IMPROVING PHOSPHORUS EFFICIENCY IN SUGARCANE

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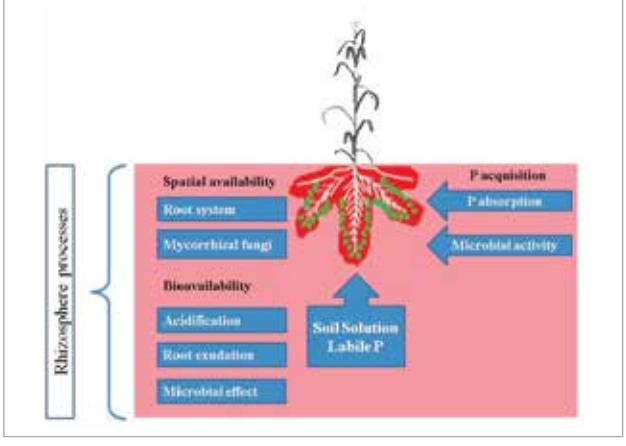

Figure 1. Dynamics of phosphorus in the rhizosphere by the interaction between plant/soil/microorganisms. Adapted from Shen et al. (2011)

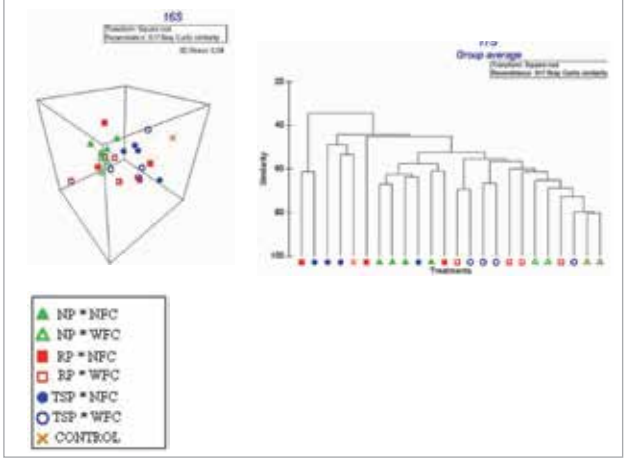

Figure 2. A) NMS (Bray Curtis similarity) plots from bacterial 16S TRFLP results and B) clusters from fungal ITS TRFLP results. Points represent samples. NP – no phosphate; RP – rock phosphate; TSP – triple superphosphate (Both at rate of 180 mg soluble P_2O_5 kg^{-1}); NFC – no filter cake; and WFC – with filter cake at rate of 10 t DM ha^{-1}

The sugarcane cultivated area in Brazil is around nine million hectares and still expanding, in order to supply the improving demand for ethanol and sugar. However, the productivity is limited by several factors, including the low soil phosphorus (P) availability and the adsorption of this P by oxy-hydroxides of Fe and Al in the soil, especially in tropical conditions. According to the rising costs of fertilizers and concerns about reduction of finite reserves of phosphate rock, the use of P by crops in general must become more sustainable. The objective of this research is to evaluate the use efficiency of P by sugarcane fertilized with organic (filter cake) and inorganic (reactive phosphate and superphosphate) sources of P applied at planting, in order to develop strategies to decrease the adsorption of this nutrient in soils and increase the recovery of P from fertilizer. Four experiments were established in field conditions in São Paulo State, as well as three experiments in controlled conditions (greenhouse). Field experiments were established in plant cane and conducted throughout the crop cycle, until the next replanting. The evaluation includes: i) production of stalks; ii) technological attributes; iii) P accumulation by the plant; iv) use efficiency of P; v) fractionation of P in the soil. Under controlled conditions, the experiments aimed to assess the soil-rhizosphere interaction in the availability and utilization of P from soil and fertilizer by plants. Thus, the main goal of the research is to develop management practices to maximize the efficiency of P use from the soil and fertilizer by sugarcane, improving the sustainability of phosphate fertilization.

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

The microbial activity and nutrient content in soil microorganisms is normally affected by the crop and/or genotype used, since the rhizosphere interaction is important to solubilize nutrients (*Figure 1*). In our study, the microbial P level was not affected by sugarcane genotypes, this was also observed under different phosphate rates, with low effect of rates in the microbial P levels in the soil. In addition, changes in the rhizosphere can be improved by microorganisms, because in our case the presence of fertilizer has altered the microbial community composition compared to no fertilizer. Under no fertilizer the microbial groups are closer to each other, indicating low diversity, which may be due to the absence of available P, reducing the interaction between microorganisms and plant. Otherwise, under phosphate application the microbial groups are more disperse, indicating more diversity for all sugarcane genotypes, indicating that the presence of phosphate has provided adequate environmental conditions for the development of a larger diversity of microorganisms, interacting each other and increasing also the plant development.

The genotype RB96-6928 was the best one to adapt under low soil P availability since it presented the largest volume of root and better plant development. The microbial community of all genotypes was changed by phosphate fertilization; more available P in soil has promoted exchanges in microbial communities (*Figure 2*). The dose of around 90 mg kg^{-1} of P_2O_5 as TSP was the most adequate to promote a good seedling development and also better soil rhizosphere parameters, like pH and acid phosphatase activity. Filter cake improved P uptake and availability of labile Pi in the rhizosphere and also modified the fungal microbial community. In addition, the combination between filter cake with rock phosphate was efficient to improve sugarcane growth, such as shoot dry matter and number of tillers per plant.

In the field, the sugarcane yield was higher with TSP as compared to RP, both superior to the control, and there was also a great productivity response when applied filter cake associated to phosphate sources at planting. This behavior was observed for both years evaluated at a sandy soil. However, in a clayey soil there was little response to fertilization, not differing between phosphate sources (TSP or RP) and application ways (broadcast incorporated or at furrow bottom). More research is necessary under field conditions to establish good parameters to get better plant results under soil P restrictions, in this way, we plan to keep this experiments at least for 6-7 years.

MAIN PUBLICATIONS

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