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Rates of biostimulant on maize at off-season in the northern of Mato Grosso

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Abstract. In recent years the corn crop has experienced new baseline level of productivity with the innovations in the productive system, among them the incorporation of biostimulants to the seeds, with obtained increases in yield, nevertheless some care should be taken concerning the addition of new chemicals to the seeds. The objective of this study was to evaluate the effect of rates the seed treatment with the biostimulant of root Aminoagro Raiz® in corn yield second crop development in the northern of Mato Grosso State, Brazil. The experiment was carried out at the area experimental of the Federal University of Mato Grosso (UFMT) campus of Sinop-MT. The treatments consisted in applying by rates of seed treatment of the biostimulants (0, 50, 100, 150 and 200 ml kg^{-1} of seeds) in the moment of sowing. The rates caused significant changes on number of leaves and leaf area, which experienced smaller values, this reduction occurred due to a possible increase in root system. Corn seeds treated with the bioestimulant Aminoagro Raiz® in the rate de 200 ml kg^{-1} of seeds, high level of the rate recommended for the fabricant, has been reductions on number of leaves and grain yield. The seed corn treatment with the bioestimulant Aminoagro Raiz® in the rate recommended for the fabricant (50 ml kg^{-1} of seeds) increased the grain yield in corn crop.
Keywords: Zea mays, off-season maize, treatments of seeds, no tillage system.

Introduction

Considering the context of global agriculture, which seeks the increase of production and cost reduction due to competitive market, new organomineral biostimulants products have had broad possibilities of use in varied agricultural crops (Luz et al., 2010). The innovations on the productive system are extensive and attention must be paid to the real gains with the incorporation of organomineral biostimulants to seed treatment, which are the main inputs of modern agriculture, being responsible for all the genetic and productive potential that ensure the success of the agricultural enterprise. However, those practices are still recent, having little information on how the biostimulants products act and influence on the productivity of corn crop. Among the new technologies appear the plant biostimulants for application to the seeds, nevertheless, little is known about the real effect of these products based on hormones, micronutrients, aminoacids and vitamins on the productivity of the crops (Vieira & Santos,2005; Silva et al., 2008).

The plant biostimulants promote the hormonal balance of the plants, enhancing the expression of its genetic potential and stimulating the development of the root system (Ferreira et al., 2007). These products act on the degradation of the supply substances of the seeds, on the differentiation, division and stretching of the cells. For best formation of the plant architecture one can opt for the use of root hormones, which stimulate and increase root formation. Evidence is shown that the root volume is a fundamental aspect on the productivity of the plants, especially in environments characterized by low availability of water and nutrients where the root system has direct relation to production increase (Sierwerdtet al., 1999; Ávila et al., 2008; Berticelli & Nunes, 2008).

The biostimulant Aminoagro Raiz® is an organomineral fertilizer class A of fluid nature, recommended to several agricultural crops, among them corn and has in its composition total organic matter (345,0 g L^{-1}), total organic carbon (195,0 g L^{-1}), water soluble nitrogen (126,5 g L^{-1}), potassium (K2O) water soluble (11,5 g L-1), besides acidifier agent phosphoric acid, chelating agent lignosulfonate, aminoacids, algae extracts and humic substances (Aminoagro, 2014).

According to Conceição et al.(2008), the use of humic acid as plant biostimulant increases the population of diazotrophic bacteria, which can bring beneficial effects to the plant, reflecting on the increase of rooting and, thus, promoting further growth of the aerial part. The use of products considered as rootings in the corn crop increase productivity, with improvements in the root system of the plants, like the exploration of larger soil volume and grants the crop endurance to stress, mainly hydric and edaphic factors with larger absorption of nutrients in the soil due to the larger volume of soil explored by the roots (Berticelli & Nunes, 2008).

In systems with high productive potential, some authors have found advantages in the use of biostimulants products regarding productivity of the corn crop (Neto et al., 2004; Berticelli & Nunes, 2008;Dos Santos et al., 2013; Krenchinski et al., 2014). Nevertheless, these authors recommend further studies in diverse conditions. As such, the objective of the study was to verify the influence of different rates of the biostimulant Aminoagro Raiz® applied on the treatment of seeds at the moment of sowing, analyzing its effects on the vegetative development and in the productivity of corn yield second crop (“corn off-season”).

Methods

The experiment was conducted in the year of 2014 in the experimental area of the Federal University of Mato Grosso (UFMT) in the town of Sinop – MT,11º50’53” S of latitude, 50º38’57” W longitude and 384 m altitude. The climate in the region, according to Koppen classification is type Am, with average annual precipitation of 2000 mm per $year^{-1}$, average annual temperature of 26º C and average annual relative air humidity of 66% (Garcia et al., 2013). The climate data of rainfall and temperature during the carrying out period of the experiment were obtained at the meteorological station of UFMT in Sinop-MT (Figure 1).

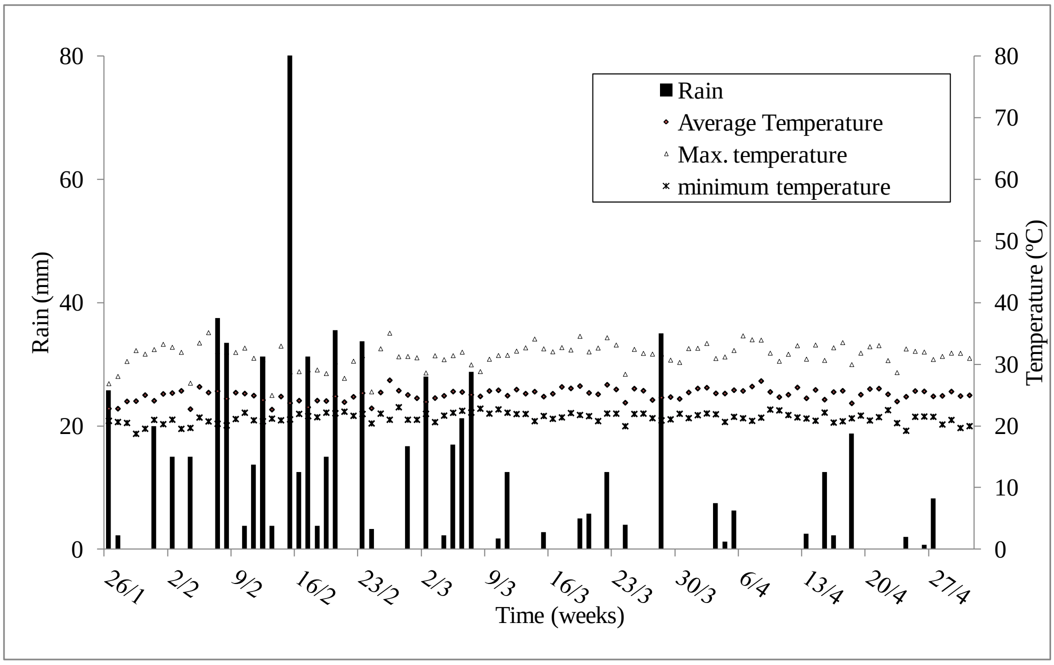

Figure 1. Precipitation (mm) and Temperatures (ºC) during the period of January, 26^{th} to April, 27^{th}, 2014. UFMT, Sinop-MT.

The soil in the experimental area is classified as dystrophic Red Latosoil (Santos et al., 2013). The results of the chemical analysis of the soil (0-20 cm depth) were: pH in H2O (6.0), Organic Matter (36.5 g kg^{-1}), P (1.4 mg dm^{-3}), K (16 mg dm^{-3}), S (4.31 mg dm^{-3}), Ca (27 mmolc dm^{-3}), Mg (17mmolc dm^{-3}), CTC in pH 7(7.21 mmolc dm^{-3}), V (59.78%). The physical analysis of the soil obtained 308; 141 and 551 g per kg^{-1} of sand, silt and clay, respectively.

The trial design adopted was of the random blocks with five repetitions. The treatments consisted in the application via treatment of the seeds at the moment of sowing (performed on the 26^{th} of January, 2014) of the biostimulant Aminoagro Raiz® at the rates of 0, 50, 100, 150 and 200 ml per kg^{-1} of seeds. The biostimulant Aminoagro Raiz® is an organic-mineral fertilizer class. A of fluid nature and its chemical composition can be found in Table 1. Agroceres 7088 VTPR02 plain hybrid corn seeds were used. 25 experimental plots were implanted with dimensions of 5 x 2,5 m and spacing of 0,50 between lines with total area of 16 m^2. It was considered as useful area for collecting data the two central lines, leaving out 0,5 m at the end of the lines, with an useful area of 6,25 m^2 remaining. The sowing was done by hand with double necessary seeds, as to ensure the final population after the thinning of 60 thousand plants per hectare.

Table 1. Chemical composition of biostimulant Aminoagro Raiz

M.O. (%)	Carbon Total (%)	Nitrogen Solubre in H_2O	Potassium Soluble in H_2O	Cu (%)	Zn (%)	Mn (%)	B (%)
30 (345 g L^{-1})	17 (195 g L^{-1})	11 (126,5 g L^{-1})	1 (11,5 g L^{-1})	0,30	0,70	1,70	0,50

The area used for carrying out the experiment was cultivated under the system of direct planting, dried 15 days before planting. In February 7th, 2014, 0.2 L ha^{-1} of the post emergent herbicide Conect was applied. Planting fertilization with 500 kg ha^{-1} of the formula 04-20-20 was performed and top dressing fertilization was performed on February, 16th, 2013 with the application of 100 kg ha^{-1} of urea by free throwing. The application of fungicide was performed together with the insecticide on the 27th of March, 2014, being applied with a back sprayer the fungicide Priori Xtra (300 ml ha^{-1}), the adjunct mineral oil Assist (500 ml ha^{-1}) and the insecticide Engeo Pleno (250 ml ha^{-1}).

The first evaluation was done by 60 days after sprouting, in the blossoming stage, when it was determined the plant height, thatch diameter, total chlorophyll, fresh mass, dry mass, number of leaves per plant and leaf area. For the variable height of plants it was obtained the average height of 6 plants from the useful plot, measured in meters from soil level until the point of insertion of the flag leaf, performed before harvest. For the thatch diameter the measurement was performed 5 cm from the soil using a pachymeter in 3 plants randomly sampled by plot. The total chlorophyll values were obtained through de use of a chlorophyll measurer. The estimate chlorophyll content was performed by means of indirect readings of SPAD units (Soil Plant Analysis Development) with the chlorophyll measurer device SPAD-502 (Minolta) at the medium part of the superior leaf opposed to the main cob, measured in 6 representative plants of the useful area of the plot. The readings performed with this equipment indicate proportional values of chlorophyll on the leaf and are calculated based on the amount of light transmitted and absorbed through the leaf in two wavelengths with distinct absorptions of chlorophyll (Argenta et al., 2001). Three plants of each plot were cropped at soil level and weighted in order to obtain the fresh mass. It was subsequently performed the separation and counting of the total leaf number of the three plants cropped and with the use of a leaf area integrator it was obtained the total leaf area of the plants cropped of each plot. All the aerial part of the cropped plants was submitted to kiln-drying with temperature of 65º C until constant weight in order to obtain the dry mass values.

The data collection referring to grain productivity was performed at the stage of physiological maturity. The productivity was determined by harvesting all the cobs of the useful area of the plot and the obtained yield expressed in kg per ha-1. The humidity of the grains was determined by the standard method of kiln with forced air circulation with temperature of 105+-3º C for 24 hours into three repetitions (BRASIL. 2009). The productivity results were corrected to a standard humidity of 13% in humid basis.

Model additivity, error normality and variance homogeneity tests were performed. Having no restrictions to presupposition of variance analysis, the obtained data were submitted to variance analysis at the level of 5% of probability by the statistics software SISVAR (Ferreira, 2011). The quantitative variables were submitted to regression analysis, choosing the best model depending on the significance of the regression coefficients and explained variation by the model.

Results and Discussion

The effects of application of rates of biostimulant Aminoagro Raiz® were significant at 5% of probability by the test F for the variable number of leaves, leaf area and grain productivity (Table 2). As for the other variables no statistical differences were detected among the rates of the biostimulant. The variation coefficients indicate good precision for the evaluated characters, varying from 10.25% for the number of leaves to 16.57% for the leaf area.

As for the variable height of plants, averaging 1.37 m and thatch diameter, averaging 24.98 mm, the quadratic effect was not significant. Similar results were obtained by Berticelli & Nunes (2008) and Martins et al. (2016), who found no significant effect of a root biostimulant for these variables. Vasconcelos (2006) also reported that the application of biostimulant did not promote effects on the height of the plants.

The total chlorophyll contents, with average reading SPAD of 60.39 were not altered by the treatments. The SPAD readings performed with chlorophyll measurer at the blossoming, according to Argenta at al. (2001), estimate with good precision the chlorophyll content in the leaves of corn, being efficient parameter for the monitoring for the Nitrogen level. The values of indirect readings of chlorophyll at the blossoming stage obtained in the present study resemble those obtained by Amaral Filho et al. (2005) and Hurtado et al. (2010).

Table 2. Summary of the variance analysis for the variables plant height (PH), thatch diameter (TD), total chlorophyll (SPAD), fresh mass (FM), dry mass (DM), number of leaves (NL), leaf area (LA) and grain productivity (PROD). UFMT-MT.

					Medium	Squares			
Variation Sources	GL	HP (m)	TD (mm)	SPAD	FM (kg ha^{-1})	DM (kg ha^{-1})	NL	LA (m^2)	PROD (kg ha^{-1})
Blocks	4	0,0086	1,6271	80,4126	0,0101	0,0203	1,5160	0,0062	1085,24
Rates of bioestimulant	4	0,0264	9,1449	92,5805	0,0385	0,0273	7,0220*	0,1508*	983,04*
Error	16	0,0309	13,2175	44,9934	0,0371	0,0199	0,8243	0,0164	1787,8650
General average		1,37	24,98	60,39	1,340	0,416	8,86	0,77	7440,40
CV(%)		12,78	14,55	11,11	14,37	13,88	10,25	16,57	14,09

*significant at 5% of probability according to test F

The fresh mass and dry mass of the plants were not influenced by the treatments, with average values of 1.341 kg per $plant^{-1}$ and 0.416 kg per $plant^{-1}$, respectively. However, the average values for the treatments that received the different rates were higher in comparison to the testifying treatment, as well as observed by Berticelli & Nunes (2008). The results also confirm the ones obtained by Vasconcelos (2006), where the application of biostimulant did not promote effects on the production of dry mass of the corn plants.

The number of leaves with the significant quadratic model was influenced negatively in all the concentrations of root biostimulant, where it was obtained in average the highest values in testifying with subsequent reductions with the increase of the dosages of the product (Figure 2). For the treatments studied by Siewerdt et al. (1999) no statistical differences were found for the variables evaluated and, although plants with greater heights were obtained, this characteristic did not increase the number of leaves, which oscillated little, reaching at maximum 7 leaves per plant.

For the leaf area the best adjustment took place with the quadratic model (Figure 3). The smallest leaf area of the treatments that received the product was probably due to the stimulus in root growth in corn crop rather than the growth of the leaf area according to effect observed by some authors (Neto et al., 2004; Berticelli & Nunes, 2008; Dos Santos et al., 2013; Krenchinski et al., 2014).

The grain productivity varied according to the quadratic model (Figure 4). The rate recommended by the product manufacturer of 50 ml per kg^{-1} of seeds of biostimulant provided greater value to the grain productivity (8,388 kg per ha^{-1}). At the rate of 200 ml per kgv of seeds of biostimulant it was observed the greatest reduction with the smallest value in the grain productivity, which was of 6,552 kg per ha^{-1}. In the study of Neto et al. (2004), who analyzed the effect of biostimulant in different rates on the productivity of corn, there was an increase of productivity in comparison to the control treatment without the application of biostimulant. Other authors also observed increase in grain productivity with the use of biostimulants in relation to the testimony without biostimulants (Berticelli & Nunes, 2008; Dos Santos et al.; 2013; Krenchinski et al., 2014).

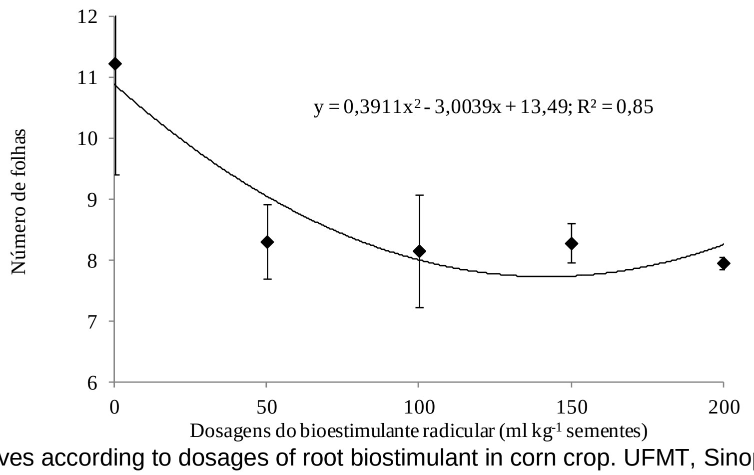

Figure 2. Number of leaves according to dosages of root biostimulant in corn crop. UFMT, Sinop – MT.

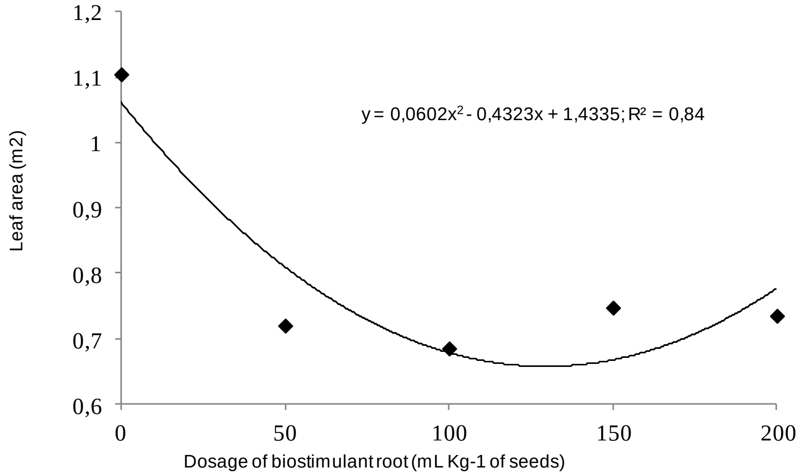

Figure 3. Leaf area according to dosages of root biostimulant in corn crop. UFMT, Sinop – MT.

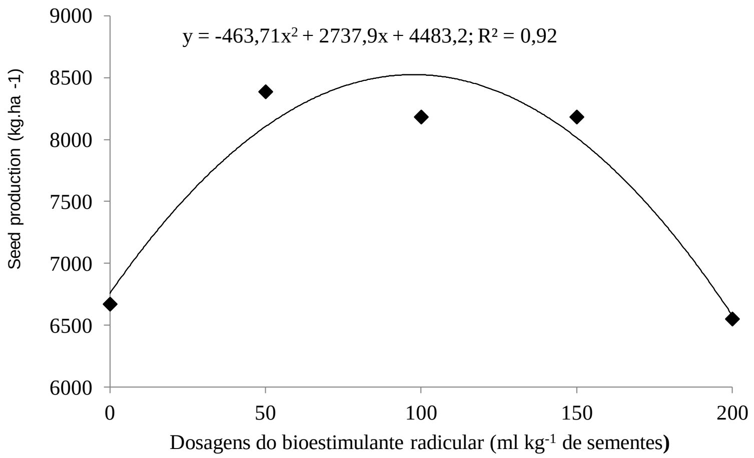

Figure 4. Grain productivity according to dosages of root biostimulants in corn crop. UFMT, Sinop – MT.

The grain productivity obtained in the experiment varied from 8,388 to 6,552 kg per ha^{-1}, with average of 7,470 kg per ha^{-1}. These values of corn grain productivity can be due to the good levels of pH, soil nutrients, high content of organic matter in the soil and to the fact that the area had been previously cultivated with continuous crops of soy beans. These values are considered high for the region where the experiment was conducted, considering the climate conditions at off-season harvest and the average productivity of corn in Brazil (CONAB, 2017). Results of research in the country show that off-season maize ("safrinha") has greater productivity potential than 6,000 kg per ha^{-1}, cultivated or not in succession to soy crop (Duarte, 2013; Silva et al., 2015; Fiorini et al. 2015).

More studies with the biostimulant are necessary in different locations, climate conditions and soil conditions with lower levels of nutrients, considering that the good levels of nutrients in the soil might have affected the maximum efficacy of the product.

Conclusions

The rates of biostimulants did not affect the height of the plants, thatch diameter, total chlorophyll, fresh matter and dry matter of the aerial part.

The rates of biostimulants promoted significant changes on the number of leaves and the leaf area, which suffered reduction in the values, given that this reduction occurred due to a possible increase in the root system of the plants.

The treatment of corn seeds with the Aminoagro Raiz, at the rate of 200 ml per kg^{-1} of seeds, higher than the manufacturer recommended dose, reduces the number of leaves and grain productivity.

The treatment of corn seeds with the biostimulant Aminoagro Raiz at the rate 50 ml per kg^{-1} of seeds recommended by the manufacturer increased grain productivity

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