PHOSPHORUS FERTILIZATION IN THE PLANTATION OF SUGARCANE WITH FILTER CAKE ENRICHED WITH SOLUBLE PHOSPHATE

Santos DH, Tiritan C.S., Foloni J.S.S.
University Western São Paulo (Unioeste), 700 José Bongiovani St., 19050-920, Presidente Prudente-SP, Brazil. Tel: 55 018 39091977. minuano1@hotmail.com

1 INTRODUCTION

Phosphorus is considered an essential element for the plants and is in low amount in the Brazilian soils. The filter cake is a residue composed of a mixture of mulch and ground sludge decantation, from the process of clarification of sugarcane juice for the manufacture of sugar. This residue is an excellent organic product for the recovery of depleted soils with low fertility because it has high levels of organic matter and phosphorus, it is also rich in nitrogen and calcium, and has significant levels of potassium, magnesium and micronutrients. The phosphorus in the filter cake is organic, and the liberation of phosphorus and nitrogen happen gradually, by mineralization and by attack of microorganisms in the soil. This study aimed to evaluate the vegetative growth and productivity of sugarcane (*Saccharum officinarum* L.) in relation to nitrogen filter cake enriched with soluble phosphate (triple superphosphate) at the bottom of the furrow. Due to the fact that phosphorus sources have low efficiency in tropical soils, the hypothesis was to assess whether the mixture of filter cake with a source of phosphorus will improve the phosphorus utilization, using a multi organic filter cake to protect the phosphorus fixing.

2 MATERIALS AND METHODS

2.1 Location

The experiment was conducted under field conditions in the experimental field of Agronomy, University Western São Paulo, Unoeste, located in the geographic coordinates 51°26'00"W, 22°07'30"N and high altitude of 433 m, Presidente Prudente city, São Paulo state, Brazil, during the months of november 2007 to august 2008. The climate, according to the classification of Köppen, is the ´Cwa` type, it means to be tropical, rainy and hot well defined between the months of september to march and a dry winter with temperatures between the months of april to september. The soil was characterized, according to EMBRAPA (1999) as Red Oxi Soil, with gently rolling, undulating and good drainage. Samples were collected to characterize the chemical (Raij et al., 2001) and size, in the 0-20 cm, with the following results: pH ($CaCl_2$ 1 mol L^{-1}) 5.9, 18 g dm^{-3} MO, 16 mg dm^{-3} P, 27 $mmol_c$ dm^{-3} H + Al, 1.2 $mmol_c$ dm^{-3} K, 38 $mmol_c$ dm^{-3} Ca, 12 $mmol_c$ dm^{-3} Mg ; 52 $mmol_c$ dm^{-3} SB, 69 $mmol_c$ dm^{-3} of CTC, 74% of base saturation (V), 740 g kg^{-1} sand, 80 g kg^{-1} silt and 180 g kg^{-1} clay. The results of analysis of organic fertilizer made by the Unoeste Laboratory of Soil Science for the filter cake used in the experiment showed the following values, expressed in dry matter: pH ($CaCl_2$ 1 mol L^{-1}) 5.4, lost moisture at 65°C 70.7%, 57.25% of organic matter, 9.5 g Kg^{-1} N, 3.3 g Kg^{-1} P, 4.6 g Kg^{-1} K, 9.1 g kg^{-1} Ca, 2.5 g Kg^{-1} Mg, 7.2 g Kg^{-1} S, 124 mg Kg^{-1} Cu, 758 mg Kg^{-1} Mn, 282 mg Kg^{-1} Zn and 23.808 mg Kg^{-1} Fe.

2.2 Ratings

Each plot consisted of 5 rows of 5 meters in length, spaced 1.50 meters. It was used a randomized complete block design, in the factorial outline 5 x 4, where the first factor consisted of doses of filter cake (0; 0.5; 1.0; 2.0 and 4.0 ton ha^{-1}) and the second, doses of phosphorus fertilizer (0, 50, 100, 200 Kg ha^{-1} of P_2O_5), with 4 repetitions, totaling 80 plots. The sugarcane variety used was RB867515 (regional recommendation). Assessments of productivity were made in three axis of each plot. The first parameter evaluated was the number of tillers. To this, tillers were counted in the 30, 60, 90 and 120 days after planting. Counting the number of tillers was performed during 120 days after planting because this period is when the cane sugar is in tillering stage, characterized by intense emission growth and branching. During this stage, the competition between tillers by growth factors (light, water, nutrients, space) becomes stronger, so that we see the decrease and stoppage of this process (Segato et al., 2006). For the determination of ^{o}Brix, a refractometer was used in the field, which directly provides the percentage of soluble solids in the juice of sugarcane. The ^{o}Brix of the middle of the tiller was determined by taking 5 tillers per plot, and values are presented as arithmetic mean of 5 tillers assessed, using a methodology proposed by Landell et al. (2005). In november 2008, we assessed production components essential to the agricultural potential, namely, stem height (measured from the base of leaf insertion +3, sampling five stems followed in each row), the average diameter of the stem (estimated in the same five stems, measured in the middle of the internode at the time given by one-third the length of the stem), the weight of the stems clipped, and the number of stems, with the estimated count of the stalks in all lines of the plot, according to the methodology proposed by Raij et. al (2005). According to the same author, considering the density of the stem equals 1, the value of tons of cane per hectare (TCH) can be estimated by the following formula: TCH = (d^2 x h x C x 0.007854) / E, where "d" is the diameter of stems (cm), "C" is the number of tillers per meter, "h" is the average height of culms (cm) and E is the spacing between the grooves, in this case, 1.5 meters.

2.3 Statistical analysis

The experiment evaluated the number of tillers at 30, 60, 90 and 120 days after the planting, ^{o}Brix degrees and productivity. The results were submitted to analysis of variance and regression analysis by test F.

3 RESULTS AND DISCUSSION

The results of analysis of variance indicated that, for productivity of stems, there were significant doses of filter cake applied at the bottom of the furrow, ie, the cane yield was significantly influenced by the levels of filter cake applied to the soil . According to Rossetto et al. (2008), the use of this residue in the sugarcane increases the yield by providing organic matter, phosphorus, calcium and other nutrients. Complete even the most efficient use of the filter cake is to apply it in the furrow where the water content inside the pie promotes sprouting of sugarcane and where the match, to be mineralized, is close to the roots. There was also significant at 1% probability by F test for the variable doses of phosphate when assessing the productivity of stems. Analyzing the values of degrees ^{o}Brix juice at harvest, it was observed that there was significant effect of doses of filter cake to the values of degrees ^{o}Brix. This result is in agreement with Cantarella et al. (2002), that in assessing mixtures in different ratios of phosphate rock and phosphate soluble in water for cane sugar, found no effect on the accumulation of sugar by the plant. Already Vijav and Verma (2001), studying the effect alone or combined organic and mineral fertilizers, noted that the mineral fertilizer associated with the organic cause a significant increase in the level of sugar in sugar cane juice. The results obtained by Nema et al. (1995) in India, who worked with filter cake associated with chemical fertilizers, have reduced the level of sugar in the cane juice in the application of mineral fertilizer alone and increases when the values were used organic fertilizers combined or not with chemical fertilizer. Although the climatic conditions in India are different from those found in Brazil, it is interesting to compare the results in order to enrich the discussion. In relation to the doses of phosphate and filter cake x phosphate interaction, there was no significant effect. As the profiling, we observed a significant effect at 1% probability by F test for the variable doses of filter cake and days after planting, and significant effects at 5% probability for the variable doses of phosphate. For variables 'Phosphate x Filter Cake', 'Filter Cake x Days', 'Phosphate x Pie x Days' and 'Days x Phosphate' no significant effects were found. These positive results for straw yield is because the organic matter of filter cake has an important role in improving soil fertility and its physical properties. The positive productivity was expected since the use of filter cake, associated with phosphate fertilizer, has been adopted as a practice in some plants, because the presence of organic radicals in the filter cake in decomposition can occupy sites of fixation phosphorus (Rossetto et al., 2008), protecting this nutrient reaction with the clay minerals and iron oxides. According to Alleoni and Beauclair (1995), organic matter of filter cake increases the water retention because it is hygroscopic, reaching up to hold water six times its own weight, promotes a decrease in soil bulk density and increasesd the total soil porosity, form aggregates that reduce erosion and increases cation exchange capacity by the action of humic colloidal micelles with activity superior to clay. It also enhances the levels of nitrogen, phosphorus and sulfur from the decomposition and mineralization of organic matter. Form soluble chelates of iron, manganese, zinc and copper, making them available to the roots and encourages microbial activity and addition of new microorganisms, plants and diversifying the soil microflora. All this reacts to form soil humus, which provides an excellent root environment, even in poorer soils, which increases the absorption of nutrients by plants.

TABLE 1 **F values calculated by analysis of variance and regression to the cane yield (TCH), °Brix of the juice at harvest and crop tillering of sugarcane at 30, 60, 90 and 120 days after planting (DAP) in ratio mixtures of doses of soluble phosphate with filter cake doses, applied in the planting furrows.**

Cause of variation	Tons of cane (TCH)	°Brix	Tillering
Doses Filter Cake	2.72*	2.86*	18.94**
Doses Phosphate	9.23**	0.42 ns	2.79*
Days after planting	-	-	539.10**
Filter Cake x Phosphate	1.59 ns	1.11 ns	1.37 ns
Filter Cake x Days	-	-	1.29 ns
Phosphate x Days	-	-	0.31 ns
Filter Cake x P x Days	-	-	0.24 ns
CV (%)	16.86	3.06	19.62

Regression Analysis	TCH		°Brix	
Filter Cake (ton ha^{-1})	Linear (1)	Quadratic	Linear	Quadratic
0.0	5.27*	13.28**	0.83 ns	2.71 ns
0.5	4.45*	0.15 ns	0.79 ns	0.32 ns
1.0	11.34 **	0.03 ns	0.30 ns	0.64 ns
2.0	0.01 ns	0.48 ns	1.27 ns	0.50 ns
4.0	9.02 **	0.48 ns	3.53 ns	0.01 ns

Phosphate (kg ha^{-1} P_2O_5)	Tillering							
	30 days after planting		60 days after planting		90 days after planting		120 days after planting	
	Linear (2)	Quadratic	Linear	Quadratic	Linear	Quadratic	Linear	Quadratic
0	1.02 ns	0.17 ns	6.09*	0.03 ns	10.74**	0.62 ns	11.61**	1.30 ns
50	0.15 ns	0.48 ns	10.68**	1.48 ns	6.83**	3.22 ns	8.37**	2.64 ns
100	1.02 ns	0.13 ns	4.01*	0.05 ns	5.36*	0.13 ns	6.12*	0.04 ns
200	0.58 ns	0.22 ns	1.16 ns	0.03 ns	1.90 ns	3.74*	2.51 ns	4.51*

* and ** significant at 5% and 1% probability, respectively. ns: not significant. (1) linear and quadratic equations calculated for the deployment of doses of soluble phosphate in each dose of filter cake. (2) linear and quadratic equations calculated for the split doses of filter cake within each level of interaction between doses of soluble phosphate and days after planting.

4 CONCLUSIONS

The results show that the efficient use of fertilizers can provide adequate and balanced nutrients, encouraging the best use of what is applied and further development of culture, using the filter cake as a source to protect the organic phosphate without loss . The yield of stems and tillers were influenced by the levels of filter cake applied to the soil. The increase in productivity can be attributed to the supply of organic matter, phosphorus, calcium and other nutrients in filter cake, and the protections it provides against phosphate reactions with clay minerals and iron oxides. The levels of filter cake and their combination with the phosphate does not change the quality of cane juice, because it changes the value of degrees Brix of the juice at harvest.

REFERENCES

Alleoni L R F, Beauclair E G F 1995. Cana-de-açúcar cultivada após milho e amendoim, com diferentes doses de adubo. Scientia Agricola 52, 409-415.

Cantarella H, Rosseto R, Landell M G A, Bidóia M A P, Vasconcelos A C M. Mistura em diferentes proporções de fosfato reativo natural e fosfato solúvel em água para a cana-de-açúcar. In: CONGRESSO NACIONAL DA SOCIEDADE DOS TÉCNICOS AÇÚCAREIROS E ALCOOLEIROS DO BRASIL, 8., 2002, Recife. Anais... Recife, 2002. p. 218-224.

EMBRAPA, Empresa Brasileira de Pesquisa Agropecuária 1999. Centro Nacional de Pesquisa de Solos. Sistema brasileiro de classificação de solos. Rio de Janeiro, Embrapa, 412 p.

Landell M G A, Pinto L R, Creste S, Xavier M A, Anjos I A, Vasconcelos A C M, Bidóia M A P, Silva D N, Silva M A. Seleção de novas variedades de cana-de-açúcar e seu manejo de produção. Encarte do Informações Agronômicas, Associação Brasileira para Pesquisa da Potassa e do Fosfato. Piracicaba, nº 110, 2005.

Nema G K, Vaidya M S, Bangar K S 1995. Response os sugarcane to fertilizer nitrogen and organic manures in black calcareous soils of Madhya Pradesh. Journal of Soils and Crops 2, 129-132.

Raij B, Andrade J C, Cantarella H, Quaggio J A 2001. Análise química para avaliação da fertilidade de solos tropicais. Campinas: Instituto Agronômico, 284 p.

Rossetto R, Dias F L F, Vitti A C 2008. Problemas nutricionais dos solos nas novas fronteiras canavieiras. Revista Idea News 94, 78-90.

Segato S V, Mattiuz C F M, Mozambani A E. Aspectos fenológicos da cana-deaçúcar. In: Segato S V, Pinto A S, Jendiroba E, et al. Atualização em produção de cana-de-açúcar. 1.ed. Piracicaba: Livroceres, 2006. p.19-36.

Vijav K, Verma K S. Effect of N, P, K, Zn fertilizers and organic manure on plant and ratoon crops of sugarcane and soil fertility under continous cropping. In: Annual Convention of the Sugar Technology Association of India, 63, 2001, Jaipur. Abstracts… New Delhi: Sugar Technologists Association of India, 2001, p.135.