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LEVELS OF N AS COATED UREA AS AFFECTING UPLAND RICE PRODUCTION

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Introduction

Nitrogen fertilization can improve upland rice grain yield. Urea is the most used N fertilizer for upland rice. However, this fertilizer has a great percentage of N loss. Galloway et al. (2002) reported that even in well-managed cereal crops, about 40 to 60% N is lost. Urea is the most common N source in rice production worldwide (Fageria, 2009). Tisdale et al. (1993) also reported that the most cost effective granular form of N is urea [(CO(NH2)2], which is widely used as a N source because it has a high N concentration (45%) and lower relative manufacturing, handling, storage, and transportation cost. The use of products that provide reduction of N loss from urea fertilizer can contribute to increase N use efficiency in rice crops. As examples of products to be used to reduce N loss in the agricultural systems we have polymer-coated urea (PCU), which provide reasonable/good control over the rate of N release (Trenkel, 2010). The N-(n-Butyl) thiophosphoric triamide (NBPT) is one of the most thoroughly studied urease inhibitor (Kiss and Simihaian, 2002). The organo-phosphorus compounds are structural analogues of urea and are some of the most effective inhibitors of urease activity, blocking the active site of the enzyme (Trenkel, 2010). Another product is urea coated with boric acid and copper sulfate, which provide positive effects in reducing N volatilization losses (Fansuri et al., 2008). The acidifying effect, the similar structural characteristics of boric acid with urea and the defensive effect of B and Cu from the soil microorganisms may deviate part of the urease activity towards boric acid, and consequently decrease N volatilization losses (Faria et al., 2013).

Data related to comparison of PCU and common urea in upland rice grown on Brazilian Oxisols are limited. The objective of this field research was to determine the effect of N rates applied in the form of coated urea in the grain yield of upland rice.

Methods

The field experiments were conducted for two growing seasons (2010/2011 and 2011/2012) at Capivara Farm, located in the city of Santo Antonio de Goias, GO, Brazil. The geographical coordinates of the site are 16° 28' 00" S, 49º 17' 00" West. The altitude of the site is 823 m. The climate is tropical savanna, considered Aw according to the Köppen classification. There are two well-defined seasons: usually, the dry season extends from May to September (autumn / winter) and the rainy season from October to April (spring / summer). The historic average annual rainfall ranges from 1500 to 1700 mm. The historic average annual temperature is 22.7 °C, ranging annually from 14.2 °C to 34.8 °C.

The soil was classified as a clay loam (kaolinitic, thermic Typic Haplorthox) acidic soil. Prior to the experiment chemical characteristics of the soil were determined at depth of 0-0.20 m to characterize the soil in the experimental area. In the area pH was 5.9 ($CaCl_2$), organic matter 22 mg dm^{-3}, Ca 4.3 cmolc dm^{-3}, Mg 1.4 cmolc dm^{-3}, Al 0.0 cmolc dm^{-3}, H + Al 2.4 cmolc dm^{-3}, K 169 mg dm^{-3}, P 7 mg dm^{-3}, S-SO_4 3 mg dm^{-3}, B 0.2 mg dm^{-3}, Cu 1.3 mg dm^{-3}, Fe 35 mg dm^{-3}, Mn 62 mg dm^{-3}, and Zn 3.6 mg dm^{-3}. The soil analysis was performed according to Embrapa (1997).

The experimental area has been cultivated in a crop-livestock no-tillage system (NTS) for seven consecutive years, which consists of following the crop rotation program with soybean (summer), followed by upland rice (summer) and the common bean (winter), followed by corn and Brachiaria (summer), followed by two years of grazing pasture. The installation of the experiments was conducted in plots wherein the upland rice was the crop to be grown following the program of crop rotation.

The experimental design was a randomized complete blocks layout arranged in a 4x4 factorial design with four replications. The treatments consisted of four source of N fertilizer [1. traditional urea, 2. Polymer coated urea for slow release of N (PCU), 3. urea with the urease inhibitor N-(n-Butyl) thiophosphoric triamide (NBPT) and 4. urea coated with copper sulfate and boric acid as urease inhibitors (UCCB)] with four fertilization rates (0, 30, 60 and 90 kg ha^{-1} of N). The plots consisted of 10 eight-meter-long rows, spaced 0.35 m apart. The useful area of each plot was formed by the six central meters of the six central rows.

The sowing was performed mechanically, using 80 kg of rice seeds per hectare from a mutant line 07SEQCL441 CL, which is derived from a Primavera variety and is resistant to Imazapyr + Imazapic herbicide. The seed was sowed on December 4th, 2010 and November 17th, 2011 in the first and second growing seasons, respectively. The base fertilization, to be applied in the sowing furrows, was calculated according to the soil's chemical characteristics and the recommendations of Sousa and Lobato (2004). The fertilizer consisted of 17.50 kg ha^{-1} of N (urea), 105 kg ha^{-1} of P_2O_5 (triple superphosphate) and 52.5 kg ha^{-1} of K_2O (potassium chloride) and was applied together with at sowing. Nitrongen application was split and 50 % of N rate was applied right after upland rice seedling emergence (on December 10th, 2010 and November 23th, 2011 in the first and second growing seasons, respectively) and 50 % at full tillering stage (on January 7th, 2011 and December 22th, 2011 in the first and second growing seasons, respectively). The fertilizer was applied in strip by hand 0.10 m far from rice rows.

Plots were evaluated with regard to: number of panicles, which was determined by counting the number of panicles in 1.0 m^2 in the useful area of each plot; percentage of full grain, which was evaluated randomly, collecting and counting number of full grain and dividing by the total number of grains and multiplying by 100 in two samples of 100 grains from each plot; and grain yield, which was determined by weighing the harvested grain of each plot, corrected to 13% of water content and converted to kg ha^{-1}.

An analysis of variance and F test were performed for all variables. A comparison of means was performed with a Tukey test ($p \leq 0.05$) for source of fertilizer. A regression analysis was used for quantitative data (fertilizer levels). These analyses were performed using SAS statistical software.

Results and discussion

Shoot dry mass, number of panicle m^{-2}, percentage of full grain and grain yield was not affected by the source of N fertilizer (Table 1). On the other hand, shoot dry mass, number of panicle m^{-2}, and grain yield were significantly influenced by the addition of N by the sources of N (Figure 1). Fageria et al. (2010) and Fageria et al. (2011 a, b) also reported increases in these characteristics with the addition of common urea and ammonium sulfate as N sources in a quadratic fashion. According to Fageria et al. (2011b), nitrogen is one of the most yield limiting nutrients in rice production and it is responsible for increasing straw yield and yield components which are positively related to grain yield.

Conclusions

Sources of N were equally effective in upland rice production in Brazilian Oxisol; Nitrogen addition by the four sources improved upland rice production.

Keywords: *Oryza sativa*, nitrogen, yield components, grain yield

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Table 1. Shoot dry mass (SDM), number of panicle m^{-2} (PAN), percentage of full grain (%GRAIN), and grain yield (GY) of upland rice in relation to source of N fertilizer and dose. Average of two growing seasons 2010/11 and 2011/12.

Factors	SDM	PAN	%GRAIN	GY
Source of N fertilizer	kg ha^{-1}	number	%	kg ha^{-1}
Urea	5645 a	230 a	75 a	4056 a
Urea polymer	5573 a	244 a	73 a	4022 a
Urea NBPT	5674 a	251 a	72 a	3941 a
Urea CuB	5285 a	229 a	76 a	3768 a

[1]Means followed by the same letter do not differ by the Tukey test for $p<0.05$.

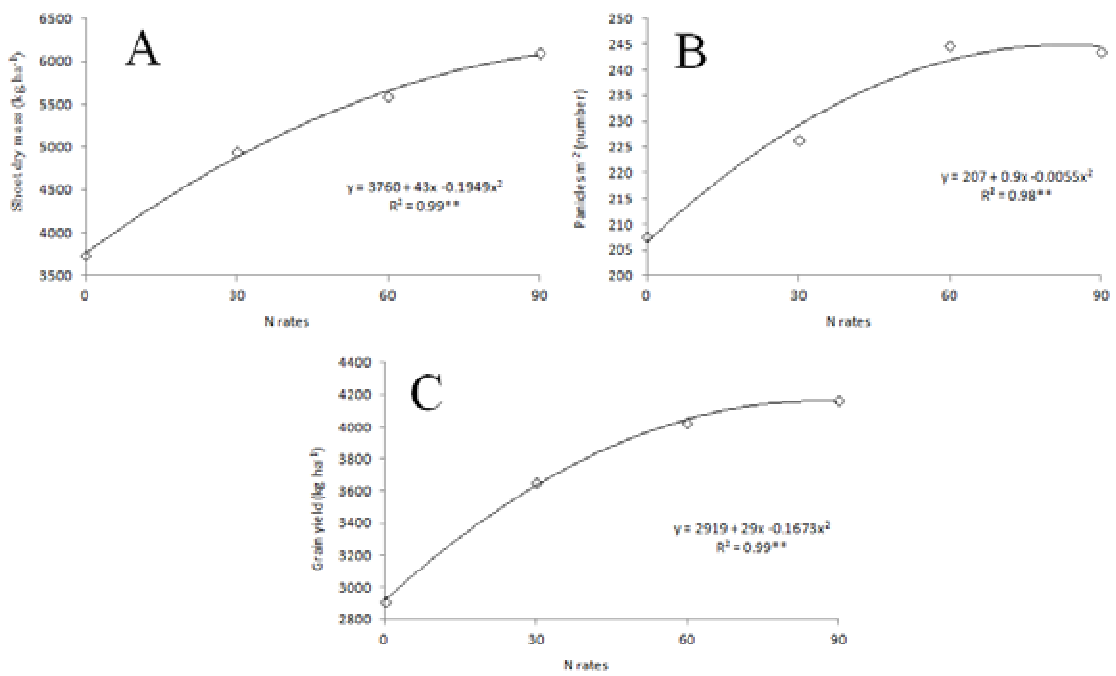

Figure 1. Shoot dry mass (A), panicle m^{-2} (B) and grain yield (C) of upland rice as a function of N rates. Average of two growing seasons