RESPONSE OF COTTON TO INCREASING RATES OF PHOSPHORUS AND POTASSIUM IN MURIAZE, NAMPULA PROVINCE, MOZAMBIQUE

RESPOSTA DO ALGODÃO A DOSES CRESCENTES DE FÓSFORO E POTÁSSIO EM MURIAZE, PROVÍNCIA DE NAMPULA, MOÇAMBIQUE

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Resumo

O algodoeiro tem forte demanda de fósforo (P) e potássio (K) para ser produtivo, devendo ser cultivado em solos com boa disponibilidade destes nutrientes ou que forem adubados adequadamente com ambos. Os solos usados em Moçambique para cultivo do algodão são pobres em P e as áreas são cultivadas até a exaustão da fertilidade natural. Neste trabalho descreve-se estudo que teve por objetivo calibrar a adubação fosfatada e potássica adequada para o algodoeiro, em solo arenoso de Muriaze, Nampula. Compararam-se as seguintes doses: 0, 70, 140, 210 e 280 kg/ha de P_2O_5 e 0, 50, 100 e 200 kg/ha de K_2O, dispostas em desenho experimental fatorial completo 4 x 5, com quatro repetições por tratamento. Cada repetição consistiu de parcelas de 5 linhas de 5 m cada, espaçadas 0,9 m entre si. Toda a área experimental recebeu 1 ton/ha de calcário dolomítico e fertilização básica com 150 kg N/ha, como Ureia, dividida em aplicação de 20 kg/ha no plantio e 130 kg/ha aos 30 dias apos a germinação. A cultivar BRS 293 foi usada no experimento, tendo sido plantada em 21/12/2012, com densidade de 10 plantas por metro linear. Analisaram-se variáveis de crescimento e os componentes de produção. Não houve resposta a adubação com potássio, uma vez que os teores existentes no solo eram suficientes. Por outro lado, houve resposta linear significativa ao fósforo, tanto no crescimento em altura quanto em produtividade, muito embora as produtividades alcançadas tenham sido baixas (574 a 912 kg/ha de algodão em caroço), devido a irregularidade de chuvas no período e forte ataque de pragas.

Palavras-chave: *Gossipium hirsutum* L.. Produtividade de plantas. Fertilidade do solo. Fertilizantes. Projeto Pró Savana.

Abstract

Cotton has got high demand of both phosphorus (P) and potassium (K) for productivity, and should be cultivated in soils with good availability of these nutrients or that are properly fertilized with them. Soils used in Mozambique for cotton production are poor in P and are used until deprived of their natural fertility. In this work it is reported a study conducted with the objective to calibrate the proper P and K fertilization for cotton in a sandy soil, in Muriaze, Nampula. It was compared the following rates: 0, 70, 140, 210 and 280 kg/ha of P_2O_5 and 0, 50, 100 and 200 kg/ha of K_2O, disposed in a complete factorial 4 x 5 experimental design, with four replications per treatment. Each replication consisted of 5 rows of 5 m each, spaced 0.9 m. All experimental area received 1 ton/ha of calcium dolomite and basic fertilization with 150 kg N/ha, as Urea, halved in an application of 20 kg/ha at the planting and 130 kg/ha 30 days after plant emergency. The cultivar BRS 293 was used for the experiment, being planted in 21/12/2012, with a density of 10 seeds per lineal meter. It was analyzed parameters of plant growth and productivity. There was no response to the K_2O rates, as the soil was well served in K. On the other hand, there was a significant linear response to P_2O_5 increasing rates, both for growth in height as well as productivity, although resulting productivity are quite low (574 to 912 kg of cottonseed/ha), due to severe drought and strong attack of insects plague.

Key-words: *Gossipium hirsutum* L.; Plant productivity. Soil fertility. Fertilizers. Pro Savana project.

Introduction

Average productivity of cotton in the Brazilian Cerrados is 3,900 kg of cotton seed/ha, with some farmers producing up to 5,000 kg/ha. However, to produce such amounts, soils are limed and fertilized with an average 120 kg of Phosphorus (P_2O_5)/ha and 180 kg of Potassium (K_2O)/ha. Cotton is a quite nutrient demanding plant. On average, to produce a ton of cottonseed, around 69 kg/ha of Nitrogen (N), 25 kg/ha P2O5 and 73 kg/ha of K_2O are extracted by the plant (Ferreira & Carvalho, 2005).

There is not yet a tradition of fertilizer addition to cotton in Mozambique, where it is mostly produced in small farms. As soils used for cotton in this country are mostly with low or medium natural fertility, overused, and water availability is limited by dry summers, productivity is only 452 kg/ha of cottonseed (Instituto do Algodão de Moçambique, 2012). As the country moves toward a more productive agriculture, there is need to study ways to improve cotton productivity. In this paper we report results of an experiment conducted to calibrate the best rate of P_2O_5 and K_2O addition to a soil in Muriaze, Province of Nampula, the largest production area of Mozambique. The objective of the experiment was to generate information that would allow a proper fertilizer recommendation for cotton in the area.

Materials and Methods

The experiment was conducted in area of the Instituto de Investigação Agrícola de Moçambique, in Muriaze, State of Nampula, in a sandy soil (Table 1). The cotton cultivar studied was the Brazilian BRS 293, whose main characteristics are presented by Morello et al. (2010). It was planted in 21/12/2012, with a density of 10 seeds per lineal meter. All area received a basal fertilization with Nitrogen equivalent to 150 kg/ha, as Urea, divided in two applications, 20 kg/ha at the planting and 130 kg/ha after 30 days of plant germination. It was also limed with one ton/ha of calcium dolomite.

It was compared the effects of five rates of P_2O_5 (0, 70, 140, 210, and 280 kg/ha) and four rates of K_2O (0, 50, 100, and 200 kg/ha). The experimental design was a factorial 5 x 4, distributed in the field in a randomized block set, with four replications per treatment. Each experimental plot consisted of rows of 5 m each, spaced 0.9 m. All fertilizers were applied at the planting date, broadcasted over the soil.

Harvest of the full experiment was made in 13/06/13 within four lineal m of the three central rows of every replication. Evaluations encompassed characteristics of plant growth (plant height and height of insertion of the first cotton bolls) and plant production (final plant stand, number of bolls per plant, average mass of bolls, number of green cotton bolls, number of open bolls, and productivity). The data obtained for each parameter was submitted to variance analysis and regression, and means were compared using Tukey test (Gomes, 1987).

Results and Discussion

The natural soil P_2O_5 availability (Table 1) is within a range considered low to cotton, which responds up to 20 mg/dm^3. On the other hand, the natural soil availability of K_2O (82 mg/dm^3) is within a range that is considered high for sandy soils (Carvalho et al., 2011). Thus, it would not be expected that the cotton would respond to the K_2O rates.

Looking at the average response for the P_2O_5 rates, it can be seen that they affected plant height, the height of the first cotton boll and cottonseed productivity (Table 2). But there was not effect for any other evaluated parameter. Regarding K_2O, as expected, there was no direct response by the plant to any evaluated parameter to the increasing rates. There was not also interaction with any rate of P_2O_5 (Table 2).

It has to be considered that there was a severe water stress during the flowering, so the plants discarded a large part of the first flower buds formed. Also, there was a severe attack of caterpillars. Overall, these constraints impaired overall production, rendering a productivity that is not much different of what is usually obtained in the area. Allied to these constraints, it has to be considered that fertilizer was broadcasted over the soil, which restricts its efficiency. There was increments varying from 0.8 to 1.7 kg of cotton seed for every kg of P_2O_5 (or 2.2 kg of Triple Superphosphate) added, which makes the fertilization non economical. It would be

recommended that the experiment is performed again, with special emphasis on burying the P_2O_5 in the planting line, to improve plant uptake and response.

Conclusions

Phosphorus fertilization increases cottonseed productivity in the studied area.
Soil natural Potassium availability suffices to good cottonseed productivity in the area.
Adverse climatic conditions and pests attacks makes necessary to rerun the experiment over time.

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Table 1. Main characteristics of the soil in the experimental area in Muriaze, Nampula, Mozambique, October 2012.

pH[1]	P[2]	K[2]	Al[3]	Ca[3]	Mg[3]	H+Al[4]	CTCt	CTCe	SB	V	OM	Clay
in water	mg/dm^3					$mmol_c/dm^3$				%	g/dm^3	
6,0	7,5	82	0,0	13,3	4,1	17,4	36,9	19,5	19,5	52,8	11	90

[1]pH in water, 1:2.5 soil:water. [2]Extractor Mehlich-1, 1:10 soil:solution; [3]Extractor KCl 1 mol/L, 1:10 soil:solution; [4]Calcium Acetate 0.5 mol/L, pH 7.0. CTCe – soil natural Cation Exchange Capacity; CTCt – CTC at pH 7,0; SB – Sum of exchangeable basis (K+Ca+Mg); MO – Soil Organic Matter, Walkey-Black method.

Table 2. Effects of P and K rates on cotton cultivar BRS 293 final plant stand (FPS, plant/m), height of plants (HP), number of bolls/plant (NBP), average boll mass/plant (ABM), height of the first boll (H1B), number of closed bolls (NCB), number of open bolls (NOB), total number of bolls/plant (TBP) and measured cottonseed productivity per area (PRO). Muriaze, Nampula, Mozambique, cropping season 2012/2013.

Rates	FPS	HP	NBP	ABM	H1B	NCB	NOB	NTB	PRO
kg/ha	pl/m	cm	Bolls/pl	g	cm		Bolls/plot		kg/ha
Rates of P_2O_5									
0	8.9	78.5	2.6	4.6	20.1	45	66.9	111.9	382.9
35	11.4	76.7	1.9	5	20.2	44.7	68.2	112.8	421.1
70	10.1	79.0	2.4	4.9	20.4	49.2	83.8	133	520.5
140	10.2	88.9	2.6	4.9	23.4	45.7	70.7	116.4	426.9
280	10.6	90.7	2.2	4.9	21.2	54.6	92.7	147.2	574.4
Rates of K_2O									
0	10.8	81.8	2.1	4.8	20.7	48.8	78	126.8	472.4
50	10.2	81.8	2.6	5.3	20.4	50.6	78.4	129	532.8
100	9.9	82.4	2.1	4.6	20.9	52.2	78.6	130.8	437.7
200	10.1	85.0	2.6	4.7	22.2	39.8	70.8	110.5	417.7
Analysis of variance									
P_2O_5	0.97^{ns}	3.31*	0.92^{ns}	0.28^{ns}	2.57*	0.31^{ns}	2.93*	1.96^{ns}	2.26^{ns}
Regression	s/a	LE**	s/a	s/a	PE*	s/a	LE**	LE*	LE*
K_2O	0.88ns	0.23ns	1.25ns	1.37ns	1.09ns	0.68ns	0.41ns	0.89ns	1.14ns
Regression	s/a	s/a	s/a	s/a	s/a	s/a	s/a	s/a	s/a
P_2O_5 x K_2O	ns	ns	ns	ns	ns	ns	ns	ns	ns
CV (%)	36.7	17.4	51.8	25.2	16.2	63.0	34.5	35.5	45.4

*, **, and ^{ns} indicates that the effects are significant at P < 0.05, at P < 0.01, or not significant (P>0.05) respectively. LE indicates that the data shows a better fit within a first grade equation, while PE indicates a better fit within a polynomial second grade equation. $^{s/a}$ indicates no correlation between the tested variables.