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Nitrogen Fertilization Combined with Biostimulant in Second-Crop Maize

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Abstract – **In the aspects of production system for the corn crop the use of Biostimulant have great prominence. Thus, the objective of this study was to study the behavior of corn crop in the second crop in response to nitrogen doses and Biostimulants. The study was conducted at the Experimental Farm Luiz Eduardo de Oliveira Sales, in the municipality of Mineiros-GO. A randomized block design using a 5x2 factorial, corresponding to five doses of nitrogen fertilization based on urea (0, 60, 120, 180 and 240 kg ha^{-1}) was applied in two situations (presence and absence) of Festize Biostimulant Peixe® in three replicates. The planting took place on February 24. The system adopted was no-tillage with cv. 310 PRO2 in a population of 54,000 ha^{-1} plants. Nitrogen fertilization was applied in the phenological phases V4 and V8, with 50% for each and the Biostimulant in a single dose between the V7 and V8 stages, using a concentration of 2% of the commercial product and syrup in the volume of 400 l ha^{-1}. At the end of the experiment on July 13, 2016, the variables were taken. The results were submitted to analysis of variance, polynomial regression and comparison of means by Tukey test at 5% of probability. The use of Biostimulant did not influence the morphological characteristics evaluated as stem diameter, plant height, ear insertion height, ear diameter, ear length and productivity. According to the experimental conditions it is recommended the cultivation of corn cv. 310 PRO2 in the presence of Fert Peixe® Biostimulant combined with 145 kg of nitrogen.**

Keywords – **Zea Mays, Corn Safrinha, Bioregulators, Cereal.**

I. Introduction

The corn crop is one of the most important in the world due to its grain yield, chemical composition and nutritional value, being considered one of the most important cereals cultivated and consumed in the world (PIZOLATO NETO et al., 2016). For Silva et al. (2016), maize is one of the main cereals grown in the world, provides raw material to the industry for manufacturing food of human and animal origin (SILVA et al., 2016), where the United States is the largest producer 384.8, followed by China 219.6 and Brazil 91.5 million tonnes, corresponding to a record global production of 1,049.2 million tonnes in the world corn crop 2016/17, noting that Brazil had an increase of 36.6 % in reference to the 2015/16 crop (DEAGRO / FIESP, 2017).

Corn production in Brazil has been characterized by the division of production in two planting seasons. Summer plantings, or first harvest, are carried out in the traditional season during the rainy season, which varies between the end of August in the South until the months of October / November in the Southeast and Midwest, and the so-called "safrinha" maize with planting varying from January to the end of February.

The main uses of maize in the world are poultry and pig farming. World meat demand is forecast to continue to grow and estimates suggest consumption of more than 110 million tonnes of pork and nearly 70 million tonnes of poultry by 2015. The growing increase in world corn consumption (KAPPES et al., 2011). However, it is important to note that the yield of corn grains is a complex variable and depends on the interaction between genetic, environmental and management factors.

In this way, we have discussed the need to raise productivity levels and this has led to growing concern about the use of nutrients in fertilization (Martins et al., 2016). Nitrogen is one of the most limiting nutrients in the soil and one of the most required by cultivated plants to raise yield and harvest index, where corn is an example of a crop where nitrogen is used in large quantities, in the form of mineral fertilizers (CIVARDI et al., 2011).

Nitrogen is one of the essential elements for the nutrition of plants, however, there is a great difficulty in the handling of the same, since loss of this macronutrient can occur, as an example by volatilization. In relation to the plant the N is mainly part for the formation of the proteins and amino acid bonds, where they are synthesized by the foliar part of the plants. N in excess can cause intoxication and its lack causes loss of protein and decrease of green leaf area where the parts that turns yellow have lower CO2 absorption and lower metabolic reaction. According to Civardi et al. (2011), the main source of nitrogen used in Brazil is urea, which presents as advantages the high concentration of N and the lowest price of N per unit, high solubility, lower corrosiveness and compatibility with many fertilizers.

Nitrogen is the nutrient that represents the highest cost for the crop and is fundamental for the optimal growth and development of the crop in order to obtain high productivity, since the morphological components present a correlation with the productivity (SILVA et al., 2016). Their losses can occur through the processes of nitrate leaching, ammonia volatilization, denitrification and soil erosion (CIVARDI et al., 2011).

Also in the aspects of the production system, the use of Biostimulants or Bioregulators have great prominence because they are natural or synthetic substances that can be applied in seeds, plants and soil and cause changes in vital and structural processes in order to increase productivity and quality of seeds.

To achieve good performance the plant needs certain amino acids, vitamins and nutrients, for the synthesis of

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hormones and production of proteins or plant structures, Biostimulants help in this process. These bioregulators favor the expression of the genetic potential of plants through changes in vital and structural processes, promote the hormonal balance and stimulate the development of the root system (SANTOS, et al., 2013).

The objective of this work was to study the behavior of corn crop in the second crop in response to nitrogen doses and Biostimulants, under the conditions of the Municipality of Mineiros, GO.

II. Methods

The study was conducted at the Luiz Eduardo de Oliveira Sales Experimental Farm, in the municipality of Mineiros-GO, located between the geographic coordinates of 17° 34'10" South latitude and 52° 33'04" West longitude, with average altitude of 760 m. The average temperature is 22.7° C, the average annual rainfall is 1695 mm occurring mainly in spring and summer. The experimental area is classified as Aw climate (hot to dry). The soil of the experimental area was classified Neosolo quartzarenio ortico typical (EMBRAPA, 2013).

Before the installation of the experiment, soil analysis was performed in the 0-20 cm layer, with the following characteristics being verified (Table 1).

Table 1 – Attributes of soil chemistry and physics in the experimental area, UNIFIMES, Mineiros, GO.

MOS	pH	P Mehlich	K	Ca	Mg	Al	H+Al	SB	CTC	V	clay	silt	sand
g dm^{-3}	$CaCl_2$	mg dm^{-3}	----------------------mmol$_c$ dm^{-3}-------------------							%	-------g dm^{-3}-----		
35	5,6	23	1,8	25,0	8,0	0,0	16,0	34,8	50,8	68,50	160,0	20,0	820,0

A randomized block design using a 5x2 factorial, corresponding to five doses of nitrogen fertilization based on urea (0, 60, 120, 180 and 240 kg ha^{-1}) was applied in two situations (presence and absence) of Festize Biostimulant Peixe® in three replicates. The plots consisted of 4 lines of 4 m in length, spaced at 0.5 m between rows.

The planting fertilization was performed with 240 kg ha^{-1} in the formulation 7-25-25 to the haul, except for the treatment in which there was no nitrogen fertilization in which simple superphosphate was used as source of phosphorus and as a source of potassium potassium bandstand (SOUSA and LOBATO, 2004). The planting took place on February 24. The system adopted was tillage of the hybrid Formula TL Syngenta variety 310 PRO2 with 2.7 seeds per meter, totaling a population of 54,000 ha^{-1} plants.

Nitrogen fertilization was applied in the phenological phases V4 and V8, with 50% for each and the Biostimulant in a single dose between the V7 and V8 stages, using a concentration of 2% of the commercial product and syrup in the volume of 400 l ha^{-1}.

At the end of the experiment on July 13, 2016, with the grains in the humidity of 14.2%, the determination with moisture correction was carried out to 13%. The variables of stem diameter, plant height, ear insertion height, ear diameter, ear length and yield were also evaluated (BENINCASA, 2004).

The results were submitted to analysis of variance, where the description of the variables were performed as a function of the nitrogen doses, polynomial regression was performed by testing the linear, quadratic models and, with the choice of the significant models and those with the highest value of correlation with the means, observing the significance of the F test. A comparison of averages by the Tukey test was also performed at a 5% probability between the presence and absence of the Ferti Peixe® Biostimulant. All analyzes were performed using the statistical system System for Analysis of Variance - SISVAR (FERREIRA, 2011).

III. Results and Discussion

The morphological and productive behavior of the plants remained unchanged, among the analyzed variables there was no statistical effect regarding the presence and absence of the Ferti Peixe® Biostimulant via foliar. There were also averages of 21.84 mm, 227.94 cm, 73.41 cm, 47.98 mm, 14.38 cm, 143.41 sack ha^{-1}, respectively (Table 2).

Table 2. Mean of stem diameter, plant height, ear insertion height, ear diameter, ear length and yield of corn submitted to doses of urea, in the presence (P) and absence (A) of Ferti Peixe® Biostimulant via leaf. UNIFIMES, Mineiros – GO.

Factors of variance	--------------Plant--------------			-------- Spike --------		Yield
	Diameter stem	Height	Spike insertion	Diameter	Length	Sack ha^{-1}
	mm	---------cm---------		mm	cm	
Presença	22,08 a	226,93 a	73,24 a	47,49 a	13,93 a	144,99 a
Ausência	21,60 a	228,95 a	73,57 a	48,48 a	14,84 a	141,83 a
Média	21,84	227,94	73,41	47,98	14,38	143,41
DMS	0,76	4,01	2,79	0,71	0,41	8,34
CV	5,38	2,72	5,87	2,29	4,47	8,97

Means followed by the same horizontal letter do not differ from each other, by the Tukey test, at 5% probability.

The data corroborate with Martins et al. (2016) that did not find differences in stem diameter, plant height, dry shoot mass, root volume, root length and dry mass of the root system when evaluating the effect of commercial Biostimulant doses. Libera (2010) applying different Biostimulants such as MAXI ZINC®, BOOSTER®, SUPRA SÍLICA®, isolated or even mutual, also did not find differences in plant height and spike insertion parameters, as well as yield. However, Bertolin (2010) countered this information, evidencing increases of 23% in the soybean crop when compared to the control, performing a single application of biostimulant being the application via foliar or seed.

The mathematical model that best fit the stem diameter of corn plants was quadratic (Figure 1). It can be observed that in the presence of Biostimulant the stem diameter obtained a greater thickness when submitted to 144 kg of N reaching 23.71 mm, whereas in the absence, the maximum point was found in the dose of 134 kg of N, corresponding the stem diameter of 22.23 mm. Pizolato

Neto et al. (2016) and Civardi et al. (2011), did not find variation for stem diameter up to the dose of 140 and 232 kg ha^{-1} of N, respectively. It is of the utmost importance that fertilizers, especially nitrogen fertilizers, are applied in the maize crop in the most precise way possible, in order to potentiate the production systems, in the economic, productive and commercial aspects.

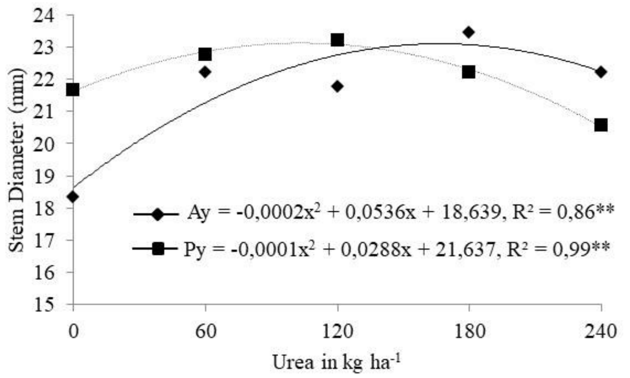

Fig. 1. Corn stalk diameter in the presence (Py) and absence (Ay) of Biostimulant via foliar, as a function of urea nitrogen fertilization. UNIFIMES, Mineiros – GO.

No adjustment of equation was observed in plant height and spike insertion parameters, both in the presence and absence of Biostimulant as a function of the urea doses. Differently from Pizolato Neto et al. (2016), observing that the dose between 110 kg ha^{-1} and 113 kg ha^{-1} provided the maximum plant height, with values below or above that promoted a decline in height. This is because a plant well nourished in N has a better development of leaf area and root system, since the nutrient directly influences the division and expansion of the cell and the photosynthetic process. According to Kappes et al. (2011), the greater the relationship between height of spike insertion and height of plant, the more dislocated will be the center of gravity of the plant and the greater the possibility of stem breakage, since corn allocates about 50% of the biomass in the grains at the end of the cycle. Because of this, breeders are seeking to obtain plants that have a lower spike insertion (PIZOLATO NETO et al., 2016).

According to the analysis of Figure 2, it can be observed that the highest average for ear length in the presence of Biostimulant was 99 kg of urea, which was 15 centimeters long, and in the absence of Biostimulant it required 227 kg of this to reach the largest length of 14 centimeters.

Similar results obtained by Civardi et al. (2011) evaluated the average length of corn cobs at different urea uptakes, it was concluded that the incorporated urea provided an average value (13.81 cm), followed by the higher dose of polymerized urea applied on the surface (12.94 cm) (12.24 cm), evidencing that the higher doses applied, and especially the urea application, had a direct influence on ear length.

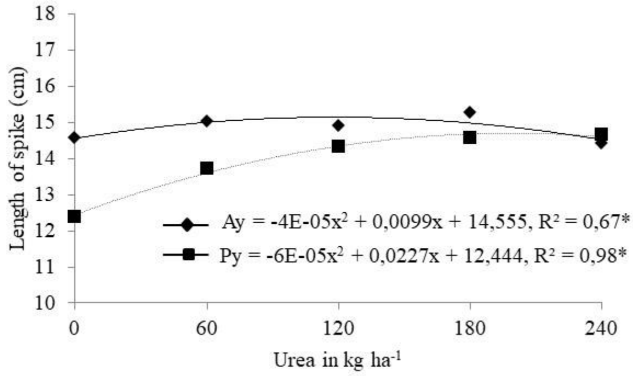

Fig. 2. Length of the corn ear in the presence (Py) and absence (Ay) of Biostimulant via foliar, as a function of nitrogen fertilization based on urea. UNIFIMES, Mineiros – GO.

The diameter of the spike was only influenced in the presence of Biostimulant, that is, the application of Fert Peixe® as a stimulant to increase the diameter of the spike were larger with the dose of 137 kg of N ha^{-1} obtaining a stem diameter with 55, 11mm (Figure 3). Studies by Civardi et al. (2011) corroborates with the data of this experiment, when not observing variations in the average diameter of the spike, when in the absence of Biostimulant, using coated urea and conventional surface applied. Lucas (2016) concluded that urea treated with urease inhibitors and nitrification did not promote significant differences in growth, nutritional status, and consequently corn grain yield relative to conventional urea.

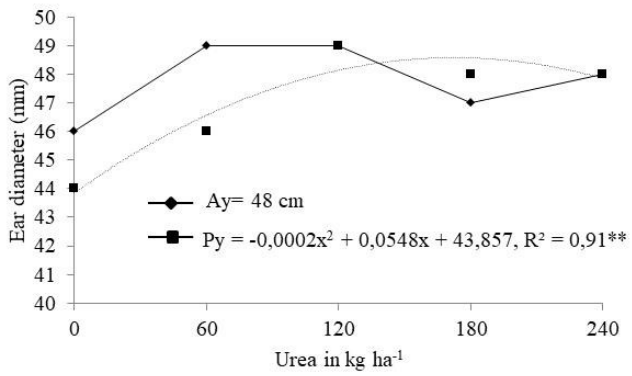

Fig. 3. Diameter of the ear of corn in the presence (Py) and absence (Ay) of Biostimulant via foliar, as a function of nitrogen fertilization based on urea. UNIFIMES, Mineiros – GO.

Nitrogen doses influenced productivity levels. In the presence of Biostimulant the optimized dose was 145 Kg of N, estimating a productivity of 167 sc ha^{-1} and, in the absence of Biostimulant, the dose that provided the highest productivity was 170 Kg of N reaching a yield of 146 sc ha^{-1} (Figure 4). The values were well above the averages of Brazil 95.86 sc ha^{-1}, Central West 101.3 sc ha^{-1}, Goias 112.82 sc ha^{-1} and Miners 135 sc ha^{-1}, referring to the second crop year 2015 (SIDRA-IBGE, 2017).

For silva et al. (2016), the success of cultivating this crop is due to the proper management, use of high quality seeds and, above all, to the correct application of nitrogen fertilizers, since fertilizer is the main input of modern agriculture, and is responsible for ensure the full potential of crops. Pizolato Neto et al. (2016) concluded that nitrogen fertilization provided a linear increase in maize productivity, where the highest value was found in the 140 kg ha^{-1} of N, which yielded a productivity of 6065.89 kg ha^{-1}. The linear responses were also found in corn crop by Silva et al. (2016).

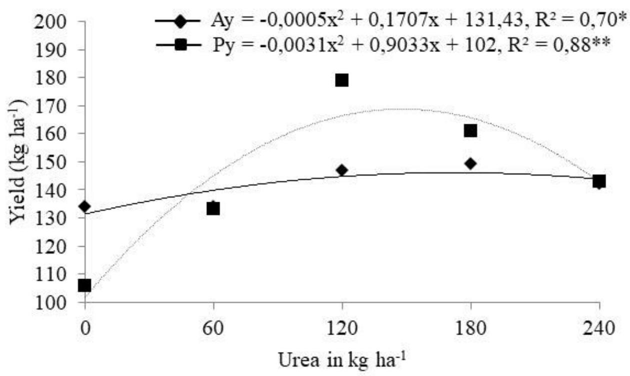

Fig. 4. Yield of corn in the presence (Py) and absence (Ay) of Biostimulant via foliar, as a function of urea nitrogen fertilization. Mineiros – GO. UNIFIMES, 2016.

According to Souza and Soratto (2006), in order to measure the best N doses, the application of 120 kg ha^{-1} of N provided a 22.1% increase in productivity, in relation to the control, but with the application of 60 kg ha^{-1}, productivity of only 1.5% was obtained. Data from Mar et al. (2003) also corroborate where he states that for grain yield, it was influenced by doses and times of application of N, where the highest productivity was obtained by the application of 131 kg.ha^{-1} of N, when the plants were in V8.

For Galvão and Miranda, (2014), most nitrogen research is focused on the definition of critical values above which there are no answers, serving such results to be used in programs of fertilization recommendations for maize.

IV. Conclusion

The use of Biostimulant did not influence the morphological characteristics evaluated as stem diameter, plant height, ear insertion height, ear diameter, ear length and productivity.

According to the experimental conditions it is recommended the cultivation of corn cv. 310 PRO2 in the presence of the Fert Peixe® Biostimulant combined with 145 kg of nitrogen.

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