Agronomic Characters of Corn as Function Fertilizers and Rates of Nitrogen at Winter

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RESUMO – O nitrogênio é o nutriente absorvido em maiores quantidades pelo milho e o que tem maior influencia no rendimento de grãos e sua dinâmica no sistema solo-planta depende do seu manejo. Esta pesquisa teve o objetivo de avaliar o efeito de fontes e doses de nitrogênio em cobertura em algumas características agronômicas da cultura do milho irrigado no período de inverno. Os tratamentos foram constituídos da combinação de duas fontes nitrogenadas (uréia e sulfato de amônio) com cinco doses de nitrogênio em cobertura (0, 40, 80, 120 e 160 kg ha^{-1}) em que metade da dose foi aplicada na quarta folha expandida e a outra metade na sexta folha expandida. O delineamento experimental foi em blocos casualizados no esquema fatorial (2x5) com quatro repetições em cada tratamento. Observou-se que entre os componentes de produtividade do milho, o número de grãos por fileiras apresentou resposta quadrática em relação à dose de N em cobertura. A dose de máxima eficiência técnica foi de 105,8 e 71,5 kg ha^{-1} de nitrogênio para uréia e sulfato de amônio o que correspondeu a 8.481,70 e 8.645,7 kg ha^{-1} respectivamente.

Palavras-chave: *Zea mays* L., adubação, terceira época.

Introduction

Corn crop has been presented great importance to agro-economic worldwide situation because of its importance to human, animal food and biofuel production in the United States of America. In Brazil, several researches has been presented high grain yield potential, in some cases 10.000 kg ha^{-1} at research conditions and farmers that has been adopted adequate technologies (CARVALHO et al., 2004).

In the last years, this crop has been changed relation to management as fertilization, use of adequate hybrid, crop season, and this resulted an increase of grains yield in several regions in the country. (VON PINHO et al., 2009). One of main factors to low yield is inadequate fertilization management. Among them, nitrogenous fertilizers use to corn fertilization demand a bigger attention than other because it efficiency is influence by soil tillage, kind of nitrogenous fertilizer, environmental conditions and hybrid (PORTO & STORCK, 2003; SILVA et al., 2006). The demand of mineral nutrient demand must be supply because of big nutrient uptake from soil. Nitrogen is the most demand nutrient by corn and it rates ranges from 50 to 90 kg ha^{-1} in dry fields and 120 to 150 kg ha^{-1} for irrigated places (SOUZA et al., 2003).

There is a big concern about nitrogenous fertilizers use, because of loss by erosion, leaching, volatilization and high energetic costs to produce them and this has been increase some alternatives to combine rate, kind of nitrogen fertilizer to get better corn plant nutrition, grains yield and decrease nitrogen loses (LOPES et al., 2004; SOUSA & LOBATO, 2004). Nitrogen soil availability to plants is controlled by straw degradability and mode of supply of this nutrient to crop, and, has been looked that when is used cover soil crops with low relation C : N in dry weight, the conversion from nitrogen organic to mineral is faster than cover soil crops with high C : N relation (SILVA et al., 2006; PAVINATO et al., 2008).

Several researches has been carried out looking for get the best combination between rate and nitrogen fertilizer but results are inconsistent. Oliveira and Caires (2003) did not see difference between ammonium sulfate and urea to grains yield. However, Cabezas et al. (2005) looked that ammonium sulfate (before planting and at coverage) increase grains yield (847 kg ha^{-1}).

So, is necessary search for agricultural techniques that reduce nitrogen loss, increasing nitrogen use efficiency, and corn yield at winter to attract farmers interest and solidify a new planting season at Brazil. Although many studies has been looked the Best combination between rate and nitrogen fertilizer at first and second crops, but are little researches at winter. Therefore, researches must be carried to verify that combination to corn at winter.

This research seek to verify rates and fertilizers of nitrogen on sidedressed to irrigated corn at winter in Selvíria-MS.

Materials and Methods

This research was carried out at field in experimental area of Universidade Estadual Paulista “Júlio de Mesquita Filho” in Selvíria, Mato Grosso do Sul State. Geographical coordinates were 51º 22’West and 20º 22’ South with elevation of 335 m above sea level. Soil type is a Latossolo Vermelho Distrófico (EMBRAPA, 2006). The average of annual temperature is 23.5 ºC, with rainfall of 1.370mm and air humidity ranges from 70 to 80% (HERNANDEZ et al., 1995).

Therebefore corn planting were collected twenty soil samples at 0-0,2 m depth to chemical evaluation of soil fertility according to methodology proposed by Raij & Quaggio (1983) and results were: pH ($CaCl_2$) = 5.0; 31.0 mg dm^{-3} of P; 3.1; 15.0; 8.0; 36.0; 26.1 and 62.1 mmolc dm^{-3} of K, Ca, Mg, H+Al, SB and CTC, 19.0 g dm^{-3} of organic matter and (V%) = 42.0.

Soil tillage was did with one harrow plow and two leveling harrow, one of this after harrow plow and the other before planting. Corn was planted at 12th July at 6 seeds m^{-2} and 0.9 rows, hybrid used was Herculex I. At planting fertilization was used 450 kg ha^{-1} of 04-30-10 + 0.3% of Zn. Corn seeds was coated with 2.5 + 1.0 g of a.i. ha^{-1} of fludioxonil + metalaxil-M and with 0.2 g + 0.8 g of i.a. of insecticides deltrametrina + pirimifós metílico, in each 100 kg. Water supply was done by a sprinkler irrigation system, and to water management, in each five days, was provided 40mm. Weeds control at post emergence was done with 1.500 g do i.a. of atrazine ha^{-1}, at 2nd expanded leaf, tembotrione (100.8 g ha^{-1} of a.i.) at 4th and nicosulfuron (60 g ha^{-1} of a.i.) at 5th.

Experimental design used was randomized blocks at factorial scheme 2x5 with four replications. Treatments applied were two nitrogenous fertilizers (urea and ammonium sulfate) and five nitrogen rates (0, 40, 80, 120 and 160 kg ha^{-1}). Nitrogen fertilization was made two times: first half of rate was sidedressed at 4th expanded leaf and the other at 6th. Plots had four plant lines of 4 m length at 0.9 m row spacing.

Were evaluated; rows in cob and grains in row, five randomized cobs were chosen and were counted the number of rows in cob and grains in row in each cob; grains in cob, was multiplied the number of rows in cob with grains in row; leaf area index (LAI), readings were made at flowering at first con height using a linear ceptometer model AccuPAR LP-80. In each replication were made four simultaneous readings above and below canopy between 13:30 and 15:00 without intermittent clouds; weight of one hundred grains, were weighted two randomized subsamples of 100 grains in each plot and weight was corrected to 13% moisture; grains yield; grains from plots were weighted and this was adjust to 13% moisture and results converted to kg ha^{-1}.

Statistic evaluations of results were made by Tukey test at 5% of probably. Regressions were fit when looked significative effect of planting densities or interaction between planting densities and nitrogenous fertilizers and was chosen mathematic model that showed biggest R^2 value.

Results and Discussion

The averages of rows in cob (RIC), grains in row (GIR), grains in cob (GIC) and leaf area index (LAI) to corn, at winter, as function fertilizers and rates of nitrogen in sidedress are presented in Table 1.

Treatments did not significative effect to rows number in cob. Tomazela et al. (2006) researching cultivars and rates of nitrogen also didn't found difference to rows in cob among treatments used in them research. Ohland et al. (2005) reported that rows in cob is a yield compound relationed to genotype and it's not influenced by crop practices.

The number of grains in row was influenced only by rates of nitrogen. Results had a quadratic adjust as function increase of nitrogen rate an the biggest value, 36 grains in row, was gotten with 83 kg ha^{-1} of nitrogen. Veloso et al. (2006) looked that 39 grains in row was find with 116 kg ha^{-1} of nitrogen.

Grains in cob didn't show significative effect of nitrogenous fertilizers, rates and interaction among them wasn't significative. Souza et al. (2011) in study with hybrid AG520 in two years at second crop, didn't look significance of nitrogenous fertilizers. Silva et al. (2006) in research with hybrid DKB350 looked quadratic adjust to this characteristic with biggest answer, 496 grains in cob, at 230 kg ha^{-1} of nitrogen.

Leaf area index was influenced only by nitrogen rates. Results had a linear adjust since 0 to 160 kg ha^{-1} of nitrogen. Veloso et al. (2009) in study with 0, 50, 100, 150 and 200 kg ha^{-1} of nitrogen at hybrid 30P70 also verify increase of leaf area index of corn plants as function rate increase. This can be relationed to big nitrogen levels in the soil because increase of rate and it is the most demand nutrient and that had influence increase of leaves area and light interception (TAIZ & ZEIGER, 2009).

At one hundred weight didn't looked significative effect of rates, nitrogenous fertilizers and interaction among them wasn't significative. This can be relationed to similar grains in cob and assimilated translocation was similar among treatments. Oliveira and Caires (2003) didnt't find difference among urea at sidedressed or with mixture with soil and ammonium sulfate at sidedressed in no tillage. Casagrande and Fornasieri Filho (2002) also didn't looked effect of rates and seasons of application at one hundred weight.

Grain yield had effect of rate, nitrogenous fertilizer and interaction among them was significative. Unfold of nitrogenous fertilizers and rates are presented in Table 3. Nitrogenous fertilizers inside was looked that urea was superior to ammonium sulfate. Rate inside fertilizer had a quadratic adjust as urea so ammonium sulfate, however, the biggest grain yield was gotten with 105.8 and 71.5 kg ha^{-1} of nitrogen to urea and ammonium sulfate and this provide

8.481,70 and 8.645,7 kg ha^{-1} respectively. Mar et al. (2003) also verify positive answer of nitrogen fertilization in corn and the biggest grain yield was provide with 120 kg ha^{-1} of nitrogen.

Conclusion

Was looked that among yield compound of corn, the grains in row had quadratic adjust in relation to nitrogen rate in sidedressed. The biggest grain yield was gotten with 105.8 and 71.5 kg ha^{-1} of nitrogen to urea and ammonium sulfate and this provide 8.481,70 e 8.645,7 kg ha^{-1} respectively.

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Table 1. Averages of rows in cob (RIC), grains in row (GIR), grains in cob (GIC), one hundred weight (OHW), grains yield (GY) and leaf área índex (LAI) of corn as function fertilizers and rates of nitrogen in sidedressed at winter. Selvíria, MS, Brazil, 2011(1).

Treatment		RIC	GIR	GIC	OHW	GY	LAI
Nitrogenous fertilizes (NF)	Urea	18,0a	37,8a	652,5a	19,82a	8.073,65a	2,58a
	Ammonium sulfate	18,0a	37,0a	643,3a	18,89a	6.891,24b	2,69a
Rates (R) (kg ha^{-1})	0	16,0	39,0(2)	647,2	17,20	7.010,60	2,28(3)
	40	16,0	38,0	644,4	18,28	7.823,57	2,48
	80	18,0	36,0	631,5	20,89	7.595,06	2,60
	120	18,0	38,0	681,0	19,80	7.836,10	2,75
	160	18,0	40,0	635,5	20,61	7.146,90	3,08
DMS		0,54	1,27	30,88	0,19	2,89	386,73
F test	NF	$0,14^{ns}$	$1,65^{ns}$	$0,37^{ns}$	$0,45^{ns}$	41,22**	$1,45^{ns}$
	R	$1,82^{ns}$	3,90**	$1,35^{ns}$	$1,04^{ns}$	3,47*	8,46**
	NF x R	$0,50^{ns}$	$0,31^{ns}$	$0,17^{ns}$	$0,24^{ns}$	3,11*	$0,64^{ns}$
VC (%)		4,79	5,25	7,34	11,12	19,48	6,74

[1]Averages followed of same letter don't differ among them in column at 1 and 5% probably by Tukey test. ^{ns} not significative; ** e * significative at 1 and 5%. [2]$Y = 0,0004N^2 – 0,0664N + 38,23$; $R^2 = 0,86$. [3]$Y = 0,0047N + 2,26$; $R^2 = 0,96$. VC (variation coefficient).

Table 2. Unfold of interaction between nitrogenous fertilizers and nitrogen rates to grain yield. Selvíria, MS, Brazil, 2011.(1)

Treatments (kg ha^{-1})	Urea	Ammonium sulfate	F test
0	7.621,53a	6.399,67b	8,80**
40	7.861,83a	7.785,31a	$0,03^{ns}$
80	8.161,85a	7.028,26b	7,57*
120	8.886,65a	6.785,55b	26,03**
160	7.836,39a	6.457,42b	11,21**
-	R.Q**[2]	R.Q**[3]	-

[1]Averages followed of same letter don't differ among them in column at 1 and 5% probably by Tukey test. ^{ns} not significative; ** e * significative at 1 and 5%. [2]$Y = -0,09N^2 + 19,04N + 7474,7$; $R^2 = 0,56$. [3]$Y = -0,13N^2 + 18,59N + 6.651,9$; $R^2 = 0,54$.