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Replacement of nitrogen application in the soil by foliar in the culture of green corn

Substituição da aplicação de nitrogênio via solo pela foliar na cultura do milho verde

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Abstract: The fresh corn or green corn, consists of an alternative to generate income for small and medium producers because to the great demand for the product allied a good price. That cereal requests a strong absorption of nitrogen in his growth, and the deficiency of that substance is one of the largest factors that limits his productivity. The objective of this work is to evaluate the efficiency in the methods of application the nitrogen fertilizer in the characteristics of productivity of the green corn. This study has set up as completely randomized design, with four treatments, five blocks and two repetitions. The experiment was composed of four treatments, being: treatment 1 without the application of nitrogen in covering; treatment 2 with the application of urea on the soil surface; treatment 3 with the liquid application of a solution, in the interlineation of the corn; treatment 4 with the foliar application in a concentration of 14,3% of urea and 2% of sucrose. The forms of application of nitrogen in the green corn crop interfered in his productivity. The variance analysis revealed that there was significant difference among the application forms to 5% of probability for the test T. The application forms are restricted for a good performance in the productivity characteristics, could be recommended the forms of, soil applied, liquid solution and the foliar application without causing any loss in the weight and medium diameter of the ears of corn.

Keywords. fertilizer, urea, *Zea mays*

Resumo: O milho in natura ou verde, consiste em uma alternativa para geração de renda a pequenos e médios produtores devido à grande demanda pelo produto aliada a um bom preço. Esse cereal requer uma forte absorção de nitrogênio em seu crescimento, e a deficiência dessa substância é um dos maiores fatores limitantes à sua produtividade. O objetivo desse trabalho é avaliar a eficiência das formas de aplicação do fertilizante nitrogenado nas características de produtividade do milho verde. Nesse estudo, utilizou-se o delineamento experimental em blocos casualizados com quatro tratamentos, cinco blocos e duas repetições por bloco. O experimento foi composto de quatro tratamentos, sendo: tratamento1 sem a aplicação de nitrogênio em cobertura; tratamento 2 com a aplicação a lanço de ureia; tratamento3 com a aplicação fluida de uma solução, na entrelinha do milho; tratamento 4 com a aplicação foliar em uma concentração de 14,3 % de ureia e 2% de sacarose. As formas de aplicação de nitrogênio na cultura do milho verde interferiram em sua produtividade. A análise de variância revelou que houve diferença significativa entre as formas de aplicação a 5% de probabilidade pelo teste T. As formas de aplicação são limitantes para um bom desempenho nas características de produtividade, podendo ser recomendadas as formas a lanço, fluida e foliar sem ocasionar nenhuma perda nos rendimentos de peso e diâmetro médio das espigas.

Palavras-Chave. adubação, ureia, *Zea mays*

Introduction

The state of Tocantins, located in the central region of Brazil, has the potential to be a great producing center and distributor of wealths. Your agricultural activity has been growing, with emphasis on the production of soybeans, corn, rice and cotton. Although there is not being a tradition in the cultivation of vegetables, in the recent years the growing demand and the incentives of the government have been contributing to the formation of a "green belt" in the region of Palmas city.

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The corn (*Zea mays*) is a species of the grass family, originated in Mexico and Guatemala. It is the third cereal most cultivated in the world, extensively used as human food or animal feed because of the nutritional qualities. The green ears, it's an alternative to generate income for small and medium producer's due to the great demand for the product, allied to a good price. The green corn can be considered a vegetable because of the time of his permanence in the field until the moment of harvest, which is approximately 90 days after the planting. According to the agricultural census accomplished in 2006, were produced more than 268 thousand tons of green ears in Brazil. At present, with the agricultural techniques as well disseminated, the green corn is no longer seasonal passing to be produced during the whole year.

In corn plants, there is an intense absorption of Nitrogen in the early stages of development, being this deficiency one of the major limitations to the productivity (Deuner et al. 2008). The efficiency of the use of the nitrogen (N) in cereals in the world is only 33%. Considering the 67% of N that are not used, there is a substantial annual cost of nitrogen fertilization (Raun and Johnson 1999), in addition to the probable negative impacts on the environment (Schroder et al. 2000). In the case of the maize, the application of this element rarely exceeds 50% of efficiency as mineral fertilizer (Lara et al. 2004). This happens because the N applied in the soil is exposed to losses by leaching, surface runoff, denitrification, ammonia volatilization and immobilization in microbial biomass (Dawn et al. 2005). In general, it is thought that the main loss of N from the soil is by leaching, and to avoid it, is recommended to split fertilization. In fact, this loss is small. (Reichardt et al. 1982), studying data from various authors, concluded that leach losses are not a problem with the application of 90 kg N / ha. In tropical conditions, these losses are on the order of 4.5 grams of N per millimeter of rain, that is, 5% of that applied with 1,000 mm of rainfall. The main losses of N happen because of the soil mobilization of ammonia and denitrification. (Lara and Yamada 1999) showed losses of nitrogen because of the volatilization of urea greater than 30% in tillage planting, when it was applied superficially in the soil, and above 70% in no-tillage planting. In the attempt to minimize such losses, the fluid fertilizer of urea is a practice widespread in the culture of the sugarcane. With that same purpose, the foliar application of urea can be a practice to be followed, and a bit of that can be absorbed directly by the leaves. Calonego et al. (2012) in his study they had a positive response with the use of urea foliar spraying at low amount (5 kg ha^{-1}) in maize, in this way, the authors indicate this amount in a sequential way during the period of development of the corn. According to Rosolem and Boaretto (1989), the application of considerable amounts of nitrogen to leaves can come up against the problem of phytotoxicity occurrence, which can be minimized with the choice of the source of the nutrient, nozzle type, spray volume, and the time of pulverization.

The objective of this work is to evaluate the efficiency of the forms of application the nitrogen fertilizer in the yield characteristics of green corn.

Materials and Methods.

The experiment was developed in the experimental area of the Tocantins Catholic College, Campus of Agricultural, Environmental and Biological Sciences, located in the geographical coordinates 48°17'31.77 "W and 10°17'2.80 "S, and altitude of 230 meters, in the municipal district of Palmas - TO, in the period of February to May of 2012. According to the international classification of Köppen, the climate of the region is of type C2wA'a' - Climate humid with small water deficiency, in winter, potential evapotranspiration annual average of 1,500 mm, distributing it in the summer around 420 mm along the three consecutive months with highest temperature, presenting temperature and annual medium precipitation of 27,5º Celsius and 1600 mm respectively, and humidity relative average of 80% (INMET, 2012). The soil of the area is classified as red yellow Latosol, medium texture, with 22% of clay, 11% silt and 67% sand, the chemical analysis from 0 to 20 cm supplied by following results: pH in H_2O = 5,01; Ca = 3,2 $cmol_c/dm^3$; Mg = 2,0 $cmol_c/dm^3$; Al = 0,2 $cmol_c/dm^3$; H+Al = 1,7 $cmol_c/dm^3$; K = 50,8 mg/dm^3; P Mehlich = 3,6 mg/dm^3; O.M. = 17,1 g/kg. The conventional tillage planting occurred

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on 27/02/2012 with 31 kg/ha de N, 159 kg/ha de P_2O_5 e 95,6 kg/ha de K_2O, spacing 80 cm between lines and 2,8 seeds per linear meter equivalent to 35 thousand plants per hectare. The cultivar used in this study is a double-cross hybrid of corn Ag-1051. The experimental design consisted of randomized blocks with four treatments, five blocks and two replicates per block. Each block corresponds to an area of 6m², in other words, 2.5 meters in length over 2.4 meters of width. The experiment was composed of four treatments, being: T1 without the application of nitrogen; T2 with the application of urea on the soil surface in covering, using the equivalent dose of 100kg/ha at stages V3 and V5, totaling 200kg/ha; T3 with the fluid application of a urea solution, in the maize rows simulating a " liquid sidedressing " containing the equivalent of 100kg of urea diluted in 100 liters (lt) of water per hectare, applied at stages V3 and V5, totaling of 200kg/ha; T4 with the foliar application in a concentration of 14.3 % of urea equivalent to 50kg/ha plus 2% sucrose, in a solution equivalent of 350 lt/ha, at stages V3, V5, V6 and V7, thereby totaling 200kg/ha of this fertilizer. All of the treatments were accomplished after 18:00 hours. The characteristics evaluated in the productivity of maize were: length, diameter and weight of ears of corn with green ears with straw. The harvest of green ears of corn it happened on 12/05/2012.

The data were submitted to the variance analysis, being the averages compared by the test T to 5% of probability, using the Assistat software. The study was aimed to improve the efficiency of nitrogen fertilization and prove the effectiveness of foliar application and liquid in comparison of the application on the soil surface "in covering". It also allows flexibility in the forms of application of this nutrient in view of the technological levels available for the small, medium and large producers. The objective of this study was to evaluate and compare which would be the most effective way of applying this fertilizer, and his interference in the appraised productivity parameters.

Results and Discussion.

The forms of application of nitrogen in the culture of the corn (Ag 1051), interfered in the yield of green ears. The variance analysis revealed that there was significant difference among the application forms to 5% of probability for the test T.

The treatment 1, without nitrogen fertilization, presented value statistically equally only in relation to the average length of the green ears in the treatment 4, which was 22.87 cm in front of 23.00 cm from T1. Already for all the other appraised characteristics, the treatments 2, 3 and 4 were equally proportional amongst themselves and superiors in relation to T1 (Table 1). Albuquerque et al. (2013), they also observed increase in the yield of corn with nitrogen fertilization.

Table 1. Agronomic characteristics of green ears of corn. Palmas TO, 2012.

Agronomic characteristics of corn	T1 - Without Nitrogen	T2 - Soil surface	T3 - Fluid	T4 - Foliar	General Average	CV (%)
Average weight (grams)	164,63 B	207,67 A	200,99 A	195,06 A	192,09	14,79
Average length (cm)	23,00 B	25,15 A	24,79 A	22,87 B	23,95	7,96
Average diameter (cm)	4,61 B	5,04 A	4,93 A	4,90 A	4,87	5,46

[1]Average following for the letter do not differ statistically among themselves by T test at 5% probability.

Similar Biscaro et al. (2001), the applications of N in covering in comparison with the foliar did not influence on the diameter of the ears. The values found in this experiment with an average diameter of ears with straw, were 5.04 cm and 4.90 cm in treatments 2 and 4 respectively, which is equal among themselves, according to the statistical test, and higher than

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the value found by Couto et al. (2017) which was 4.73 cm and that is the same variety of corn employed in this study. The liquid and foliar fertilizer proved to be an efficient practice, without bringing any loss to the production, and can be recommended as an alternative to farmers, besides that, could be used the same equipment for pulverization of crop protection.

The schedule of application has to be observed, for the T2 and T4, since the distribution of urea on the soil surface may occur volatilization losses, according to the type of planting (tillage 30% and no-till 70%) according Lara e Yamada (1999). In agreement with that, T2 was equally proportional to T3 and T4, once that under conventional tillage planting, the volatilization cited above is low and with that, his efficiency was effective. In addition, the foliar application (T4) can cause phytotoxicity if applied in the hours that are not recommended.

Opposing Rosolem e Boaretto (1989) the application of "considerable" amount of nitrogen was possible in this research, that amount of nitrogen in T4 were exactly the recommended for the culture in subject, and that is the similar for T2 and T3 with 200kg/ha of urea.

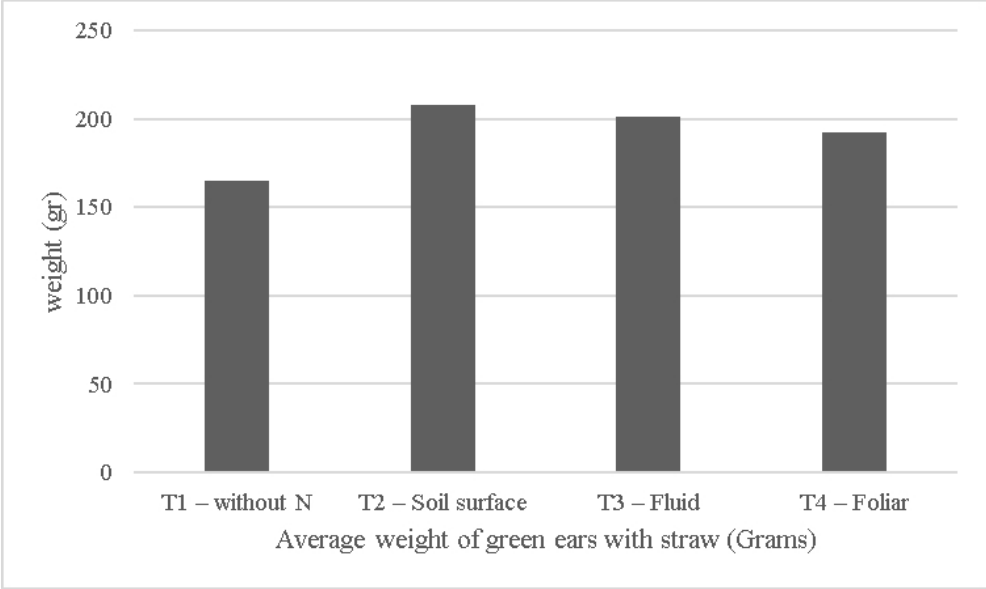

Figure 1. Graph of the average weight of ears. Palmas TO, 2012.

In the same way, T4 didn't show considerable phytotoxicity, so that for diameter and weight of ears (Figure 1), the values were statically the same to T2 and T3.

According to Kappes et al. (2013) considering the high prices of nitrogen fertilizers and the urgency of sustainable agriculture, the urea shows a cheap source of nitrogen available in the Brazilian market, and associated with sucrose in the pulverization solution, becomes a way to decrease phytotoxicity as it explains Malavolta (1980), " The presence of sugar in the solution of urea has the virtue of providing carbon skeletons which, by accepting ammonia, reducing the concentration in the tissue, preventing the toxicity", becoming a reality economically probable and having potential to be accepted by growers and the rural extension.

We can consider that the foliar application of nitrogen, in concentration of 14.3 %, did not cause phytotoxicity in corn in accordance with the methodology applied, contradicting the table proposed by Wittwer et al. (1963), which is extensively used as base for foliar feeding recommendation by private companies and others. As stated by Wittwer et al. (1963), the tolerance of maize is 0.6 to 2.4% concentration of urea applied in the leaves. Already in the opinion of Calonego et al. (2012), in his conclusion affirms that, a low dose of urea applied to leaves increases the productivity of corn. Sousa et al. (2017), obtained increase in the percentage of number of commercial ears, which the foliar feeding was more efficient. The author evaluated different levels of nitrogen and three forms of supply micronutrients in the culture of green corn cultivar Ag 1051.

In general, the forms of application of nitrogen presented can be used without bringing any loss to the appraised parameters of productivity of the green corn.

Conclusions.

The forms of application of nitrogen fertilizer are efficient to increase the yield of green corn. Are required for future studies, evaluate: plant height; weight of ears without straw; the number of ears; stem diameter; chlorophyll content in the leaves; and also repeat the experiment with no-tillage system planting.

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