GRAIN PRODUCTION OF CORN HYBRIDS UNDER DIFFERENT NITROGEN FERTILIZATIONS IN LOCAL SUBSUPERFICIAL IRRIGATION SYSTEM

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ABSTRACT: The objective of this study was to determine the most adequate nitrogen dose (0, 60, 120, 180 kg ha^{-1}) for grain production in six different hybrids: Dow 2B587 (H_1), Dekalb 175 Pro (H_2), Pioneer 30F53VYHR (H_3), Dow 2B587 PW (H_4), Dow 2B633PW C4M Cruiser (H_5) and St Helena SHS7930 PRO2 (H_6) grown under subsurface drip irrigation system. The experiment was conducted during the period from November/2016 to March/2017 in the experimental area of ESALQ / USP, in the city of Piracicaba - SP. The experiment was set in a randomized block design in a factorial scheme (6 x 4) with four replicates. Was evaluated the total grain yield. The data were analyzed using analysis of variance and the means were compared using the Tukey test, adopting a level of significance of 5% and regression analysis for studies of N rates. Nitrogen fertilization influenced significantly ($p < 0.05$) grain yield, where the six hybrids obtained increasing linear responses to nitrogen rates. Grain yield was significant ($p < 0.05$), where hybrids H_5 and H_6 obtained better results (9.63 and 9.65 Mg ha^{-1}, respectively), than H_1 (7.08 Mg ha^{-1}).

KEY WORDS: urea, drip, Zea mays, cultivars, rates, tensiometer.

PRODUÇÃO DE GRÃOS DE HÍBRIDOS DE MILHO SOB DIFERENTES ADUBAÇÕES NITROGENADAS EM SISTEMA DE IRRIGAÇÃO LOCALIZADA SUBSUPERFICIAL

RESUMO: Objetivou-se com este estudo determinar a dose de nitrogênio mais adequada (0; 60; 120; 180 kg ha^{-1}) para a produção de grãos em seis diferentes híbridos: Dow 2B587 (H_1), Dekalb 175 Pro (H_2), Pioneer 30F53VYHR (H_3), Dow 2B587 PW (H_4), Dow 2B633PW C4M Cruiser (H_5) e Santa Helena SHS7930 PRO2 (H_6), cultivados sob sistema de irrigação por

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gotejamento subsuperficial. O experimento foi conduzido durante o período de novembro/2016 a março/2017 na área experimental da ESALQ/USP, no município de Piracicaba - SP. O delineamento utilizado foi blocos ao acaso em esquema fatorial (6 x 4) com quatro repetições. Foi avaliada a produtividade total de grãos sob as diferentes doses de N aplicadas. Os dados foram analisados utilizando-se a análise de variância e as médias foram comparadas utilizando-se o teste de Tukey, adotando-se um nível de significância de 5% e análise de regressão para os estudos das doses de N. A adubação nitrogenada influenciou significativamente ($p < 0,05$) a produtividade de grãos, onde os seis híbridos obtiveram respostas lineares crescentes para doses nitrogenadas. A produtividade de grãos foi significativa ($p < 0,05$), onde os híbridos H_5 e H_6 obtiveram melhores resultados (9,63 e 9,65 Mg ha^{-1}, respectivamente), comparados ao H_1 (7,08 Mg ha^{-1}).

PALAVRAS-CHAVE: ureia, gotejamento, *Zea mays*, cultivares, doses, tensiômetro.

INTRODUCTION

Recently, maize crop cultivated in irrigated systems has significantly increased, which has led to alterations on the farming management, by planning a more intensive surface use to compensate the high investments, with a higher number of crops on the systems and the possibility of using a higher amount of fertilizers (Pavinato et al., 2008).

Results have been demonstrating that nitrogen is the most required nutrient in amounts by the maize crop, it also is the one that most frequently limits the grain yield. (Pavinato et al., 2008).COELHO & FRANÇA (1995) have discussed that the low yields average found in Brazil have as main generating factors, besides fertilization, mainly with N and K, the high extractive capacity of the maize crop. While in Brazil the average amount of N used is 60 kg ha^{-1}, in the United Stated and China, it is 150 and 130kg ha^{-1}, respectively (Araújo et al., 2004). In irrigated areas, as the risks of a severe crop production breakdown are minimized, the farmers tend to use higher amounts of fertilizers, even above the recommended levels, expecting a higher yield (Pavinato et al., 2008).

Nitrogen is amongst the nutrients that affect the most the grain yield increase in maize crop culture, for; it takes a structural part in cytochromes as well as in the chlorophyle molecule (BULL, 1993). This crop responses to nitrogen fertilization, such as those from other crops, are related to characteristics inherent to the cultivars sewn, the crop management, mainly the seeding density, soil usage conditions and climatic conditions, mainly the rainfall distribution (LANTMANN et al., 1985).

For having such an important economic representation, many studies are under development to improve this very crop, especially in what concerns nitrogen fertilization. The main objective in exploiting this culture is determining yield as a function of maximizing the profits, so fertilizing takes a main place in improving the system and achieving the desired yield. Considering this, the objective of this work was determining the response of six maize hybrids to the application of different nitrogen amounts.

MATERIAL AND METHODS

The experiment took place in an experimental area at ESALQ/USP (Latitude 22º 42' south and Longitude 47º 38' west, altitude of 546 m) from November 2016 to March 2017. The climate in the region, according to Köppen's classing is Cwa – Subtropical dry winter, where hot summers take places, not frequent rimes and rainfall concentrated during the summer (KOTTEK et al., 2006). The soil in the region is classed as "Nitossolo Vermelho eutroférrico latossólico" in the brazilian soil system (SANTOS et al., 2010).

Seeds were sown manually on November 5th 2016, fertilizers used on sewing were of formulation 0-14-14 (N, P_2O_5, K_2O) and the amount used was 400 kg ha^{-1}. Cover fertilization took place along with nitrogen fertilization on December 10th 2016. Crop management required only two manual weedings. The following maize hybrids were used: DOW 2B587 (H_1), DEKALB 175 Pro (H_2), PIONEER 30F53VYHR (H_3), DOW 2B587 PW (H_4), DOW 2B633PW C4M CRUISER (H_5) and Santa Helena SHS7930 PRO2 (H_6).

Each plot was irrigated by drip lines which had emitters disting 0,5m from each other, the average flow rate was 1 L h^{-1}, and three drip lines by plot were used between the crop sewing lines. Irrigation management was based on 6 tensiometers set at 0,20m deep. The observed data was collected every 4 days and irrigated when the observed level was at 10 kPa according to (ANDRADE; STONE, 2011). A 20 mm irrigation took place after sewing for the germination. This way, the applied irrigation depth was determined by the difference between volumetric moisture on field capacity and (Θ_{cc}) and annual volumetric moisture (Θi), times the effective root depth (Z), which was equal to 400 mm. Moisture at field capacity (θ_{cc}) was considered as moisture correspondent to the value of Ψ_m = 0,06 bar (ANDRADE; STONE, 2011). The values of Θi were estimated based on a soil water retention curve, obtained with the aid of a Richards' extractor at “Laboratório de Solos e Qualidade da Água” at ESALQ/USP and ajusted by the following equation (VAN GENUCHTEN, 1980):

$$\Theta i=0,268+\left[\frac{(0,4934 - 0,2938)}{[1+(0,113\Psi_m)^{1,3211}]^{0,2431}}\right] \text{ ; } (R^2=1,00 \text{ e } p<0,01)$$

Where:

Θi = Actual volumetric moisture (cm^3 cm^{-3})

Ψ_m = Actual soil water matric potential (bar)

Irrigation depth accumulated while the experiment lasted was 34.76 mm distributed on 3 subsequent irrigations. While the experiment lasted, total rainfall was 700.6 mm, of which 407.8 mm on vegetative phenological growth stages and 292,6 mm on reproductive growth stages.

The harvest took place 150 after seeds were sewn. In order to evaluate grain yield, corn cobs in 1 linear meter were taken, sewing distance of 0,7m, totalizing 0,7m² of usable area to evaluate each treatment. That was an average of 7 plants by linear meter, the distance between plants of 15 cm and plant population density was of 100 thousand plants per ha^{-1}.

The experiment was set in randomized block design with factorial scheme, factor 1 was maize hybrids (a total of six) and factor two the nitrogen levels (0, 60, 120 e 180 Nitrogen kg ha^{-1}), with four repetitions. The experiment was composed of 96 experimental plots which had dimensions of 3.2 m x 3.85 m, a total surface of 12.32 m² each one, totalizing 1182,72 m² for the whole experiment. The data was submitted to an analysis of variance by a factorial test with a 5% significance level and when significant differences where accused, a Tukey test for the factor “hybrids” was made and a regression analysis to the factor nitrogen. The software used for this analysis was Assistat 7.7 beta (FRANCISCO; CARLOS, 2016).

RESULTS AND DISCUSSION

The average grain yield of the respective hybrids are shown on table 1.

TABLE 1

Hybrids H_5 and H_6 had the highest total grain yield (TGY) followed by hybrids H_2 and H_4. Hybrid 1 had the lowest PTG when compared to hybrids H_2, H_5 and H_6, about 35 and 36% lower to hybrids H_5 and H_6, respectively.

FIGURE 1

From this regression analysis, a linear trend was observed for the variable TGY (Figure 1). According to this figure, the highest TGY is observed for the N fertilizer level (180 kg ha^{-1}) which is according to Souza et al. (2016), who, working with experiments in sweet corn at Chapadão do Sul/MS found a maximum water usage efficiency to a N level very similar to the one found in this experiment (N dose 168.4 Kg ha^{-1}). Such behavior suggests that even higher yields may be achieved with higher N amounts.

Silva et al. (2016) obtained similar linear responses to TGY, with a level of 9011.7 kg ha^{-1} achieved with his highest tested amount of nitrogen (90 kg ha^{-1}). Although in the present experiment the highest amount of nitrogen was 80 kg ha^{-1}, which corresponded to a PTG of 10745.6 Kg ha^{-1}, higher when compared to the obtained by Silva et al. (2016), the response was slightly more preeminent. Such behavior was supposedly due to edaphoclimatic influences and the sewing of different maize hybrids.

Higher productivities were obtained by Freire et al. (2010), which found an increasing linear PTG in function of N levels, which has led to yields of 15 and 16 Mg ha^{-1} with a maximum nitrogen amount of 200 kg ha^{-1}. In an experiment where urea was used in soil cover fertilization, Silva and Silva (2003) obtained a maximum green corn cob yield of 14.8 Mg ha^{-1} (Silva e Silva, 2003). Nonetheless, Fernandes and Buzetti (2005) evaluated the influence of the defoliation on corn development and grain yield and a maximum yield was obtained by the cultivar AVANTE (6991 kg ha^{-1}) with the estimated nitrogen amount of 142 kg ha^{-1}.

The response of maize in yield increments in function of N amounts is possibly due to the fact that this nutrient may cause more significant effects in growth and development characteristics in plants, which, directly or indirectly affect the yield, where the N must be available to the (Okumura et al., 2011). Thus the larger doses may have prolonged the effect of nitrogen along the corn growth and contributed to the higher yields.

However, when hybrids are submitted to elevated nitrogen amounts there is a decrease in total grain yield which may be for the fact that the N supply may exceed the crop needs, characterizing luxury consumption (Fernandes et al., 2005). The potential yield requires that the nutritional needs be plenty satisfied due to the high extraction of soil nutrients, being nitrogen the most required one and the one that most frequently limits the yield (Fornasieri Filho, 2007). The present experiment identified the nitrogen level of 180 kg ha^{-1} as the one with the highest correspondent yield, but it did not identify the nitrogen level which will return the maximum crop potential grain yield.

CONCLUSION

1. The amount of nitrogen influenced the total grain yield.
2. The N amount of 180 kg ha^{-1} was the level with the highest observed grain yield.
3. The hybrids presented increasing responses to the N fertilizer levels, but the maximum amount of N fertilizer which will result in the highest yield was not found.
4. For grain yield, the highest values were observed for the hybrids H_5 and H_6 (9625.4 e 9651.7 kg.ha^{-1}, respectively) when compared to H_1 (7080.6 kg.ha^{-1}), which significantly differed ($p < 0.05$).
5. The genetic material influences directly on the yield, in response to the proposed investment, either fertilization or irrigation.

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Table 1. Average grain yield per hectare, from each hybrid, Piracicaba-SP, 2016/2017.

Variable	Maize hybrids						Average
(kg ha^{-1})	H_1	H_2	H_3	H_4	H_5	H_6	
TGY	7080,6 c	8694,3 ab	8024,2 bc	8570,1 abc	9625,4 a	9651,8 a	8607,7

* The averages followed by the same letter do not differ statistically amongst themselves considering a Tukey test at 5% significance.

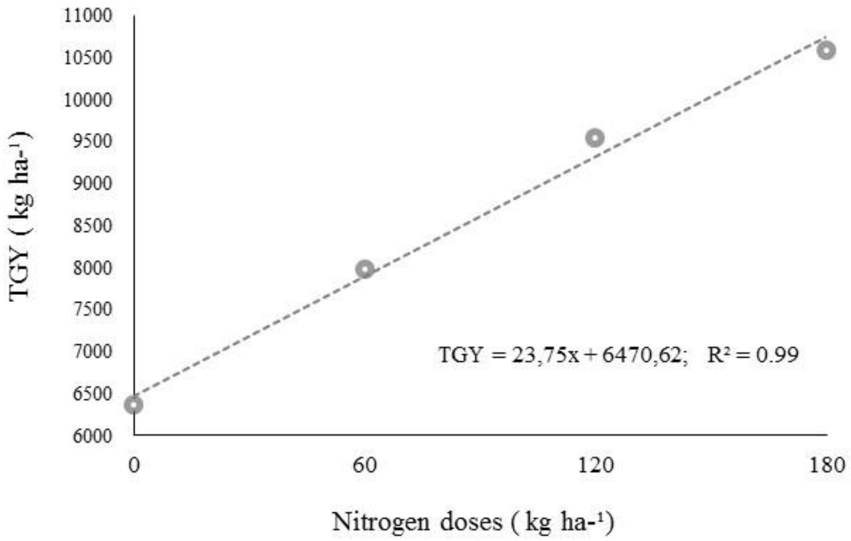

Figure 1. Regression analysis to Total Grain Yield (TGY). Piracicaba-SP, 2015/2016.