WHEAT RESPONSE TO NITROGEN IN THE PROVINCE OF NIASSA, MOZAMBIQUE

RESPOSTA DO TRIGO AO NITROGÊNIO NA PROVÍNCIA DE NIASSA, MOÇAMBIQUE

José Eloir Denardin[1]; Celso A. P. Mutadiua[2]; Henoque Ribeiro da Silva[3]; Cesar Heraclides Behling Miranda[3]. Pedro Moreira da Silva Filho[4]; Gilvan Ferreira Barbosa[5]; Ivan Cruz[6]; Maria da Conceição Santana Carvalho[7]; Maurisrael de Moura Rocha[8]; Norman Neumaier[4]; Raul Porfirio de Almeida[5]; Fernando João Sualei[9]; João Leonardo Pires[1]

[1]Embrapa Trigo, Rod. BR 285, km 294, C.P. 451, 99001-970, Passo Fundo, RS, Brasil. E-mail: jose.denardin@embrapa.br and joao.pires@embrapa.br [2]MRE-ABC, IIAM-CZNw, Av. De Trabalho, Lulimile, C.P. 238, Lichinga, Niassa, Moçambique. E-mail: celsomutadiua@yahoo.com.br. [3]Embrapa SRI, Parque Estação Biológica - PqEB s/n°, Brasília, DF, Brasil. E-mail: henoque.silva@embrapa.br; cesar.miranda@embrapa.br. [4]Embrapa Soja, Rod. Carlos João Strass, Distrito de Warta, C.P. 231, 70770-901 Londrina, PR, Brasil. E-mail: pedro.moreira@embrapa.br and normann.neumaier@embrapa.br. [5]Embrapa Algodão, Rua Oswaldo Cruz, Centenário, C.P. 174, 58428-095 Campina Grande, PB, Brasil. E-mail: Gilvan.ferreira@embrapa.br and Raul.almeida@embrapa.br [6]Embrapa Milho e Sorgo, Rod. MG 424, km 65, C.P. 285 or 151, 35701-970 Sete Lagoas, MG, Brasil. E-mail: Ivan.cruz@embrapa.br. [7]Embrapa Arroz e Feijão, Rod. GO 462, km 12, Zona Rural, C.P. 179, 75375-000 Santo Antônio de Goiás, GO, Brasil. E-mail: maria.carvalho@embrapa.br. [8]Embrapa Meio Norte, Av. Duque de Caxias, 5650, Buenos Aires, 64006-220 Terezinha, PI, Brasil. E-mail: maurisrael.rocha@embrapa.br. [9]IIAM-CZINw, Av. De Trabalho, Lulimile, C.P. 238, Lichinga, Niassa, Moçambique. E-mail: fsualei@gmail.com

Resumo

A produção de trigo moçambicana atende apenas 5% da demanda nacional, fato que justifica investir no desenvolvimento de sua agricultura. Nesse contexto, o trigo assume relevância na composição de sistemas diversificados de produção, seja em atenção as metas do plano nacional de produção de alimentos, seja na prevenção de evasão de divisas do país. O Nitrogênio (N) é um importante componente da produção de trigo, ficando atrás apenas da água. Neste trabalho descrevem-se resultados de experimento conduzido para verificar a resposta do trigo a adubação nitrogenada em área do Corredor de Nacala. O desenho experimental foi de blocos ao acaso, com cinco tratamentos, correspondentes a doses de 0, 40, 80, 120 e 150 kg de N/ha. O objetivo deste estudo foi avaliar o desempenho da cultivar de trigo BR 18, que é adaptada a condições de savanas tropicais, a doses de 0, 40, 80 e 160 kg/ha de nitrogênio. A fonte de N foi a uréia, com 45% N. Cada tratamento teve quatro repetições. As unidades experimentais cobriram 8,4 m2 (1.4 x 6 m), em linhas espaçadas entre si 0,2m. Avaliações de crescimento e produção foram feitos em área de 1,8m2, nas três linhas centrais (0,6 m de largura). A variedade de trigo usada foi a BR 18, que é adaptada para condições de savanas tropicais. A dose de N estimada para o máximo rendimento de grãos, 2,075 kg/ha, foi de 140 kg N/ha. Para a máxima eficiência técnica, no entanto, a dose econômica foi de 78 ou 104 kg N/ha, correspondendo, respectivamente, aos rendimentos de 1,868 e 2,006 kg/ha de grãos.

Palavras chave: *Triticum* spp. Fertilizantes. Adaptação de plantas. Savanas.

Abstract

Wheat is an important part of the Mozambique diet, but national production accounts for only five percent of demand. Thus, it is urgent to invest in the development of production system of this cereal, to attend the national plan of food production as well as to prevent revenue expenditures abroad. Nitrogen is an important component of wheat production, second only to water. In this work it is described the results of an experiment whose objective was to evaluate the response of wheat to N fertilization in area of the Nacala Corridor. Experimental design was a randomized block encompassing five treatments, corresponding to rates of 0, 40, 80, 120 and 150 kg N/ha. N source was Urea, with 45% N. Each treatment was replicated four times in the field. Experimental units covered 8.4 m^2 (1.4 x 6 m), in lines spaced 0.2 m. Evaluations were made within a useful area of 1.8 m^2, encompassing the three central lines (0.6 m wide) and 3 m of length. Wheat cultivar was BR 18, which is adapted to tropical savannas conditions. The N rate estimated for maximum yield of grains, 2.075 kg/ha, was 140 kg N/ha. The maximum technical efficiency was estimated with the economical rate of 78 or 104 kg N/ha, corresponding, respectively, to 1.868 and 2.006 kg/ha of grains.

Key words: *Triticum* spp. Fertilizers. Plant adaptation. Savannas.

Introduction

Nitrogen (N) is second only to water deficiency as limiting factor for agricultural production. It is the largest nutrient for wheat productio, being part of proteins, enzymes, coenzymes, nucleic acids, fitochromes and chlorophyll. Its presence affects the rate of foliar expansion (PÖTTKER & ROMAN, 1998) and determines the number of ears per plant (MUNDSTOCK & BREDEMEIER, 2002). Its deficiency reduces evapotranspiration and water use efficiency (NIELSEN & HALVORSON, 1991), as well as the interception of solar radiation (ABBATE et al., 1995). So, the availability of N, in appropriated amounts, is essential to assure wheat productivity and grain quality.

All wheat production determinant components can benefit from N availability, except plant stand (ZAGONEL et al., 2002). N may increase the number of spikelets per spike, the number of grains per spikelet, size and mass of grain. The late is poorly affected because of strong environmental effects during its formation. Although N determines increments, there are compensatory interactions among these components, and results can be either positive or negative in each one. Thus, within a same pattern of productivity it is possible to see different measurements for each of these parameters, rendering difficult to establish an optimal combination of these wheat productivity components (LAMOTHE, 1998).

The main source of soil N is the soil organic matter. Its availability to plants depends upon the organic matter mineralization rate, which is variable according to temperature, moisture, aeration, and soil pH (URQUIAGA & ZAPATA, 2000). Given this complexity of interactions, several studies on soil and environmental conditions of Brazil have indicated that an efficient supply of N to wheat relies on the adequate use of N fertilizers (PÖTTKER & ROMAN, 1998).

It is important to check out the response of wheat in the environmental specific conditions where this crop is being. Here we report a study conducted in this line of research in the Province of Niassa, Mozambique.

Material and Methods

The experiment was conducted in the experimental field of the Centro Zonal de Investigação Noroeste (CZINw), of the Instituto de Investigação Agrícola de Moçambique, in Lichinga, province of Niassa, in the crop season 2012/2013. Soil in the area is a clayish one, with main characteristics as presented in Table 1.

Experimental design was a randomized block encompassing five treatments, corresponding to rates of 0, 40, 80, 120 and 150 kg/ha of N. N source was Urea, with 45% N. Each treatment was replicated four times in the field. Experimental units covered 8.4 m^2 (1.4 x 6 m), in lines spaced 0.2 m. Evaluations were made within a useful area of 1.8 m^2, encompassing the three central lines (0.6 m wide) and 3 m of length.

Wheat variety used as control plant was wheat cultivar BR 18, generated by Embrapa, which was planted in 14/12/2012. Plant emergence started 19/12/2012, flowering started in 28/02/2013, and physiological maturation of grains was attained in 18/03/2013. Full harvest was made in 6/04/2013. The following evaluations were made at the final harvest: plant stand; height of plants; number of spikelet per unit area; number of grains per spikelet and per ear; grain production and weight of 1000 grains.

Data measured for every parameter was compared with variance analysis at 5% probability and, when significant, submitted to regression analysis.

Results and discussion

If compared to the criteria nowadays used for statement of soil fertility in brazilian cerrados (savana-like) soils, that are similar to those in the studied area, we can assume that the soil has got medium fertility (Table 1). Availability of Potassium (K) is “good” and of Phosphorus (P) is “very good”. Basis saturation is “low”, as it would be better if above 50%. Soil pH, Al^{+3} saturation and organic matter are “low”, all according to LOPES (1994).

The measured values for plant final stand, height of plants, number of spikelet per unit area, number of grains per spikelet and per ear, and weight of 1000 grains are presented in Table 2. None of these parameters showed significant effect (P>0.05) of the N rates, being difficult to establish a sole cause for such result, as there were several problems affecting the best performance of the plants.

There was an unexpected higher number of plants/m2 (varying from 505 to 759), far above the ideal 360 plants/m^2, according RCBPTT (2013). Stand was also affected by manual cleaning of weeds in the inter-row space during plant growth. Also, and more important, there was a severe water stress during the vegetative stage, followed by excess of water through rain during the grain filling stage. These external factors affected most components of wheat production. None of the measured parameters that add to plant production (weight of 1000 grains, plant height, stand of plants, number of spikelets per unit of area, number of grains per spikelet or spike) showed significant correlation ($P>0.05$) with grain productivity.

On the other hand, the number of grains per unit of area and grain productivity were positively affected by the N rates, with a quadratic response, as can be seen in Figure 1.

The higher number of grains PE area was estimated to be 12,085, with a rate of 136 kg of N/ha. FRIZZONE et al. (1996) describes that increasing rates of N reduces the aborting of wheat ears and increases the number of grains per spike and per unit of area, although not necessarily having effects on the grains mass.

There was a positive and significant correlation ($P<0.05$) between the number of grains per unit of area and the rate of 140 kg N/ha. This is better expressed by the equation $Y = 1.92X + 285$ (Equation 1), with a coefficient of determination (R) equals = 0.982. At this rate of N, maximum grain productivity would be 2,075 kg/ha. According to MALLMANN et al. (1994), the number of grains per unit of area usually is more important to the grain productivity than the mass of grains.

Considering 90% of the maximum estimated productivity of grains (1,868 kg/ha) as the maximum efficiency of fertilization with N, according to FAGERIA et al. 1997), the best economical rate of N would be 78 kg/ha. However, if we consider that in Mozambique the actual relation of kg of N and kg of wheat grain is 3.9, the best economical rate of N would be 104 kg/ha. This rate would be enough to an equivalent production of 2,006 kg/ha, extrapolating data using Equation 1. These N rates are higher than those indicated for wheat crop in the Brazilian Cerrados, around 60 kg/ha (RCBPTT, 2013).

One reason for such large discrepancy may be credited to the high level of rains at the beginning and at the end of the wheat cycle in this study, which may have caused high lixiviation of N away from the plants roots, and, hence, lower N efficiency. But this assumption has to be seen with caution, because it is known that the response to N depends not only upon environmental conditions, but also on the wheat variety ability to look for N in the soil. We tested a single variety, which performs well in similar conditions in Brazil, but not necessarily in the environmental conditions of Lichinga. Also, the economical efficiency varies with the relation between the cost of N as fertilizer, and the cost of the wheat grain.

Conclusions

The N rate estimated for maximum grain productivity (2,075 kg/ha) of wheat cv. BR 18, in the cropping season 2012/2013, was 140 kg/ha.

The economical rate of N estimated for maximum technical efficiency of wheat cv. BR 18, in the 2012/2013, cropping season was 78 or 104 kg/ha, equivalent, respectively, to 1,868 or 2,006 kg of grains per hectare, depending upon the tested technique.

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Table 1. Chemical characteristics of the soil within the experimental Field of the Centro Zonal de Investigação Noroeste (CZINw), Lichinga, Niassa, Mozambique, determined in samples collected in October 2012 from 0 to 20 cm depth.

Clay	pH water	P	K	MO	Al	Ca	Mg	V
g/dm³		mg/dm³		g/dm³	cmol/dm³			%
440	5.1	23.7	116	24	0.65	11.5	4.5	25.7

Table 2. Yield components of the wheat cultivar BR 18 under nitrogen increasing rates in the experimental field of the Centro Zonal de Investigação Noroeste (CZINw), Lichinga, Niassa, Mozambique, cropping season 2012/2013.

Nitrogen rate (kg/ha)	Thousand seed weight (g)	Plant height (cm)	Stand of plants (plants/m^2)	Spikelet density (number/m^2)	Grain per spikelet	Grain per spike
0	45.98	65.95	505	7,269	0.35	5.08
40	50.00	73.15	719	10,636	0.31	4.54
80	49.14	73.95	722	11,167	0.37	5.70
120	45.69	75.10	759	11,238	0.44	6.35
160	49.71	75.20	624	9,242	0.47	6.91
CV (%)	7.56	9.94	24.38	25.34	33.86	30.66

Observação: Dados não significativos pela análise da variância a 5% de probabilidade de erro.

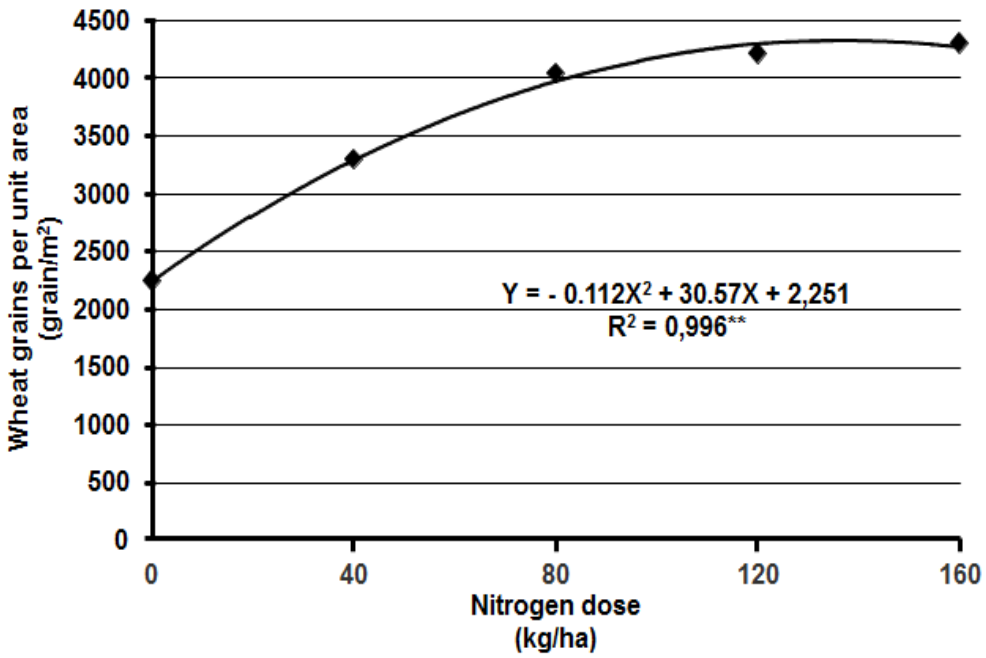

Figure 1. Wheat cv BR 18 number of grains per unit of area (grains/m^2)in response to increasing N rates in the environmental conditions of Lichinga. Experimental field of IIAM/CZINw, Lichinga, Niassa, Moçambique. Crop season 2012/2013.

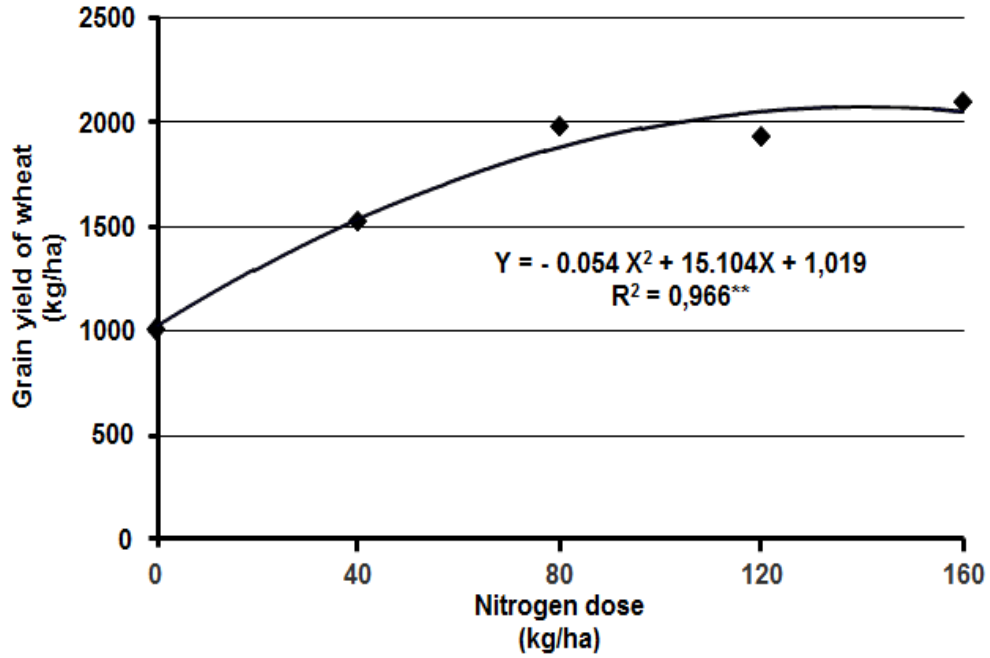

Figure 2. Wheat cv BR 18 grain yield (kg/ha) in response to increasing N rates in the environmental conditions of Lichinga. Experimental field of IIAM/CZINw, Lichinga, Niassa, Moçambique. Crop season 2012/2013.