EFFECTS OF THE METHOD OF PHOSPHORUS FERTILIZER APPLICATION ON COTTON GROWTH AND PRODUCTION IN MURIAZE, NAMPULA, MOZAMBIQUE

EFEITOS DO MÉTODO DE APLICAÇÃO DE FERTILIZANTES FOSFATADOS NO CRESCIMENTO E PRODUÇÃO DE ALGODÃO EM MURIAZE, NAMPULA, MOÇAMBIQUE

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Resumo

O algodoeiro necessita de solos com bons teores de fósforo (P) disponível ou adubação fosfatada anual para corrigir suas necessidades de extração de 25 kg of P/ha para produzir uma tonelada de algodão em caroço. O adubo fosfatado é caro e deve ser usado com máxima eficiência. Os solos de Moçambique são pobres em fósforo e o adubo é raro no mercado local, devidos ao pouco uso e seu preço elevado. Assim, fez-se esse estudo com o objetivo de verificar o efeito da aplicação de P e qual a melhor forma de localização do adubo fosfatado. Testou-se duas doses de P_2O_5 (0 and 80 kg/ha), com quatro combinações de aplicação: sem correção; correção superficial seguida de incorporação com enxada; correção superficial, sem incorporação; e correção na linha de plantio. Cada tratamento teve quatro repetições, consistindo de parcelas de 5 linhas de 5 m cada, espaçadas 0,9 m entre si. Toda a area experimental recebeu calcário (1 ton/ha de calcário dolomítico) e fertilização básica com 150 kgN/ha e 100kg K_2O/ha. A cultivar BRS 293 foi usada no experimento, tendo sido plantada em 21/12/2012, com densidade de 10 plantas por metro linear. O algodão cresceu melhor na presença do P, mas não houve resposta na produtividade, devido a perda de flores e macas pequenas por causa de intenso ataque de insetos pragas e seca severa durante o período de crescimento.

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

Abstract

Cotton needs soils with good amounts of available phosphorus (P) or annual fertilization to correct its needs of extracting 25kg of P per ha to produce a ton of cottonseed. Phosphorus fertilizer is expensive and should be used with maximum efficiency. Soils from Mozambique are poor in P, and fertilizer is rare in the local market, due to poor demand and high cost. Thus, a study was conducted to check out the effect of application of P and the best way of disposing P fertilizer in the soil. Two rates of P_2O_5 (0 and 80 kg/ha) were compared, with four methods of application: no application; broadcasting over the soil; broadcasting and incorporation into the soil; and incorporation in the planting row. Every treatment was replicated four times, being each one 5 rows of 5 m each, spaced 0.9 m. Before planting, all experimental area received liming (1 ton/ha of calcium dolomite) and basic fertilization with 150 kg N/ha and 100 kg K_2O/ha. The cultivar BRS 293 was used for the experiment, being planted in 21/12/2012, with a density of 10 seeds per lineal meter. Cotton grew better in the presence of P, but there was not response in its productivity, because of loss of cotton flower buds and small bolls due to strong insect attacks and severe drought during the growth period.

Key words: *Gossipium hirsutum* L. Productivity. Plant stress. Soil fertility. Pro Savana Project.

Introduction

Cotton (*Gossipium hirsutum* L.) is a plant that needs fertile soils, or good annual availability of nutrients if growing in poor soils, to render good productivity. To produce one ton of cottonseed per hectare, it exports around 69 kg/ha of nitrogen (N), 25 kg/ha of phosphorus (P_2O_5), and 73 kg/ha of potassium (K_2O) from the soil. From these, 34, 12 and 22 kg/ha, respectively, are exported away from the field with the harvested products (Carvalho et al., 2011). In the Brazilian Cerrados, with adequate soil correction and fertilization, it was obtained an average productivity of 3,689 kg cottonseed/ha in the 2012/2013 cropping season, cultivated in 893 thousand hectares. Some producers managed to harvest above 5.000 kg/ha (CONAB, 2013). Regarding P_2O_5, on average, these areas are fertilized with around 120 kg P_2O_5/ha. If the fertilizer is applied in the planting row, the better is its efficiency (Silva, 1999), especially in soils with low P_2O_5 availability.

In Mozambique, there are about 188,000 ha under cotton cultivation, usually in small family properties (“machambas”). According to the Instituto de Algodão de Moçambique average productivity in these machambas is around 452 kg of cottonseed/ha (Instituto de Algodão de Moçambique, 2012). Some reasons for such low productivity include exploitation of soils naturally poor in P_2O_5 and organic matter, and lack of fertilizers application (Ronquim et al, 2013; Bolfe et al., 2011).

In this work it is reported a study conducted to test out some methods of phosphorus fertilizer addition to a Mozambican soil, plus the addition of a surplus rate, with the objective of determining the best way to improve efficiency of P_2O_5 application.

Material and Methods

The experiment was conducted in area of the Instituto de Investigação Agrícola de Moçambique, in Muriaze, Province of Nampula, in a sandy soil (Table 1).

Two rates of P_2O_5 (0 and 80 kg/ha) were compared, in parallel to four methods of application: no application; broadcasting over the soil; broadcasting and incorporation into the soil; and incorporation in the planting row.

Experimental design was a completely randomized factorial 2 (rates) x 4 (methods), with four replications for each treatment. Each experimental plot consisted of rows of 5 m each, spaced 0.9 m. All experimental area received liming (one ton/ha of calcium dolomite) and basic fertilization (150 kg N/ha and 100 kg K_2O/ha) before planting. The Brazilian cotton cultivar BRS 293 (Morello et al., 2010) was used for the experiment, being planted in 21/12/2012, with a density of 10 seeds per lineal meter.

In 13/06/2013 plants were harvested 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 boll) 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).

Result 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. With that, it would be expected that the plants would respond to the phosphorus application. Indeed, the applied rate induced increases in the height of plants. However, id did not reflected into increases of productivity (Table 2). A possible explanation for that is that the plants suffered a strong water stress between February and March, which resulted in a great loss of cotton flower buds and small cotton bolls. It is known that a wealthy plant blossoms early and presents great formation of bolls. It is possible that plants in the control treatment had blossomed later than those in the fertilized treatment, thus being less affected by the hydric stress. Added to the water stress, there was a strong attack by caterpillars, which impaired even further plant productivity.

There was no effect of the method of P_2O_5 on any measured parameter but the number of cotton bolls per plant (Table 2). However, this variable showed a large coefficient of variation (36 %), which may indicate that the loss of flower buds was an important factor of variability to explain productivity under the evaluated conditions.

With that, it is advisable to perform the experiment once again, in the same conditions, to check out the replicability of the results.

Conclusions

There was clear indication of plant response to P_2O_5 application in the studied conditions.
Productivity was affected by severe water stress and pests attack during the blossoming stage.
There was no effect of method of P_2O_5 application in the studied conditions.
It is recommended that the experiment be replied 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_2O_5 rates and application method on final plant stand (FPS), height of plants (HP), number of bolls/plant (NBP), average boll mass (ABM), height of first boll (H1B), number of closed bolls (NCB), number of open bolls (NOB), total number of bolls (TNB) and average cottonseed productivity (PRO). Muriaze, Nampula, Mozambique, 2012/2013.

Treatment	FPS	HP	NBP	ABM	H1B	NCB	NOB	TNB	PRO
	pl/m	cm	boll/pl	g	cm		bolls/plot		kg/ha
					Rate of P_2O_5 application (R)				
No P_2O_5	13.8a[1]	70.3a	5.7a	4.4a	25.5a	137a	135.7a	272.8a	734a
80 kg P_2O_5/ha	12.9a	80.9a	7.0a	4.6a	27.7a	112b	114.5a	226.7b	626b
					Method of P_2O_5 application (M)				
Control	13.7a	76.6a	5.8b	4.5a	28.0a	130a	120.6a	250.4a	667a
Broadcasted	12.9a	79.5a	8.7a	4.3a	25.5a	111a	133.5a	244.5a	674a
Broadcasted & incorporated	12.9a	70.2a	5.5b	4.4a	25.2a	132a	113.6a	246.1a	621a
Only in the planting row	14.0a	76.2a	5.2b	4.7a	27.6a	125a	132.8a	258.1a	759a
					Analysis of variance				
R	0.61ns[2]	6.87*	2.71ns	1.87ns	2.45ns	6.25*	3.51ns	8.63**	4.70*
M	0.29ns	0.93ns	3.97*	0.82ns	1.02ns	0.92ns	0.74ns	0.15ns	1.35ns
R x M	0.49ns	2.2ns	0.37ns	0.26ns	1.81ns	2.05ns	0.88ns	0.28ns	0.48ns

[1]Values followed by the same letter in every parameter are not different (P<0.05).

[2] ns, *, and ** means, respectively non-significant (P>0.05), or significant (P<0.005 and P<0.001).