The Effect of Soil Acidity Factors on Crop Yields IX. Taniers[1,2]

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ABSTRACT

Yield of taniers on a Corozal clay (Ultisol) decreased with increasing soil acidity from 16.3 t/ha at pH 5.0 with 12% saturation of the CEC with Al, to 4.2 t/ha at pH 4.2 and 70% Al saturation. Similar results were obtained on Corozal clay subsoil. Much lower yields were produced on Coto clay (Oxisol). These yields were lowered only at the highest acidity level, pH 4.5, and 34% Al saturation of the soil CEC. Foliar composition of the taniers was not affected by soil acidity, except that the Ca content was appreciably less at the highest level of acidity on the Corozal soil and subsoil. For all soils combined, pH and percent Al saturation of the soil CEC correlated very closely with yields. Overall yields were close to maximum when the soil had a pH of 5.2 and no exchangeable Al.

INTRODUCTION

Taniers or cocoyams (*Xanthosoma* sp.) are an important source of carbohydrates throughout the humid tropics. They can produce over 20 t of edible tubers/ha and a similar amount of corms which can be used for feeding pigs (11).

Research information on taniers is generally limited to cultural practices (6, 9, 10, 12, 13), but there is very little information on their response to liming. Abruña et al. (1) found that taniers did not respond to liming in two Ultisols with pH of 5.0 and 5.3.

This paper presents the results of a study to determine the effect of soil acidity factors on yields and foliar composition of taniers growing on two Ultisols and one Oxisol.

MATERIALS AND METHODS

The experiments were conducted on a Corozal clay soil and subsoil (Aquic Tropudults) and on a Coto sandy clay (Tropeptic Haplorthox). There were 30 4 × 4-m plots at each of the Corozal sites and 40 on the Coto soil. All plots were surrounded by ditches to prevent runoff from one plot to another and were arranged in complete randomized blocks.

[1] Manuscript submitted to Editorial Board September 30, 1982.

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The plots varied widely in soil acidity because of differences in rates of lime applied during previous years.

All plots were planted to the Morada variety of taniers with corm sections weighing about 100 g each at .6 × .6 m. At planting and 6 mo later, all plots received 500 kg/ha of a 10–10–10 fertilizer with 30 kg/t of a minor element mixture containing 6% Mg, 7.7% Mn, 4.8% Cu, 7% Fe, 8% Zn and 2.5% B. The plots were sprinkle irrigated at the rate of 50 mm weekly during dry periods and were harvested 1 year after planting.

Mature-active leaves were taken from plants in the center row of each plot 8 mo after planting, washed with distilled water, dried at 70°C, ground, and analyzed after wet digestion for P, colorimetrically as molibdate (7); for K, by flame photometry; for Mn, colorimetrically as permanganate after oxidation with KIO_4; and for Ca + Mg, by the Versenate method (4). Nitrogen was determined in a separate sample by the Kjeldahl method.

The soil in all plots was sampled about 4 mo after planting by 10 borings from 0- to 15-cm depths in each plot. The samples were air dried and passed through a 20-mesh screen. Exchangeable Ca, Mg, K, and Mn were extracted with neutral *N* NH_4OAc. Potassium, Ca + Mg, and Mn were determined as for the leaf samples. Exchangeable Al was extracted by *N* KCl and determined by the double titration method (8). The Al saturation percentage of the effective CEC of the soil was calculated by dividing the exchangeable Al by the sum of exchangeable Ca, Mg, K, Al, and H (5). Soil pH was measured with a glass electrode for 1:1.5 mixtures of soil and water.

For statistical comparisons of the yield data, plots were grouped into Al saturation ranges of 10%, with 0 content as a separate category. The effect of various soil acidity factors were related to yield through regression analyses.

RESULTS AND DISCUSSION

COROZAL CLAY SOIL

Taniers yield was not affected until soil pH dropped below 4.8 with 25% Al saturation of the CEC (table 1), decreasing further to only about 25% of maximum at pH 4.2 with 78% Al saturation.

Taniers are relatively tolerant to high soil acidity. At 50% Al saturation of the soil, taniers, yams and cassava produced, respectively, about 55%, 19% and nearly 100% of their maximum (2, 3).

Leaf composition was not appreciably affected by soil acidity, except that the Ca content dropped when pH decreased from 4.6 to 4.2.

Regression analysis showed that all soil acidity factors correlated with yields at the .01 level (table 2). Exchangeable Ca + Mg contents explained

TABLE 1.—*Effect of soil acidity factors on yields and foliar composition of taniers grown on two Ultisols and one Oxisol*

Soil acidity factors					Yield		Contents in leaves					
pH	Exch. Al	Exchangeable Ca + Mg	Al saturation of CEC	*Exch. Al* / Exch. base	Tubers	Corms	N	P	K	Ca	Mg	Mn
	me/100 g	*me/100 g*	%		*t/ha*				%			
					Corozal clay soil							
5.80	0	13.46	0	0	16.3 a[1]	19.1	3.07	.23	2.65	1.25	.56	208
5.00	1.36	9.75	12	.14	16.3 a	18.9	3.06	.22	2.78	1.18	.51	144
4.80	3.17	9.24	25	.33	13.2 a	12.1	3.06	.23	2.83	1.22	.46	205
4.70	4.01	7.25	35	.55	8.2 b	8.9	3.09	.22	2.61	1.18	.48	230
4.60	6.12	5.89	50	1.06	9.2 b	9.7	3.11	.22	2.79	1.21	.48	176
4.40	8.12	3.82	67	2.11	7.0 bc	8.2	2.96	.23	2.53	1.08	.54	174
4.20	10.80	2.90	78	3.62	4.2 c	4.7	2.95	.22	2.56	1.00	.43	200
					Corozal clay subsoil							
5.40	0	13.58	0	0	16.0 a	13.3	3.06	.23	2.59	1.21	.55	153
5.00	.85	9.06	7	.07	16.0 a	13.5	3.12	.23	2.81	1.12	.49	126
4.80	2.91	8.03	26	.37	12.6 ab	11.3	3.08	.22	2.48	1.16	.60	150
4.60	4.78	6.32	42	.74	13.0 ab	12.1	3.11	.21	2.69	1.15	.53	196
4.50	6.51	5.58	53	1.11	8.9 b	7.7	2.99	.24	2.61	1.02	.57	136
4.40	7.52	3.69	67	2.08	9.0 b	7.7	2.91	.23	2.39	1.17	.57	150
4.20	9.59	2.05	81	4.60	4.6 c	6.0	2.94	.22	2.52	1.02	.42	178
					Coto sandy clay							
6.10	0	4.71	0	0	5.3 ab	15.7	2.58	.22	3.37	1.19	.43	129
5.00	.32	4.02	7	.07	4.8 ab	17.0	2.60	.20	3.17	1.26	.42	178
4.70	.84	3.11	20	.25	5.9 a	20.1	2.55	.21	3.13	1.13	.42	172
4.50	1.26	2.36	34	.46	3.6 b	15.4	2.58	.21	3.40	1.21	.45	236

[1] Means followed by one or more letters in common do not differ significantly at the 5% probability level (Duncan multiple range test).

about 50% of the variations observed, percent Al saturation of the soil CEC explained 45%, and the ratio of exchangeable Al to exchangeable bases, 37%. The Ca content of the leaves correlated significantly with yields, explaining 38% of the variations observed.

COROZAL CLAY SUBSOIL

The effects of soil acidity factors on yields of tubers and corms in the subsoil were similar to those in the Corozal soil (table 1). Leaf composition was not appreciably affected by acidity, except that Ca content was depressed at the highest level of soil acidity.

TABLE 2.—*Relationship between tanier yields and soil acidity factors on two Ultisols and an Oxisol*

Soil acidity factor	Tuber yields (t/ha)	Correlation coefficient (r)
	Corozal clay-soil	
pH	$Y = -147.7 + 57.0X - 4.9X^2$	.66*[1]
Percent Al saturation	$Y = 16.2 - .14X$	.67*
Exch. Al/Exch. bases	$Y = 13.4 - 2.6X$	.61*
Exch. Ca + Mg	$Y = 1.96 \times 1.17X$	.72*
Ca content of leaves	(X) vs. yield (Y) $= -19.0 + 24.9X$	.62*
	Corozal clay-subsoil	
pH	$Y = 42.3 + 11.3X$	.76*
Percent Al saturation	$Y = 16.9 - .13X$	.71*
Exch. Al/Exch. bases	$Y = 14.2 - 2.17X$	.71*
Exch. Ca + Mg	$Y = .42 + 2.55X - .106X^2$	.71*
Ca content of leaves	(X) vs yield (Y) $= -10.05 + 18.3X$	.52*
	Coto sandy clay	
pH	$Y = 19.27 + 8.95X - .76X^2$	.44*
Percent Al saturation	$Y = 6.8 - .04X$	.35*
Exch. Al/Exch. bases	$Y = 6.8 - 2.95X$	.36*
Exch. Ca + Mg	$Y = .77 + 2.88X - .34X^2$	.37*
Ca content of leaves	(X) vs yield (Y) = not significant	

[1] Significant at least at .05 level.

Table 2 shows that all soil acidity factors correlated with yields at the .01 level. Soil pH explained about 58% of the variation in tuber yields. Percent Al saturation of the soil CEC, exchangeable Ca + Mg, and the ratio of exchangeable Al to exchangeable bases explained about 50% of the variations in yield. Calcium content of the leaves correlated with yields, but explained only about 27% of the observed variations.

COTO SANDY CLAY

The yield of tubers was very low and was depressed further only by the highest level of acidity, pH 4.5, and 35% Al saturation of the soil

CEC (table 1). Yield of corms was almost as high as that obtained on Corozal soil and was not affected by soil acidity. Soil acidity did not affect foliar composition appreciably.

Tuber yields correlated weakly with soil acidity factors (table 2), and did not correlate with the Ca content of the leaves.

ALL SOILS COMBINED

Regression analysis of the combined data for the three soils (fig. 1 and 2) showed that either pH or percent Al saturation of the soil CEC explained more than 80% of the variations observed in tuber yields.

Yields of tubers were close to maximum when the soil pH was around

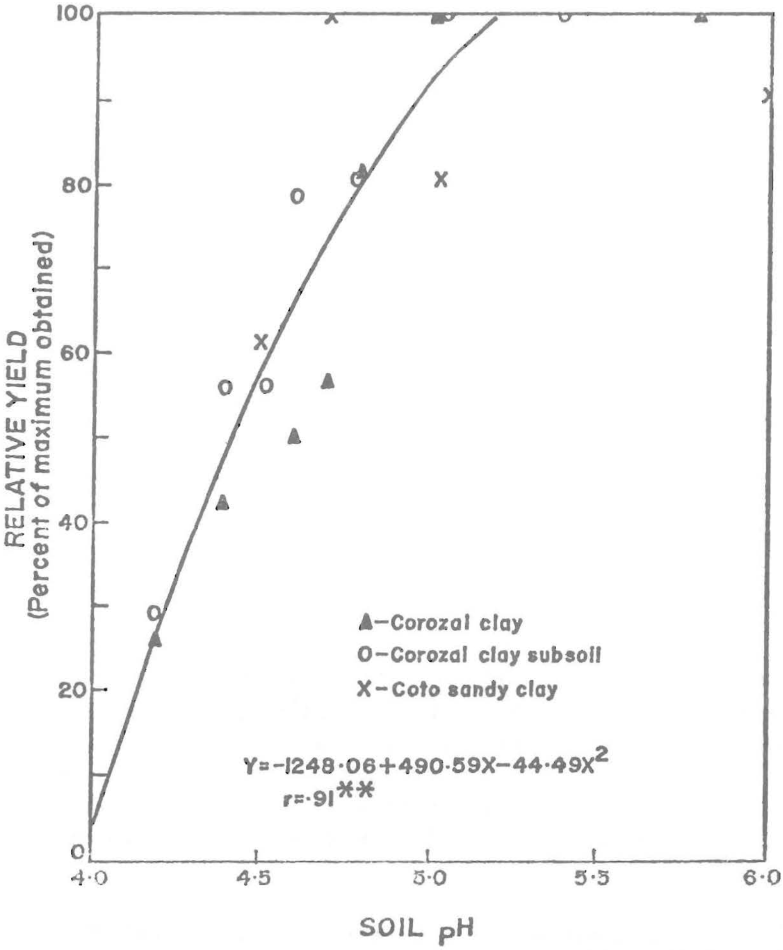

FIG. 1.—Relationship between pH of two Ultisols and one Oxisol and tuber yield of tanier.

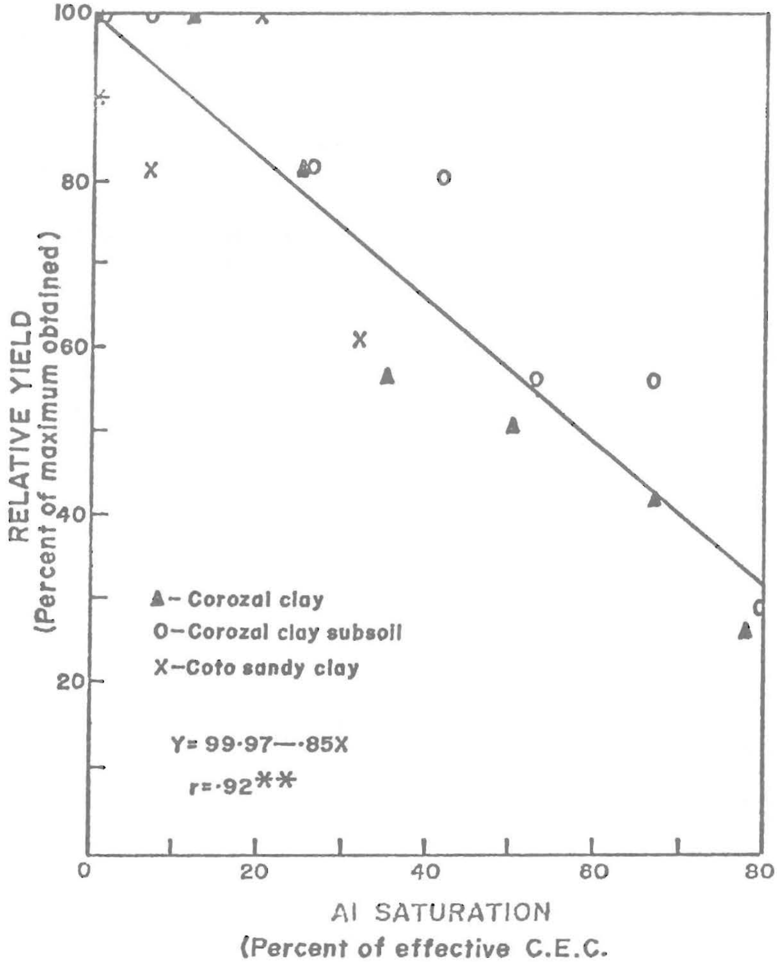

FIG. 2.—Relationship between percent Al saturation of the effective cation exchange capacity of two Ultisols and one Oxisol and tuber yield of tanier

5.2 with no exchangeable Al in the soil, but only about 50% of maximum yields when the soil pH was about 4.5 and Al saturation of the soil CEC was 60%, a level common in Ultisols.

RESUMEN

Se estudió el efecto de los factores de acidez del suelo en la producción y composición foliar de la yautía en dos Ultisol en Corozal y un Oxisol en Isabela. En el suelo Corozal la producción de tubérculos disminuyó cuando el pH del suelo bajó de 4.8, lo que correspondió a 25% de saturación de la capacidad de cambio del suelo con aluminio. Cuando el pH del suelo bajó a 4.2, que corresponde a un 78% de saturación de la capacidad de

cambio del suelo con aluminio, la producción fue de solamente un 25% del máximo. La producción de "madres" (cormos) siguió un patrón similar al de los "hijos".

El efecto de los factores de acidez en la producción de la yautía creciendo en subsuelo Corozal fue similar a la que creció en el suelo.

En el suelo Coto, la producción de hijos fue mucho más baja que en el Corozal y disminuyó solamente cuando la acidez bajó a pH 4.5, lo que corresponde a 34% de saturación de la capacidad de cambio con aluminio. La producción de "madres" fue casi tan alta en el suelo Coto como en el Corozal, sin afectar la acidez.

Los rendimientos más altos se obtuvieron cuando el pH del suelo fue de 5.2 o más, a cuya acidez no hay aluminio cambiable en el suelo. A 60% de saturación de los suelos con aluminio, equivalente a pH 4.5, el rendimiento fue alrededor del 50% del máximo.

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