Supplementary Information for

Improving Phosphorus Sustainability of Sugarcane Production in Brazil

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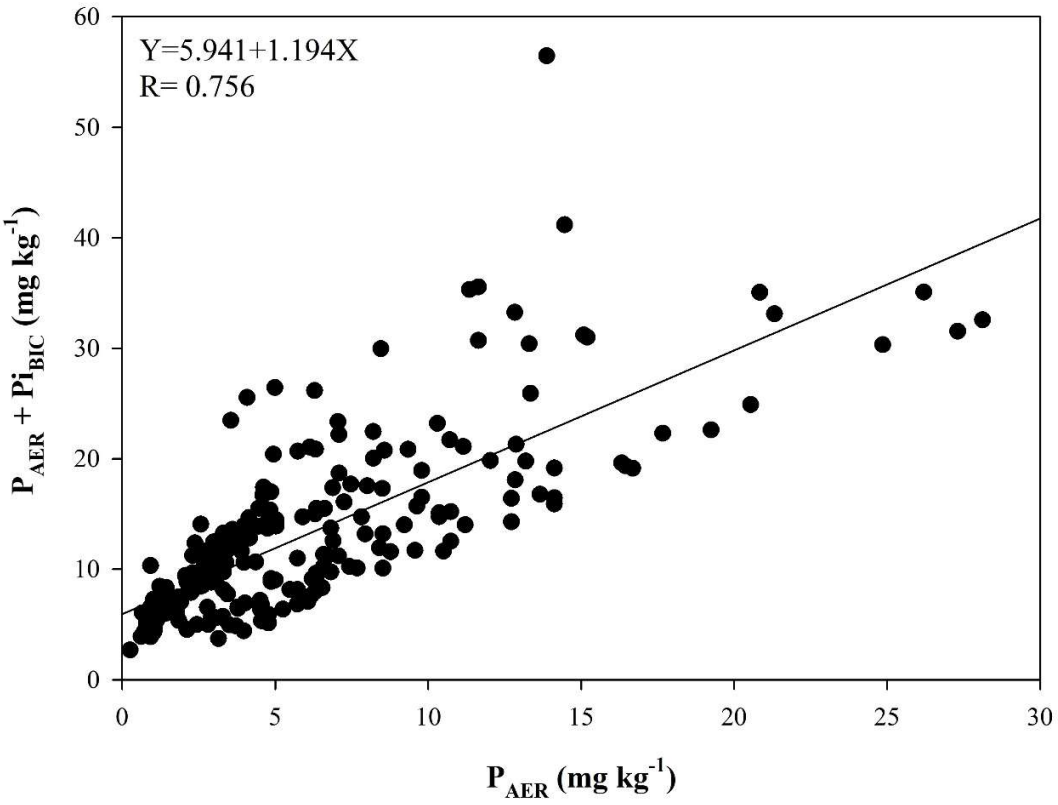

Supplementary Figure 1. Relationship between inorganic labile P (P_{AER} + Pi_{BIC}) and resin P (P_{AER}) in 8 different Brazilian sugarcane fields investigated in this study.

Supplementary Table 1. Advantages and disadvantages of different sources of phosphorus applied in Brazilian sugarcane fields

Phosphate Sources			Advantages	Disadvantages
Primary sources				
	Water soluble	MAP, DAP, SSP, TSP	• High initial agronomic efficiency • High amount of water soluble P_2O_5	• Expensive • More susceptible to loss via erosion
	Less soluble	Rock phosphate	• Less expensive • Low P loss via leaching and erosion	• Releases P slowly suitable for areas with medium to high soil P levels • Low agronomic efficiency in short term • No water soluble P_2O_5
		Thermophosphate	• Contains magnesium, micronutrients and silicon • Low P loss via leaching and erosion • Low P fixation by Fe and Al (hydr)oxides due to the presence of silicon	• Expensive
	Biofertilizers		• Reduce P rates by 25-30% • Replacing expensive sources of P with rock phosphate	• Difficulties associated with isolation and multiplication of pure strains of PSBs
Secondary sources				
	Filter cake		• Reduce the need for mineral fertilizers • Contains 1.2-1.8% of P • Contains 70% humidity which guarantees the sprouting of cane planted in winter	• It is free but the transport cost from the mill to the field is expensive • Slow release P as it is mainly organic
	Vinasse		• Reduce the need for mineral fertilizers • Provide water retention • Increase organic matter and soil microflora	• It is free but the transport cost from the mill to the field is expensive • Slow release P as it is organic • Contains very high amounts of potassium • Risk of salinization in rates higher than 400 m^3 ha^{-1} • Causes delay of the maturation process in high quantities • Contamination of ground water via leaching
	Straw		• Reduce the need for mineral fertilizers • Reduces erosion • Improve soil carbon content • Provide water retention	

Supplementary Table 2. Soil phosphorus fractions in the sites investigated in this study

	Brotas†	Sorocaba†	Agudos‡	Ipaussu§	Macatuba‡	Manduri†	Valparaiso§	Jatai§
P_{AER}	1.2	1.1	4.0	3.8	7.3	5.6	10.1	4.5
Pi_{BIC}	5.6	6.0	7.6	9.4	8.6	11.1	9.7	21.4
Po_{BIC}	47.6	56.5	16.0	23.8	16.3	28.5	38.9	9.4
$Pi_{HID-0.1}$	23.1	22.9	21.0	83.4	18.5	32.1	28.1	62.3
$Po_{HID-0.1}$	45.7	109.2	45.5	42.7	94.1	183.0	89.1	72.6
P_{HCl}	1.3	0.8	32.5	14.8	11.5	2.6	14.2	4.5
$Pi_{HID-0.5}$	6.9	9.2	22.0	128.0	34.2	15.0	11.2	74.4
$Po_{HID-0.5}$	46.4	47.0	26.5	33.2	65.5	82.5	79.4	73.2
$P_{residual}$	77.0	418.0	76.9	667.2	274.5	1127.0	202.7	328.8
P_{total}	255.0	671.0	252.0	1006.5	530.5	1487.0	489.5	650.9

†unpublished data obtained by A. Soltangheisi

‡data from Soltangheisi et al. (2019)

§data from Cherubin et al. (2016)

P_{AER}: P extracted with anion exchange resin; Pi_{BIC} and Po_{BIC}: inorganic and organic P extracted with 0.5 mol L^{-1} $NaHCO_3$; $Pi_{HID-0.1}$ and $Po_{HID-0.1}$: inorganic and organic P extracted with 0.1 mol L^{-1} NaOH; P_{HCl}: phosphorus extracted with 1.0 mol L^{-1} HCl; $Pi_{HID-0.5}$ and $Po_{HID-0.5}$: inorganic and organic P extracted with 0.5 mol L^{-1} NaOH; $P_{residual}$: phosphorus extracted with concentrated H_2SO_4+30% H_2O_2 and saturated magnesium chloride. Sequential fractionation in all sites was performed by a methodology proposed by Hedley, Stewart, & Chauhan (1982) and modified by Condron, Goh, & Newman (1985).

Supplementary References

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