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Nitrogen rates descendant from slow release fertilizers in maize top-dressing fertilization

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Maize (*Zea mays* L.) is a very important cultivation for Brazilian agriculture and throughout the years it has been enlarged in the country. It is cultivated in two seasons, the summer plantation and the winter-maize which happens after the soy harvesting. Brazil is one of the biggest maize producers and in order to increase this production it is necessary to use certain practices such as nitrogen manuring, which can be realized with low release fertilizer, namely Sulfammo®. This work was realized in the vegetation house located in the State University of Maringá – Umuarama Campus, through which the objective was to evaluate the maize plants' development with different doses of the product. The treatment obtained the following amounts: 0, 50, 100, 150 and 200 mg dm^{-3}. The statistical variability includes the plant's high, the culm's diameter, the chlorophyll content, the plant's color and the dry matter. It was observed that the increasing doses of nitrogen did not influence the maize plants.

Key words: *Zea mays* L., nitrogen manuring, agronomic characteristics.

INTRODUCTION

Maize (*Zea mays* L.) is a species of great importance in agriculture. Over the years it has been gaining ground in the country, it was grown in just one season, now the seeding is done in two seasons, the traditional summer planting, which took place during the rainy season, and maize, which refers to maize sown between February and March, usually after the early soybean (Embrapa, 2008).

According to FAO (2009/2010), the Brazilian harvest in 2008/2009 was around 51 million tonnes with yield close to 5000 kg ha^{-1}. To increase yield it is necessary to perform some suitable crop practices, such as fertilizer, especially nitrogen which is very important for the maize development (Embrapa, 2007). To Farinelli and Lemos (2010), nitrogen is a nutrient that acts on vegetative growth, directly influencing the division and cell expansion and plant photosynthetic process. In years when climatic conditions are favorable for the maize crop, the amount of N required to optimize the yield can reach values greater than 150 kg ha^{-1}. High quantity can hardly be supplied only by the soil, no need to use additional sources of this nutrient. Among these, stands alone or combined use of mineral fertilizers, manure and legumes (Amado et al., 2002).

In this alternative there is the use of slow release nitrogen fertilizer that provides nutrients to plants gradually, so requiring less frequent application, reducing spending on manpower for the subdivision and to avoid

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Table 1. Chemical characteristics and soil texture.

pH	P	O.M.	Ca	K	Mg	Al	C.C.C.	B.S.
$CaCl_2$	mg dm^{-3}	g dm^{-3}	--------------------cmol$_c$ dm^{-3}--------------------					%
4.2	2.3	6.4	1.38	0.13	1.0	0.0	6.78	36.9

Soil texture		
Sand	Silt	Clay
	--g kg^{-1}----------------------------------	
819	34	147

O.M. = Organic Matter. C.C.C. = cationic change capacity. B.S. = basis saturation.

injuries caused by excessive applications. An advantage of this product is that it is somewhat susceptible to losses, minimizing the risks of environmental pollution (Shaviv, 2001). Faria and Pereira (1992) commented that these sources also help to reduce losses by leaching and volatilization.

According to Kainuma et al. (2001), fertilization with slow release of nutrients is more feasible, because these types of source nutrients are being released to the culture according to the time and also the needs of this. An alternative to the use of slow release nitrogen fertilizer is the use of Sulfammo ®, which is a fertilizer with a 22% nitrogen, 19% in the form amide and the remainder as ammonium, where a double membrane coating of organo-type mineral interferes with the release of the molecules of the complex N-mppa (Drabl, 2008). Given the above, the objective was to determine the effect of nitrogen that comes from slow-release fertilizer in the maize development.

MATERIALS AND METHODS

The experiment was conducted in a greenhouse on the farm of Maringá State University, Regional Campus Umuarama-PR, the soil being used classified as oxisol (USA, 1998). The experiment consist of twenty 15 L vessels, which contain one plant per pot after thinning, the hybrid was used DKB 390PRO. The seeds were sown in February 2012. The soil was collected in an area not used for agriculture (Table 1), had characteristics with soil acidity, low organic matter content, low V%, these values were improved with fertilization at sowing which was made on the basis of soil analysis and recommendations (Cantarella and Raij, 1997).

The experimental design was a randomized complete block with four replications. Treatments will consist of rates of slow release nitrogen (0, 50, 100, 150 and 200 mg L^{-1}). The source Sulfammo® fertilizer was applied to cover, without addition, with the formation of Sulfammo® is 22% N, 18% K 2 O, Ca 4%, 2% Mg, 7% S, supplying the need for micronutrients. The nitrogen fertilization was performed in a single application, when the maize was at V5, plants had five expanded leaves, as recommended by Fancelli and Dourado Neto (2004).

The weed control was done manually with the emergence of the infestation. During the growing season measurements were made using plant height to tape, measuring the soil surface to the apex of the stem. We evaluated the diameters of the stalks in the first internode of the stem near the soil surface, using a caliper, the valuations of these characteristics were taken at 27, 34, 41, 48, 55 days after plant emergence.

We also measured the chlorophyll content in leaves using portable chlorophyll (SPAD) at the beginning of flowering. The color of the sheets using the colorimeter, which has a scale "L" ranges from 0 (black) -100 (white), the sheets colored nearest 0 are darkest and 100 are closer to clearer. The device also has a range "a" ranging from -120 (green) to +120 (red), with leaves that have more negative values show greenest, and the leaves that have more positive values show red coloration.

After removing the tops of the vessels, they were placed in paper bags and carried to the circulation oven at 65°C for 48 h for dry matter determination. Data were submitted to variance analysis, using the program Sisvar®, using the 5% level of significance. Means were analyzed by linear regression analysis and quadratic for the same level of significance.

RESULTS AND DISCUSSION

Through the analysis of variance it can be seen that there was no significant difference in plant height among treatments (Table 2), a result observed by Aratani et al. (2006), shows that when used increasing doses of nitrogen at V5 maize plant was observed. It was also found that the nitrogen did not influence the measurement of stem diameter (Table 3), agreeing with Carmo et al. (2012) with rates of 0, 50, 100 and 150 kg ha^{-1}, did not observe significant differences among treatments.

Stem diameter increased with days after emergence, but the smaller-sized plants with stems showed better development. Stems diameters on vegetative phase from18 to 20 mm, which is within the normal height of maize for this stadium. With the passage of time and change of stage, they may be higher, considering the claims of Fancelli and Dourado Neto (2004), where the authors noted that the stem is not only to support the plant, but it also used storage structure as soluble solids to be used for grain formation.

Table 4 shows the readings taken in chlorophyll (SPAD), the colorimeter (L and A) and dry, which showed no significant differences between treatments. Malavolta et al. (1997) reported that the chlorophyll has been used to determine the content of N of the sheet, as chlorophyll and nitrogen in plants are positively correlated.

Table 2. Plant height (cm) of maize under to nitrogen, using fertilizer sulfammo as a source (Umuarama/PR, 2012).

Rates (mg dm^{-3})	Plant height (cm) (DAE)				
	27	34	41	48	55
0	49.7	67.2	108.2	129.2	151.8
50	55.0	73.5	122.8	141.7	171.5
100	53.2	74.0	130.5	149.7	182.7
150	49.2	66.0	116.5	138.2	167.2
200	56.0	75.8	125.9	143.0	166.0
F test	n.s.	n.s.	n.s.	n.s.	n.s.
L.R.	n.s.	n.s.	n.s.	n.s.	n.s.
Q.R.	n.s.	n.s.	n.s.	n.s.	n.s.
V.C. (%)	7.1	7.6	13.4	12.7	11.5

DAE: Days after emergence, n.s. = not significant a 5% of probability, L.R. and Q.R. = Linear regression and quadratic regression, respectively, V.C. = Variation coeficient.

Table 3. Stem diameter (mm) of maize under to nitrogen, using fertilizer sulfammo as a source (Umuarama/PR, 2012).

Rates (mg dm^{-3})	Stem diameter (mm) (DAE)				
	27	34	41	48	55
0	14.8	17.2	18.1	18.7	19.3
50	14.9	16.1	16.9	17.3	17.8
100	15.0	17.1	17.8	18.2	18.7
150	13.3	16.2	17.0	17.7	18.1
200	14.3	16.7	17.7	18.3	18.7
F test	n.s.	n.s.	n.s.	n.s.	n.s.
L.R.	n.s.	n.s.	n.s.	n.s.	n.s.
Q.R.	n.s.	n.s.	n.s.	n.s.	n.s.
V.C. (%)	12.7	9.8	9.5	9.3	9.1

DAE: Days after emergence, n.s. = not significant a 5% of probability, L.R. and Q.R. = Linear regression and quadratic regression, respectively, V.C. = Variation coeficient.

Suggested parameters for them to chlorophyll maize plants will be 45 to 48, and values greater than those found in the experiment. The chlorophyll content was not significant chlorophyll, analysis is important for plant development, as said by Rambo et al. (2004) it serve to differentiate the N-deficient plants which show adequate levels of N, besides presenting a rapid diagnosis of crop and decision-making at the right time, about the need for nitrogen fertilizer. Besides being a faster method than the laboratory at low cost and does not involve the destruction of the leaves (Argenta et al., 2001).

By using the colorimeter it was observed that the intensity of color correspond to the formation of sheets, the values of "L" have a white color (100) to black (0), then the closest to the sheets 100 are more clear, since the values closer to 0 the leaves are darker. The values corresponding to "A" are green (-120) and red (+120), then treatments that have the most negative values are the treatments with the leaves greener. It was concluded that there was no significant difference between the doses used. Amarante et al. (2010) concluded that using the colorimeter was useful for determining the color intensity of the leaves and chlorophyll content.

In the dry there was no difference between treatments, contrary to what was observed by Araújo et al. (2004), when used nitrogen rates of 0, 60, 120, 180 and 240 kg ha^{-1}, where the amount of dry matter was increased and high doses of nitrogen was observed. There are some factors that suggest that the treatments were not significant, such as immobilization and mineralization of organic matter that occurs during decomposition of this, Malavolta (1980) stated that only 2% of nitrogen is mineralized in the soil for years, so even if soil has low amount of soil organic matter it may contain a nitrogen content that can meet the needs of the plant. According to Fernandes (2006) the largest amount of nitrogen absorbed by the plant is coming from the soil and to a lesser amount is coming from fertilizers added. However,

Table 4. Chlorophyll meter readings (spad), colorimeter readings (L and A) in leaves and shoot dry matter (grams) of maize under to nitrogen, using fertilizer sulfammo as a source (Umuarama/PR, 2012).

Rates (mg dm^{-3})	Chlorophyll meter readings	Colorimeter readings		Dry matter
	SPAD	L	A	grams
0	37.4	35.3	-13.1	52.5
50	35.4	34.4	-10.3	42.5
100	37.2	31.8	-10.0	42.5
150	34.5	33.5	-12.4	50.0
200	37.8	35.4	-10.9	55.5
F test	n.s.	n.s.	n.s.	n.s.
L.R.	n.s.	n.s.	n.s.	n.s.
Q.R.	n.s.	n.s.	n.s.	n.s.
V.C. (%)	31.5	10.4	24.1	21.4

DAE: Days after emergence, n.s. = not significant a 5% of probability, L.R. and Q.R. = Linear regression and quadratic regression, respectively, V.C. = Variation coeficient.

the amounts of the nutrients contained in the soil was sufficient for the culture to produce a satisfactory development and does not need to use nitrogen coming from the added fertilizer.

Conclusion

Rates of slow release nitrogen fertilizer Sulfammo® did not significantly influence the vegetative growth of maize.

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