Sugarcane Production Related to Extractable Soil Phosphorus in Florida Organic Soils

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Introduction

- Sugarcane (*Saccharum* spp.) is grown on 155,000 ha in the Everglades Agricultural Area (EAA) of Florida
- Impact of P fertilizer application is a major environmental concern because the EAA drains into the Everglades
- Soil testing for P fertilization is part of a successful BMP program in the EAA
- Water-extractable P is currently used for fertilizer recommendations on organic soils
- Limitations of the water extractant:
  1) Developed for short-season crops (vegetables), not long-term crops (sugarcane)
  2) Very pH-dependent
- There is a need for an updated P fertilizer calibration with an extractant appropriate for sugarcane on organic soils

Objectives

1) Relate soil-extractable P to cane and sugar yield response to P fertilizer
2) Develop updated P fertilizer recommendations for sugarcane on organic soils

Materials and Methods

- Eight test sites with band or broadcast P fertilizer comparisons on organic soils
- All tests were randomized complete block designs with 5-8 replications
- Plots were 13.2 m (tests 1-2, 6-8) or 10.7 m (tests 3-5) long with 1.5 m between-row spacing; plots were 4 (tests 1-5) or 6 (tests 6-8) rows wide
- Banded P rates of 0, 9, 18, 36, 72, and 144 kg P ha^{-1} were applied in tests 1, 2, and 6-8
- Broadcast P rates of 0, 15, 30, 45, and 60 kg P ha^{-1} were applied in tests 3-5
- Fertilizer P source was TSP except for ratoon crops of tests 6 and 8 when MAP was used
- Soil samples (0-15 cm depth, air dried) extracted with 4 extractants:
  1) water (deionized)
  2) 0.5 *M* acetic acid
  3) Bray 2 (0.03 *M* NH_4F and 0.1 *M* HCl)
  4) Mehlich 3 (0.2 *M* CH_3COOH, 0.25 *M* NH_4NO_3, 0.015 *M* NH_4F, 0.013 *M* HNO_3, and 0.001 *M* EDTA)
- Sugarcane yield measurements were taken with either a commercial harvester and weighing wagon (tests 1-2), or by stalk counts and weights of 40-stalk samples (tests 3-8)
- 10 or 16-stalk samples were milled to estimate sucrose concentration

Table 1. Soil pH, initial soil-extractable P_i and crop years with significant ($P<0.05$) responses to fertilizer P in tonnes cane ha^{-1} (TCH) or tonnes sugar ha^{-1} (TSH)

Test	pH	Water	Acetic	Bray 2	Mehlich 3	Crop Years	TCH P Fert Response Yrs	TSH P Fert Response Yrs
		---------- g P m^{-3} ----------						
1	6.6	1.8	15.4	6.3	6.5	4	4	4
2	4.8	9.8	15.0	6.8	7.4	4	4	4
3	7.3	5.7	49.4	NA	28.7	3	1	0
4	7.0	2.7	91.3	NA	14.6	4	1	1
5	6.9	3.9	44.2	NA	10.1	3	0	0
6	6.2	1.3	26.6	15.5	10.3	3	1	1
7	6.2	1.7	25.3	23.7	19.2	1	0	0
8	6.9	2.6	87.7	20.3	10.2	2	2	2

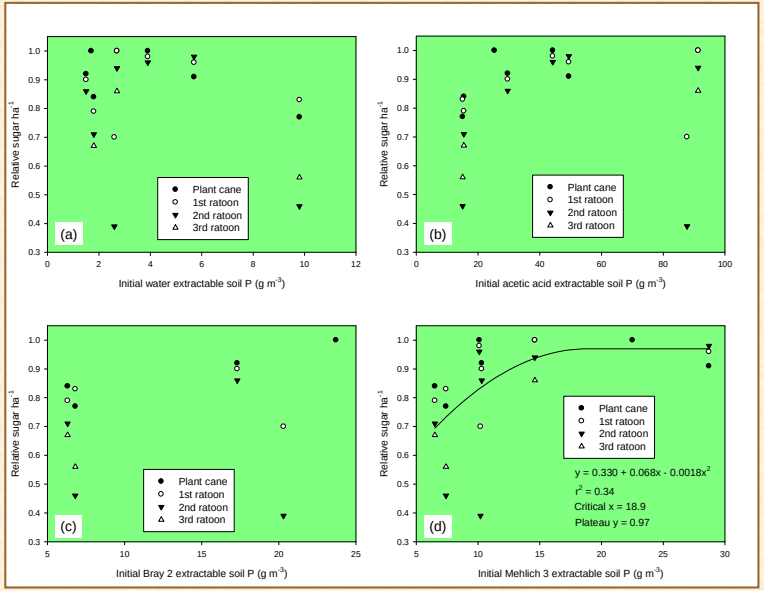

Figure 1. Relationships between soil-extractable P and relative sugar ha^{-1} using four extractants. Individual points are means for control plots (no P) in individual crop years for each test relative to the highest sugar yielding treatment.

Table 2. Proposed sugarcane phosphorus fertilizer calibration

Plant		Ratoon 1&2		Ratoon 3+	
Mehlich 3 P	P Rate	Mehlich 3 P	P Rate	Mehlich 3 P	P Rate
g m^{-3}	kg ha^{-1}	g m^{-3}	kg ha^{-1}	g m^{-3}	kg ha^{-1}
$\leq$ 10	36	$\leq$ 10	36	$\leq$ 20	25
11-15	30	11-15	30	21-40	20
16-20	25	16-20	25	> 40	0
21-30	20	21-35	20		
> 30	0	> 35	0		

Results and Discussion

- Significant responses in tonnes sugar ha^{-1} to P fertilizer in 5 of 8 locations (Table 1)
- Relative sugar yield did not relate well to extractable P with water, acetic, or Bray extractants (Fig. 1)
- As pH decreases, water-extractable P increases which causes a problem with this calibration (See test 2: Table 1, Fig. 1a)
- There were specific soils where there were high values of acetic acid-extractable P, but strong responses to fertilizer P (See tests 4 and 8: Table 1, Fig. 1b)
- There were also specific soils where there were relatively high values for Bray 2-extractable P, but strong responses to fertilizer P (See test 8: Table 1, Fig. 1c)
- Mehlich 3 extractable P has a stronger relationship with relative sugar production (Fig. 1d)
- Very strong response in tonnes sugar ha^{-1} to P fertilizer was observed in most situations with Mehlich 3 P $\leq$ 10 g m^{-3}
- Strongest responses to P fertilizer were observed in ratoon crops: Adding crop year to the model in Fig. 1d improved the r^2 to 0.48

Conclusions

- A new P fertilizer calibration is proposed (Table 2)
- The highest P fertilizer rate to which responses have been obtained was assigned to Mehlich 3 P $\leq$ 10 g m^{-3}
- No P is recommended in the plant cane crop for Mehlich 3 P > 30: This is slightly higher than the value of 28.7 in test 3 where there was a slight response in TCH
- The Mehlich 3 P value assigned to the lowest rate of P fertilizer is increased for ratoon crops to allow for some reduction in available P since the preplant soil test

Acknowledgements

- Supported by a grant from the Florida Department of Agriculture and Consumer Services
- Supported by donations from the Florida Sugarcane League
- In-kind support from the Sugarcane Growers Cooperative of Florida, Florida Crystals Corporation, and United States Sugar Corporation