SUGARCANE RESPONSE TO PHOSPHORUS SOURCES AND PLACEMENT IN A VERY CLAYEY OXISOL OF THE BRAZILIAN CERRADO

By

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Abstract

THE SUGAR-ETHANOL INDUSTRY in Brazil has expanded towards the "Cerrado" (savanna) region where sugarcane has replaced pastures on soils with low phosphorus (P) availability. Phosphorus fertilisation on sugarcane in Brazil is largely based on water-soluble fertilisers applied in the planting furrow, leading to high concentration of P in this zone due to high P rates employed and wide row spacings. In this study, alternative placement methods and P sources were evaluated in an experiment established in Brasilia, in a randomised block design with four replications. The soil was a very-fine, mixed, isothermic Rhodic Haplustox with low (1.2 mg/dm^3) Mehlich-1 P content in the top 0.0–0.2 m, and treatments were applied only to the plant cane (cultivar RB 867515). Treatments consisted of a P response curve ranging from 0 to 400 kg/ha P_2O_5 as broadcast triple superphosphate (TSP) incorporated with a disk harrow before planting and the following treatments at 200 kg/ha of P_2O_5: TSP applied at the bottom of the planting furrow (banded); TSP half broadcast and half banded; a Moroccan reactive phosphate rock (RPR) broadcast and banded; and a combination of broadcast RPR and banded TSP. Cane and sugar yields were evaluated for the plant cane and two ratoon crops. Maximum cane yields (129.9, 92.7 and 96.7 t/ha, respectively, for the three harvests) with broadcast TSP at 400 kg/ha P_2O_5 were on average 89% higher compared to the control (no P) treatment. Comparing the two P sources at 200 kg/ha P_2O_5, yields for the broadcast TSP and RPR treatments were similar for the three harvests, but when the fertilisers were band-applied, yields were on average 16% lower for the RPR. Comparing the fertiliser placement methods, average yields for broadcast TSP and RPR were 19% and 42% higher than band application, respectively. Combined broadcast and band application treatments were not significantly different compared to exclusively broadcast applications. Results show that increases in sugarcane yield and P fertiliser use efficiency in low-P Cerrado soils could be attained by increasing the volume of soil fertilised with P.

Introduction

The expansion of the sugar-ethanol sector in the Midwest region of Brazil during the last decade has been proportionally higher than the Southeast region, which is still the largest producer in Brazil (IBGE, 2012). Sugarcane expansion in the Midwest region has replaced annual crops and largely low-productivity or degraded planted pastures in acid soils with low phosphorus (P) availability, originally under savanna (*Cerrado*) vegetation.

During the 1970s and 1980s, extensive experimental efforts on phosphorus fertiliser management for sugarcane were focused on the Southeast and Northeast regions in Brazil (Orlando Filho, 1983; Korndörfer, 2004). The experimental basis for phosphorus fertilisation management for sugarcane in Cerrado soils of the Midwest region is still very limited with respect to fertiliser levels, sources and placement methods.

Guidelines for phosphorus fertilisation of plant cane in Brazil compiled by Korndörfer (2004) are restricted to maximum levels around 180 kg/ha P_2O_5 with soluble solid and liquid sources and filter cake applied in the planting furrow.

Fertilisation guidelines for crops in general in the Cerrado region (Sousa and Lobato, 2004) recommend broadcast application of P fertilisers in soils of low P content to build up their fertility status.

This recommendation has been adopted to a limited extent by sugar mills/ethanol plants in the region, complemented with high levels of P fertiliser in the planting furrow.

However, field experiments from the 1980s in soils responsive to P in other regions showed that broadcast application of granulated superphosphate or powder thermalphosphate (soluble in 2% citric acid at 1:100 w/v ratio) provided higher cane yields compared to the respective sources and levels applied in the planting furrow (Reis and Cabala-Rosand, 1986; Morelli *et al*., 1991).

Possible economic alternatives to soluble P sources in sugarcane fertilisation are the reactive phosphate rocks (RPR). These fertilisers exhibit reduced initial agronomic effectiveness, particularly when band-applied, compared to water-soluble sources for annual crops in Cerrado soils limed to water pH levels below or near 6.0. On the other hand, RPR residual effects are similar or even slightly higher (Sousa *et al*., 1999; Oliveira Junior *et al*., 2008).

In soils less responsive to P fertilisation, utilisation of RPR or mixtures of RPR and superphosphate applied in the planting furrow provided similar yields for plant cane compared to superphosphate application exclusively (Cantarella *et al*., 2002).

The objective of this study was to evaluate different strategies of phosphorus fertilisation with respect to sources and placement for sugarcane in a low-P Cerrado oxisol.

Material and methods

A field experiment was established at *Embrapa Cerrados* (Savannas Agricultural Research Center) located near Brasilia, for which responses of sugarcane to P fertilisation treatments applied to the plant cane (Table 1) were evaluated for three years. Phosphorus sources were a granulated triple superphosphate (TSP) and a Moroccan reactive phosphate rock (RPR) commercialised in Brazil as "BG-4".

Fertiliser analysis showed total P_2O_5 contents of 47% and 30%, respectively for TSP and RPR, and soluble P_2O_5 contents of 46% (neutral ammonium citrate) for TSP and 10.5% (2% citric acid 1:100 w/v ratio) for the RPR, the latter analysed for solubility in the natural (unground) form. Applied fertiliser doses were based on neutral ammonium citrate soluble P for TSP and total P_2O_5 for the RPR.

Treatments (Table 1) consisted of P levels of 0 (control treatment), 100, 200 and 400 kg/ha P_2O_5 as TSP, broadcast and incorporated before planting (treatments A to D); 200 kg/ha P_2O_5 as TSP applied in the bottom of the planting furrow (treatment E); 200 kg/ha P_2O_5 as TSP with half (100 kg/ha) broadcast and half (100 kg/ha) applied in the planting furrow (treatment F); 200 kg/ha P_2O_5 as RPR broadcast or applied in the planting furrow (treatments G and H); and finally 200 kg/ha P_2O_5 with half (100 kg/ha) as RPR broadcast and half (100 kg/ha) as TSP applied in the planting furrow (treatment I).

The 200 kg/ha P_2O_5 level (treatments C and E to I) approximates the fertilisation level commonly adopted by producers in the Cerrado region, typically 150 to 180 kg/ha P_2O_5 applied in the bottom of the planting furrow.

The experimental area, originally under *cerrado strictu sensu* (savanna) vegetation and cleared about 30 years ago, was cropped for few years (unknown fertilisation records) and left as a pasture fallow dominated by *Brachiaria decumbens* and *Andropon gayanus* grasses. The soil was a very-fine, mixed, isothermic Rhodic Haplustox.

Table 1—Yields of plant cane and two ratoon crops in response to triple superphosphate (TSP) and reactive phosphate rock (RPR), and placement methods broadcast with incorporation versus banding in the planting furrow. All treatments were applied to the plant crop.

Treatments				Cane yields [1]		
	P source	Placement	P level	2010	2011	2012
			kg/ha P_2O_5	t/ha		
A	–	–	0	74.8 d	58.4 e	41.2 e
B	TSP	Broadcast	100	110.8 cb	83.7 ab	72.6 c
C	TSP	Broadcast	200	123.1 ab	84.2 ab	88.1 ab
D	TSP	Broadcast	400	129.9 a	92.7 a	96.7 a
E	TSP	Band	200	104.7 c	72.5 cd	71.1 c
F	TSP	Broadcast + band	100+100	124.6 ab	90.8 a	86.2 ab
G	RPR	Broadcast	200	119.9 ab	85.6 ab	88.7 ab
H	RPR	Band	200	84.6 d	65.8 ed	57.1 d
I	RPR+TSP	Broadcast + band	100+100	120.5 ab	80.2 cb	78.5 cb
Coefficient of variation, %				8.9	9.0	10.5
Least significant difference (*t* test, p<0.05), t/ha				14.3	10.4	11.6

[1]Within columns, means followed by the same letter are not significantly different at p<0.05 (*t* test).

Soil testing (EMBRAPA, 1997) for 0.0–0.2 m and 0.2–0.4 m samples revealed the following results: Mehlich-1 (0.0125 mol/L H_2SO_4 + 0.05 mol/L HCl) extractable P of 1.2 and 0.7 mg/dm^3; pH in water of 5.4 and 5.1; sum of bases (Ca+Mg+K) of 3.2 and 1.4 cmol$_c$/dm^3; titratable acidity to pH 7.0 (H+Al extracted with 0.5 mol/L calcium acetate at pH 7.0) of 5.9 and 5.0 cmol$_c$/dm^3; organic carbon (Walkley-Black) of 17 and 12 g/kg; clay content (pipette method after dispersion with 0.1 mol/L NaOH) of 620 and 650 g/kg.

At the beginning of 2009, during the rainy season, grasses were mowed and the litter partially removed from the experimental area, and subsequently controlled with glyphosate after regrowth. In April, at the end of the rainy season, the following amendments were manually broadcast over the whole area, which was split into a 5x5-m grid: 1.36 t/ha dolomitic limestone (100% ECCE basis) calculated to increase soil base saturation to 50% in the top 0.0–0.2 m layer, and 4.95 t/ha of moist phosphogypsum (approximately 80% calcium sulfate) to improve subsurface chemical conditions, increasing Ca levels and decreasing Al saturation down to at least 0.80 m in the soil profile, as recommended for acid cerrado oxisols based on the subsurface clay contents (Sousa and Lobato, 2004). Fertilisers were also broadcast over the whole area: 150 kg/ha K_2O (potassium chloride) and 100 kg/ha of a commercial micronutrient source (*FTE BR-10* in powder form, containing 2.5% B, 0.1% Co, 1.0% Cu, 4.0% Fe, 4.0% Mn, 0.1% Mo and 7% Zn). Amendments and fertilisers were incorporated into the soil with a heavy disk harrow to a depth of approximately 0.20 m.

In August of the same year (2009), the experimental plots were established in a randomised complete block design, with four replications. Plots (60 m^2) consisted of five rows of 8-m length and row spacing of 1.5 m. Broadcast P fertilisers (treatments in Table 1) were manually applied and then incorporated with a disk harrow to a depth of approximately 0.15 m. Furrows were open to a depth of approximately 0.18 m. Band P fertilisers (treatments in Table 1) were manually applied in the bottom of the furrows in an approximately 0.10 m-wide band. Urea (30 kg/ha N) and potassium chloride (60 kg/ha K_2O) were also band-applied for all treatments, and fertilisers were covered with a soil layer of approximately 0.03 m.

The experiment was planted in mid-August 2009 during the dry season, with three cane setts in the furrows and approximately 17 buds per metre. The variety was RB 867515, which is presently the principal variety in Brazil. Fipronil (insecticide) for control of termites was applied at 0.2 kg/ha. Planted cane was then covered with a soil layer of approximately 0.08 m. Four irrigations with a sprinkler system were provided until the beginning of the rainy season in mid-October, with

a total net water depth of approximately 100 mm. Nitrogen as ammonium nitrate was surface-applied on each side of the row at 60 kg/ha at the beginning of December. Weeds were controlled with pre-emergent herbicides and manual hoeing for the plant cane as well as the subsequent ratoon crops.

Plant cane was manually harvested (three 5-m rows with an area of 22.5 m^2) at the beginning of September, 2010. Trash (tops, dry leaves and most of the dry sheath) was removed and the millable cane was weighed. In each plot, ten stalks of cane were sampled and analysed for quality within 48 hours for Brix, POL and dry matter following official methods adopted in Brazil (CONSECANA, 2006).

Trash was managed with a mulching chopper, simulating the condition of trash obtained following mechanical harvesting. Two irrigations with a sprinkler system were provided after harvesting to stimulate germination and initial regrowth of the two ratoon crops, with a total net water depth of approximately 100 mm. Nitrogen (120 kg/ha N) and potassium (144 kg/ha K_2O) were applied as ammonium nitrate and potassium chloride over the trash on each side of the row, in November, 2010 and 2011. The ratoon crops were harvested at the end of August, 2011 and 2012.

Average temperature and total rainfall during the plant cane and the two ratoon crop seasons were 22.4 ºC and 1091 mm, 22.1 ºC and 1190 mm, and 22.2 ºC and 1512 mm, respectively.

Results and discussion

Cane yield results for plant crop and two ratoon crops are given in Table 1. There were no significant differences ($p < 0.05$) in cane quality with respect to sugar content for the three crops (data not shown). The average Brix and POL from juice, and total reducible sugar (TRS) content expressed on a millable cane basis were, respectively, 24.7%, 21.0% and 185.2 kg/t for the plant crop (2010), 24.6%, 21.0% and 194.5 t/ha for the first ratoon crop (2011), and 23.0%, 19.1% and 178.4 t/ha for the second ratoon crop (2012). Therefore, sugar yields were directly and proportionally related to cane yield in Table 1, and results will be discussed only in terms of cane yields. These relatively high TRS contents are characteristic for sugarcane harvested during the mid-dry season in the Cerrado region.

Cane yield responses to fertilisation levels were significant for the three crops in this very clayey oxisol exhibiting very low levels of available P (1.2 mg/dm^3 by Mehlich-1 extractant), as interpreted according to Sousa and Lobato (2004). Minimum yields were obtained in the absence of P fertilisation (treatment A) and maximum yields with the highest P application rate (400 kg/ha P_2O_5) and TSP broadcast (treatment D). Respective minimum and maximum yields were 74.8 and 129.9 t/ha for the plant cane (2010), 58.4 and 92.7 t/ha for the first ratoon crop (2011), and 41.2 and 96.7 t/ha for the second ratoon crop in 2012 (Table 1). The 200 kg/ha P_2O_5 application at which the P sources and placement methods were studied resulted in yields below maximum. In the case of TSP broadcast at 200 kg/ha P_2O_5 (treatment C), cane yields for the three crops were equivalent to 95, 91 and 91%, respectively, of the maximum yield treatment (D), but not significantly different ($p < 0.05$).

Placement effects were also significant (Table 1). At the 200 kg/ha P_2O_5 level cane yields with broadcast TSP (treatment C), 123.1, 84.2 and 88.1 t/ha for the three crops, respectively, were 18, 16 and 24% higher compared to the same source banded in the furrow (treatment E). This is an important result, since band application in the planting furrow is the traditional sugarcane fertilisation practice in the Cerrado region and other regions in Brazil. However, experiments conducted in other regions in soils very responsive to P fertilisation showed that broadcast application of granulated superphosphate or powder thermal phosphate (citric acid soluble) was more effective at levels of 100 and 200 kg/ha P_2O_5 than application in the planting furrow (Reis and Cabala-Rosand, 1986; Morelli *et al*., 1991). The combination of band and broadcast applications of TSP at the same total level of P_2O_5 (treatment F) provided similar yields to the exclusively broadcast application (treatment C). These results show that, under the present experimental

conditions, P application in the planting furrow was not required to optimise the P use efficiency of soluble fertiliser by sugarcane.

The placement effect was even more pronounced for the reactive phosphate rock (RPR). Cane yields obtained with broadcast RPR applied at 200 kg/ha P_2O_5 (treatment G), 119.9, 85.6 and 88.7 t/ha for the three crops, respectively, were 42, 30 and 51% higher compared to RPR banded in the planting furrow (treatment H).

Broadcast RPR and TSP treatments (C and G) provided similar yields for the three crops. On the other hand, when P was band applied, TSP yields were significantly higher than RPR. The relative agronomic effectiveness (RAE) of RPR in relation to TSP was calculated as: $RAE\%=[(RPR–C)/(TSP–C)]\times100$, where *RPR* and TSP are the cane yields with the respective sources for the same P level and placement method, and *C* is the cane yield of the control (no P) treatment. For broadcast application, RAE values of RPR at 200 kg/ha P_2O_5 were 93, 105 and 101%, respectively for the plant cane and ratoon crops. For band application, RAE values for the RPR at the same level were 33, 52 and 53%, respectively for the plant cane and ratoon crops.

Field experiments on the evaluation of broadcast application with incorporation of RPR sources for annual crops in Cerrado soils have reported RAE values significantly lower compared to the present results with sugarcane, but similar or even slightly higher residual effects (Sousa *et al*., 1999, 2010; Oliveira Junior *et al*., 2008). The high RAE related to the fresh effect of RPR for sugarcane in the present study could be attributed to the longer growing period compared to annual crops, allowing for a higher dissolution of the RPR. Topsoil samples (0.0–0.2 m) taken from the broadcast RPR treatment (G) plots after harvesting the plant cane showed average pH values measured in water and in 0.01 mol/L $CaCl_2$, respectively, of 5.9 and 5.0, which appear not to be high enough to significantly affect its dissolution rate (Sousa *et al*., 2004).

The lower RAE of banded compared to broadcast RPR has also been reported for annual crops in Cerrado soils (Sousa *et al*., 1999, 2010; Oliveira Junior *et al*., 2008). This is explained by the placement effect leading to very high concentrations in the bottom of the planting furrow, further restraining dissolution rates, which is more pronounced for sugarcane conditions because of the high P level (200 kg/ha P_2O_5) and wide row spacing (1.5 m).

The RAE of banded RPR did not significantly improve over the three crops. In soils less responsive to P fertilisation, a reactive phosphate rock or mixtures with superphosphate applied in the planting furrow provided similar yields for the plant cane compared to superphosphate application (Cantarella *et al*., 2002).

The results of this study showed a significant sugarcane yield advantage of pre-plant broadcasting P fertilisation compared to the traditionally-adopted band application in the furrow for a very-clayey cerrado oxisol. This yield advantage was found for the reactive phosphate rock as well as for a water-soluble source (TSP). TSP application in the bottom of the furrow is expected to provide high available P in this zone, allowing roots to take up this nutrient at high influx rates (uptake per root segment area).

On the other hand, for broadcast application with incorporation, a much higher proportion of the root system had access to the fertiliser, taking up P at lower influx rates. These results suggest that broadcast application was most favourable with respect to P use efficiency of fertilisers.

Conclusions

The effectiveness of broadcast incorporated triple superphosphate and a reactive phosphate rock was higher than band application at the bottom of the planting furrow, in terms of cane and sugar yields for the plant cane and ratoon crops. Sugarcane yield response to broadcasting was more pronounced for the reactive phosphate rock than TSP. These results show that increases in sugarcane yield and P use efficiency of fertilisers in low-P Cerrado soils could be attained by increasing the volume of soil fertilised with P at planting, replacing traditional exclusive band application by full broadcasting or combined broadcast and band applications.

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REFERENCES

Cantarella, H., Rossetto, R., Landell, M. de A., Bidoia, M.A.P. and Vasconcelos, A.C.M. (2002). Misturas em diferentes proporções de fosfato natural reativo e fosfato solúvel em água para a cana-de-açúcar. Anais do Congresso Nacional da Sociedade dos Técnicos Açucareiros e Alcooleiros do Brasil, 8: 218–224

CONSECANA – Conselho dos Produtores de Cana-de-Açúcar, Açúcar e Álcool do Estado de São Paulo. (2006). Manual de instruções, 5th. ed., 111p. CONSECANA, Piracicaba.

EMBRAPA – Centro Nacional de Pesquisa de Solos (1997). Manual de métodos de análise de solo, 2nd. ed. Embrapa-CNPS, Rio de Janeiro 212p.

IBGE. (2012). SIDRA - Sistema IBGE de Recuperação Automática. Produção agrícola municipal. June 10, 2012. http://www.sidra.ibge.gov.br.

Korndörfer, G.H. (2004). Fósforo na cultura da cana-de-açúcar. In: Yamada, T; Stipp e Abdalla, S.R. (eds.). Fósforo na Agricultura Brasileira, 291–305. POTAFOS, Piracicaba.

Morelli, J.L., Nelli, E.J., Baptistella, J.R. and Demattê, J.L.I. (1991). Termofosfato na produtividade da cana-de-açúcar e nas propriedades químicas de um solo arenoso de baixa fertilidade. Revista Brasileira de Ciência do Solo, 15: 57–61.

Oliveira Junior, A. de, Prochnow, L.I. and Klepker, D. (2008). Eficiência agronômica de fosfato natural reativo na cultura da soja. Pesquisa Agropecuária Brasileira, 43: 623–631.

Orlando Filho, J. (Coord.). (1983) Nutrição e adubação da cana-de-açúcar no Brasil, 369p. IAA/PLANALSUCAR, Piracicaba.

Reis, E.L. and Cabala-Rosand, P. (1986) Respostas da cana-de-açúcar ao nitrogênio, fósforo e potássio em solo de tabuleiro do sul da Bahia. Revista Brasileira de Ciência do Solo, 10: 129–134.

Sousa, D.M.G. de and Lobato, E. (eds.). (2004). Cerrado: correção do solo e adubação. 2nd. ed. Embrapa Informação Tecnológica, Brasilia 416p.

Sousa, D.M.G. de, Rein, T.A., Goedert, W.J., Lobato, E. and Nunes, R. de S. (2010) Fósforo. In: Prochnow, L.I.; Casarin, V.; Stipp, S.R. (eds.). Boas práticas para uso eficiente de fertilizantes, v.2, 66–132. IPNI, Piracicaba.

Sousa, D.M.G. de, Rein, T.A., Lobato, E. and Soares, W.V. (1999). Eficiência agronômica de fosfatos naturais reativos na região dos cerrados. Anais do Congresso Brasileiro de Ciência do Solo (CD-ROM), 27: 21p.

REPONSE DE LA CANNE A SUCRE A DES SOURCES DE PHOSPHORE ET A SA LOCALISATION DANS DES OXISOL TRES ARGILEUX DU CERRADO BRESILIEN

Par

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Résumé

L'INDUSTRIE DE L'ÉTHANOL de sucre au Brésil, s'est étendue vers le "Cerrado" (savane) où la canne a remplacé les pâturages sur des sols où le phosphore (P) est peu disponible. La fertilisation phosphatée de la canne à sucre au Brésil est largement basée sur des engrais solubles dans l'eau appliqués dans le sillon de plantation, atteignant une forte concentration de P dans cette zone en raison des quantités élevées de P apportées et de l'écartement important des rangs. Pour cette étude, différentes localisations et sources de P ont été testées dans un essai en blocs randomisés à quatre répétitions, implanté à Brasilia. Le sol, de type isothermic Rhodic Haplustox, est de texture très fine, mélangé, avec une teneur en P Mehlich-1 de l'horizon supérieur 0,0-0,2m de 1,2 mg/dm^3. Les traitements ont été appliqués uniquement à la plantation (variété RB 867515). Les traitements étaient une courbe de réponse à P de 0 à 400 kg/ha de P_2O_5 sous forme de triple super phosphate (TSP), épandu en généralisé et incorporé à la charrue à disque avant la plantation, les autres applications étant, 200 kg/ha de P_2O_5 de TSP épandus dans le sillon de plantation ; du TSP pour moitié en généralisé et moitié localisé ; une roche phosphatée du Maroc (RPR) en généralisé et localisé, et une combinaison de RPR généralisé et de TSP localisé. Les rendements canne et sucre ont été mesurés en plantation et sur deux repousses. Les rendements maximums en canne (129,9, 92,7 et 96,7 respectivement pour les trois récoltes) obtenus avec du TSP en application généralisée à 400 kg/ha de P_2O_5 étaient en moyenne 89 % plus élevés que ceux du témoin (pas de P). Pour les deux sources de P à 200 kg/ha de P_2O_5, les rendements de l'application généralisée de TSP et de RPR étaient identiques pour les trois récoltes, mais quand les engrais ont été localisés, les rendements ont été 16% plus faibles pour le RPR. Pour ce qui concerne la méthode d'épandage, les rendements moyens en application généralisée ont été inférieurs à ceux de la localisation de 19% et 42% respectivement pour le TSP et le RPR. La combinaison application généralisée et localisée n'étaient pas significativement différentes aux applications exclusivement en généralisé. Les résultats montrent que des augmentations de rendements en canne et d'efficience de la fertilisation en P des sols à faible teneur en P du Cerrado pourraient être obtenues en augmentant la fertilisation phosphatée.

RESPUESTA DE LA CAÑA DE AZÚCAR ANTE DIFERENTES FUENTES Y SITIOS DE COLOCACIÓN DEL FÓSFORO EN UN OXISOL MUY ARCILLOSO DEL CERRADO BRASILEÑO

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Resumen

LA INDUSTRIA DEL AZÚCAR y el etanol en Brasil se ha expandido hacia la región del "Cerrado" (sabana) donde la caña de azúcar ha reemplazado a las pasturas en suelos con bajo fósforo (P) disponible. La fertilización fosfatada en la caña de azúcar en Brasil se basa principalmente en fertilizantes solubles en agua aplicados en el surco de plantación, lo que lleva a la alta concentración de P en esta zona debido a la alta dosis de P utilizadas y al espaciamiento entre hileras. En este estudio, se evaluaron fuentes y métodos alternativos de colocación de P en un experimento establecido en Brasilia, en un diseño de bloques al azar con cuatro repeticiones. El suelo, en la parte superior de 0.0-0.2 m, corresponde a un Rhodic Haplustox isotérmico muy fino, con baja contenido de P (1,2 mg/dm3) Mehlich-1, y los tratamientos se aplicaron sólo en la caña planta (cultivar RB 867515). Los tratamientos consistieron en una curva de respuesta de P que varía de 0 a 400 kg/ha de P2O5 como superfosfato triple (TSP) aplicado al voleo, incorporado con una rastra de discos antes de la siembra y los siguientes tratamientos a 200 kg/ha de P2O5: TSP aplicado en la parte inferior del surco de siembra (en banda); TSP mitad al voleo y mitad en banda; roca fosfórica reactiva de Marruecos (RPR) al voleo y en bandas, y una combinación de RPR al voleo y TSP en bandas. Se evaluó el rendimiento de caña y de azúcar en la caña planta y en dos socas. Los rendimientos máximos de caña (129.9, 92.7 y 96.7 t/ha, respectivamente para los tres cosechas) con la aplicación al voleo de TSP a 400 kg/ha de P2O5 fueron en promedio un 89% mayores que el control (sin P). Al comparar las dos fuentes de P a 200 kg/ha de P2O5 se observa que los rendimiento de los tratamientos de TSP y RPR aplicados al voleo fueron similares para las tres cosechas, pero cuando los fertilizantes fueron aplicados en banda, los rendimientos fueron en promedio un 16% más bajo para el RPR. De la comparación ente los métodos de colocación del fertilizante surge que los rendimientos medios de TSP y RPR al voleo fueron 19% y 42% superiores a la aplicación en banda, respectivamente. La aplicación combinada al voleo y en banda, no fue significativamente diferente en comparación con las aplicaciones exclusivamente al voleo. Los resultados muestran que los aumentos en el rendimiento de la caña de azúcar y en la eficiencia de uso del fertilizante P en suelos con bajos P en el Cerrado podría alcanzarse aumentando el volumen de suelo fertilizado con P.

RESPOSTA DA CANA-DE-AÇÚCAR A FONTES DE FÓSFORO E MODOS DE APLICAÇÃO EM UM LATOSSOLO MUITO ARGILOSO DO CERRADO

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PALAVRAS-CHAVE: Superfosfato, Fosfato Natural Reativo, Aplicação a Lanço, Aplicação no Sulco, Localização.

Resumo

O SETOR SUCROALCOOLEIRO no Brasil está em expansão na região do Cerrado, onde a cana-de-açúcar tem substituido pastagens em solos com baixa disponibilidade de fósforo (P). A adubação fosfatada da cana-de-açúcar no país é baseada em fertilizantes solúveis em água aplicados no sulco de plantio, o que leva a grandes concentrações de P nessa zona devido às altas doses utilizadas e aos grandes espaçamentos entre linhas da cultura. Neste trabalho, métodos alternativos de aplicação e fontes de P foram avaliados em um experimento instalado em Brasília, DF, em delineamento de blocos casualizados com quatro repetições. O solo foi um Latossolo Vermelho distrófico típico, textura muito argilosa, A moderado, caulinítico, fase cerrado tropical subcaducifólio relevo suave-ondulado, com baixa disponibilidade de P (1,2 mg/dm^3 pelo método Mehlich-1 na camada superficial de 0,0–0,2 m). Os tratamentos foram estabelecidos para a cana-planta (variedade RB 867515), e consistiram de uma curva de resposta variando de 0 a 400 kg/ha de P_2O_5 na forma de superfosfato triplo (SFT), aplicado a lanço e incorporado com grade média antes do plantio, e os seguintes tratamentos na dose de 200 kg/ha de P_2O_5: SFT aplicado no fundo do sulco de plantio; SFT com metade da dose a lanço e metade no sulco; um fosfato natural reativo do Marrocos (FNR) aplicado a lanço e no sulco; e a combinação de FNR a lanço e SFT no sulco. Rendimentos de colmos e açúcares foram avaliados para a cana-planta e duas socas. Rendimentos máximos de colmos (129,9, 92,7 e 96,7 t/ha, respectivamente para os três cortes) com SFT a lanço na dose de 400 kg/ha de P_2O_5 foram em média 89% superiores em relação ao tratamento testemunha (sem adubação fosfatada). Comparando-se as duas fontes de P na dose de 200 kg/ha de P_2O_5, quando aplicadas a lanço os rendimentos foram semelhantes nos três cortes, mas quando os fertilizantes foram aplicados no sulco os rendimentos foram em média 16% inferiores para o FNR em relação ao SFT. Comparando-se os modos de aplicação, os rendimentos médios dos três cortes para o SFT e o FNR aplicados a lanço foram, respectivamente, 19% e 42% superiores em relação à aplicação no sulco. Tratamentos combinando aplicações a lanço e no sulco não foram significativamengte diferentes em relação aos tratamentos com aplicação dos fertilizantes exclusivamente a lanço. Os resultados mostram que aumentos nos rendimento de cana-de-açúcar e eficiência de uso dos fertilizantes fosfatados podem ser obtidos em solos do Cerrado pobres em P com o aumento do volume de solo fertilizado com fósforo.