RESPONSE OF WHEAT TO SOIL LIMING IN LICHINGA, NIASSA, MOZAMBIQUE

RESPOSTA DO TRIGO A CORREÇÃO DO SOLO COM CALCÁRIO EM LICHINGA, NIASSA, MOÇAMBIQUE

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Resumo

A agricultura é fator fundamental no desenvolvimento de qualquer nação, por garantir a produção de alimentos e matéria-prima, pela geração de emprego e renda, com formação de mercados e promoção de bem-estar à população. O Projeto ProSAVANA, Componente 4 – Projeto de Investigação, objetiva gerar conhecimentos e tecnologias que viabilizem a agricultura no âmbito do Corredor de Nacala, estruturada em sistemas diversificados de produção, com base em agricultura de conservação. O trigo é uma parte importante da dieta moçambicana, mas a produção nacional atende apenas 5% da demanda. Isto justifica investir no desenvolvimento de sistemas de produção para este cereal, tanto no sentido de atender as metas do plano nacional de produção de alimentos, como na prevenção de evasão de divisas do país. O objetivo deste estudo foi avaliar o desempenho da cultivar de trigo BR18, é adaptada a condições de savana tropical, a doses crescentes de calcário dolomítico (0, 1,25, 2,5, 3,75 e 5,0 Mg/ha). O estudo foi conduzido na área do Centro Zonal Noroeste do Instituto de Investigação Agrária de Moçambique, em Lichinga, Niassa. A cultivar estudada respondeu positivamente a correção do solo com calcário dolomítico, com melhores resultados de produção até a dose de 3,2 Mg/ha, com rendimento de 1.307

kg/ha de grãos de trigo. Estes resultados indicam a necessidade do uso de calcário para garantir a produção de trigo na região.

Palavras chave: *Triticum* spp. Calcário dolomítico. Acidez do solo. Projeto Pro Savana.

Abstract

Agriculture is a fundamental factor to the economical development of any nation, being a warrant of food production and raw material, the generation of jobs and revenue, with formation of market and promotion of well fare. Trough the ProSAVANA Component 4 – Investigation Project, it is intended to generate knowledge and technologies that make viable technically and economically the agriculture in the region that encompasses the Nacala Corridor. It is based in the diversification of production systems, under the precepts of conservation agriculture. Wheat is an import 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. The objective of this study was to evaluate the performance of the wheat cultivar BR18, which is adapted to tropical savannas, when supplied with increasing rates (0, 1.25, 2.5, 3.75 and 5.0 Mg/ha) of dolomite lime. Study was conducted in area of the Northwest Zonal Centre of the Instituto de Investigação Agrária de Moçambique, in Lichinga, Niassa. This wheat cultivar showed a positive response to lime addition, with best results at the rate of 3.2 Mg/ha, with an estimated production of 1.307 kg of grains per hectare. Such result indicates the need of using dolomite lime to assure wheat production in the area.

Key words: *Triticum* spp. Dolomite lime. Soil acidity. Pro Savana project.

Introduction

Agriculture is a fundamental factor to the economical development of any nation. It could be pointed out among its main roles: production of food and raw materials; generation of jobs, cash and revenue; opportunity for new markets; and promotion of people's welfare. Also, maintenance and recovery of natural resources and economic gains of the rural sector are promoted if agriculture is practised within the precepts of conservation agriculture, with the adoption of technologies directed towards environmental preservation.

In countries such as Mozambique, there is no doubt on the importance of agriculture for development. Attending this perception, through the ProSAVANA-PI, Component 4, it we intend to generate knowledge and technologies that make viable technically and economically the agriculture in the region that encompasses the Nacala Corridor. It is based in the diversification of production systems, under the precepts of conservation agriculture.

Mozambique produces only five percent of its annual consumption of wheat. Total consume is 437 thousand ton per year, while the country produces only 22 thousand tons annually (PORTAL DO GOVERNO DE MOÇAMBIQUE, 2010). Wheat production into Mozambique is paramount not only to

meet the national plan of food production, but also to prevent country's significant remittance of funds. So, wheat is a relevant crop, both technically and economically, diversification of production systems in Mozambique, especially in areas with altitude above 600 m above the sea level, such as those in the savannas of the Province of Niassa. It is estimated that with the adoption of technologies similar to those developed for dry land wheat in the Brazilian Cerrados, with productivity reaching at least 2.000 kg/ha, it would take around 210 thousand ha of land to fully supply the country's wheat demand.

Soil acidity limits agricultural production in considerable cultivated part of the world, because of toxicity caused by Al^{3+} and Mn^{2+} and low soil bases saturation (COLEMAN & THOMAS, 1967). Liming is the agricultural practice best considered to the inhibition of these ions in the soil, while, in parallel, helping to increase availability of soils nutrients to the plants, and productivity (LOPES, 1991). According to Furlani (1989), roots of cultivated plants do no develop fully in acid soils, because of excess Al^{3+}. This íon affects absorption and metabolism of nutrients, making the plant more susceptible to water and nutrient stresses, negatively impacting productivity.

Fageria & Zimmermann (1998) states that the ideal soil pH for crops such as wheat, beans, soybeans and corn is around 6.0, which emphasizes the importance of correcting soil acidity. Increasing soil pH, liming also provides calcium and/or magnesium; reduces or eliminates the toxic effects of ions Al^{3+}, Mn^{2+} and Fe^{3+}; and increases availability of soil nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and molybdenum. It decreases phosphorus fixation, raises the efficiency of fertilizers and boost soil microbial activity, thus increasing liberation of nutrients to the soil solution by mineralization of organic matter. In tropical soils it could make better or even affect soil physical properties (PRADO, 2003). If regulated enough to reach a pH 6.0 in $CaCl_2$, and maximum 80% of basis saturation, associated with production system with high deposition of organic material to the soil, causes soil aggregation, improving porosity and water and air circulation in the limed soil horizon (PRADO, 2003).

Wheat and other cereals when grown in acid soils present a physiological disturbance called "blight". Overall symptoms include leaves with a violet purple colour, blightened, leading to plant stunting. Higher impacts in plants susceptible include reduction of stems and formation of small pods, affecting productivity severely (SOUSA, 1996). According to Voss et al. (2007), the main cause of blight in wheat is Al^{3+}. Tolerant species present mechanisms of excluding its entrance into the roots or/and inactivation of its adsorption (KOCHIAN, 1995).

The objective of this study was to check the effects of increasing soil liming rates in the productivity of a wheat cultivar and its production components when cropped in Lichinga, 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, 1.25, 2.5, 3.75 and 5.0 Mg/ha of calcium dolomite. 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.

Liming was made a week before planting, which was made in 13/12/2012. Control plant was wheat cultivar BR 18, generated by Embrapa, which was planted to render 90 plants per lineal meter. Plant emergence started 17/12/2012, flowering started in 25/02/2013, and physiological maturation of grains was attained in 20/03/2013. Full harvest was made in 30/03/2013. 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

When 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).

In Table 2 is presented the measured values for plant final 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. There was no significant effect ($P>0.05$) of the liming rates on none of these parameters. It is difficult to establish a sole cause for such result, as there were several problems affecting the best performance of the plants.

First of all, plant stand was far above expected. As planting was made by hand because unavailability of mechanic planter, from an ideal 360 plants/m^2, according RCBPTT (2013), final plant stand varied from 585 to 716 plants/m^2. 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, productivity showed a quadratic response to the liming rates (Figure 1). Maximum yield would be attained with 3.2 Mg/ha of dolomite lime, reaching 1,308 kg/ha. The difference between production at that level and the unlimed treatment is 220 kg/ha. Thus, lime increased production at the maximum rate around 20% in this first year. This does not sounds as a substantial gain, but we have to consider that liming has got a residual effect in the soil for at least five years. So, analysis of the economical efficiency of lime should take into consideration productivity over years, and not only in the wheat crop, but also others crops that would be cropped in sequence in the same area, as part of integrated production systems.

Conclusions

Maximum productivity of grains (i.e. 1,308 kg/ha) of the wheat cv BR 18 cropped in 2012/2013 in Lichinga, Niassa, was estimated to be obtained with a rate of 3.2 Mg/ha of dolomite lime.

The experiment should be replicated in time, to check out effects of residual effects of lime and local climate variations.

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Table 1. Main characteristics of the clay soil in the experimental field of the Centro Zonal de Investigação Noroeste, Lichinga, Niassa, Mozambique. Samples taken in October, 2012, from 0 to 20 cm depth.

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

Table 2. Components of productivity of wheat cv BR 18 in response to increasing rates of dolomite liming in the experimental field of Centro Zonal de Investigação Noroeste (CZINw), Lichinga, Niassa, Moçambique. Crop season 2012/2013.

Liming (Mg/ha)	Thousand seeds weight (g)	Plant height (cm)	Plant stand (plants/m^2)	Grain per unit of area	Spikelet density (number/m^2)	Grain per spikelet	Grain per spike
0	47.67	78,64	716	2,324	9,531	0.23	3.49
1.25	49.43	80.00	611	2,438	9,083	0.28	4.13
2.50	45.40	76.25	676	2,777	9,823	0.30	4.34
3.75	58.11	81.63	585	2,574	9,002	0.27	4.14
5.00	45.47	82.37	618	2,648	10,562	0.28	4.31
CV (%)	15.31	4.47	22.44	15.13	23.74	23.58	20.93

Figure 1. Grain yield of cultivar BR 18 as a function of applied lime rates. Experimental field of the Centro Zonal de Investigação Noroeste (CZINw), of the Instituto de investigação Agrária de Moçambique, Lichinga, Niassa, Moçambique, na safra 2012/2013.