricultura e Reforma AgráriaRegras para análise de sementes. Brasília: MAPA/ SNDA, 2009.

BRASIL, Ministério de Agricultura, Pecuária e Abastecimento. Instrução normativa n. 25, de 16 de dezembro de 2005. Padrões para produção e comercialização de sementesde soja. Anexo IX. Diário Oficial [da] República Federativa do Brasil, Poder Executivo, Brasília, DF, 20 dez. 2005. Seção 1, p.18.

BINSFELD, J.A.; BARBIERI, A.P.P.; HUTH, C.; CABRERA, I.C.; HENNING, L.M.M. Uso de bioativador, bioestimulante e complexo de nutrientes em sementes de soja. Pesq. Agropec. Trop., v.44, n.1, p.88-94, 2014.

CAMPOS, M.F.; ONO, E.O.; BOARO, C.S.F.; RODRIGUES, J.D. Análise de crescimento em plantas de soja tratadas com substâncias reguladoras. Revista Biotemas, v.21, n.3, p.53-63, 2008.

CAMPOS, M.F.; ONO, E.O.; RODRIGUES, J.D .Desenvolvimento da parte aérea de plantas de soja em função de reguladores vegetais. Revista Ceres, v.56, n.1, p.74-79, 2009.

CASTRO, G.S.A.; BOGIANI, J.C.; SILVA, M.G.; GAZOLA, E.; ROSOLEM, C.A. Tratamento de sementes de soja com inseticidas e um bioestimulante. Pesquisa Agropecuária Brasileira, v.43, n.10, p.1311-1318, 2008.

CASTRO, P.R.C.; VIEIRA, E.L.Aplicações de reguladores vegetais na agricultura tropical. Guaíba: Livraria e Editora Agropecuária, 2001.

CRUZ, C. Genes - a software package for analysis in experimental statistics and quantitative genetics. Acta Scientiarum. v.35, n.3, p.271-276, 2013.

DARIO, G.J.A.; MARTIN, T.N.;DOURADO NETO, D.; MANFRON, P.A.; BONNECARRÈRE, R.A.G.; CRESPO, P.E.N. Influência do uso de fitorregulador no crescimento da soja. Revista da FZVA, v.12, n.1, p.63-70, 2005.

KLAHOLD, C.A.; GUIMARÃES, V.F.; ECHER, M.M.; KLAHOLD, A.; ROBINSON L.C., BECKER, A. Resposta da soja (*Glycine max* (L.) Merrill) à ação de bioestimulante. Acta Scientiarum Agronomy, v.28, n.2, p.179-185, 2006.

LEITE, V.M.; ROSELEM, C.A.; RODRIGUES, J.D. Gibberellin and cytokinin effects on soybean growth. Scientia Agricola, v.60, p.537-541, 2003.

MAGUIRE, J.D. Speed of germination-aid in selection and evaluation for seedling emergence and vigor. Crop Science, Madison, v.2, n.1, p.176-177, 1962.

MENTEN, J.O.; MORAES, M.H.D. Tratamento de sementes: histórico, tipos, características e benefícios. In: Associação brasileira de tecnologia sementes (Org.). Avanços no Tratamento e recobrimento de sementes. Londrina, v.20, n.3, 2010. (Informativo ABRATES).

MERTZ, L.M.; HENNING, F.A.; ZIMMER, P.D. Bioprotetores e fungicidas químicos no tratamento de sementes de soja. Ciência Rural, v.39, n.1, p.13-18, 2009.

MOTERLE L.M.; SANTOS, R.F.; SCAPIM, C.A.; BRACCINI, A.L.; BONATO, C.M.; CONRADO, T. Efeito de biorregulador na germinação e no vigor de sementes de soja. Rev. Ceres, v.58, n.5, p.651-660, 2011.

MOTERLE, L.M.; SANTOS, R.F.; BRACCINI, A.L.; SCAPIM, C.A.; BARBOSA, M.C. Efeito da aplicação de biorregulador no desempenho agronômico e produtividade da soja. Acta ScientiarumAgronomy, v.30, supl. especial, p.701-709, 2008.

NAKAGAWA, J. Testes de vigor baseados no desempenho das plântulas. Londrina: ABRATES, Comitê de Vigor de Sementes, 1999.

PICCININ, G.G.; RICCI, T.T.; BRACCINI, A.L.; DAN, L.G.M. Uso de Stimulate, Sett e mover no desempenho Agronômico da cultura da soja (*Glycine max* (L.) Merrill). In: Encontro Internacional de Produção Científica, 7., 2010, Maringá.Anais...Maringá:Ed. Cesumar, 2010.

VIEIRA, E. L.; CASTRO, P.R.C. Ação de Stimulate no desenvolvimento inicial de plantas de algodoeiro (*Gossypium hirsutum* L.). Piracicaba: USP, Departamento de Ciências Biológicas, 2002 (Apostila).

VIEIRA, EL; CASTRO, PRC Ação de bioestimulante na germinação de sementes, vigor das plântulas, crescimento radicular e produtividade de soja. Revista Brasileira de Sementes, v.23, n.2, p.222-228, 2001.