Crop Response to Soil Acidity Factors in Ultisols and Oxisols in Puerto Rico. XIV. Plantains and Bananas[1,2]

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ABSTRACT

The effect of soil acidity factors on yield components and leaf composition of plantains and bananas were studied on two Ultisols and one Oxisol. Both crops were extremely tolerant to soil acidity factors on all soils. On the Ultisols, plantains produced similar yields although pH varied from 4.1 to 6.0, and exchangeable Al contents from 0 to over 70% of the cation exchange capacity. On the Oxisol, similar yields were produced when pH varied from 4.25 to 5.25, and exchangeable Al contents from 0 to 48%. Soil acidity did not affect bunch weight or number or weight of fruits. Foliar composition was not affected except that Ca content decreased as acidity of the Ultisols increased. Similarly, bananas produced high yields of marketable fruit at all levels of soil acidity and none of the yield components were affected by the soil acidity factors. Foliar composition was not affected except that Ca content decreased with increasing acidity.

INTRODUCTION

Plantains and bananas are important food crops throughout tropical and subtropical areas of the world. Plantains are mainly consumed as a vegetable, whereas bananas are consumed either as a vegetable or as a fruit in the tropical countries and as a fruit in the temperate regions.

There is little and contradictory information available on the response to liming of bananas and plantains growing on acid Ultisols and Oxisols typical of vast areas of the humid tropics. Pérez-Escolar and Lugo-López (9) studied the effect of soil acidity factors in an Ultisol on plantain yields and found no correlation between yields and soil acidity factors, except for a weak correlation ($r = 0.47$) between pH and number of fruits per bunch. Bhangoo and Karon (2) working with Giant Cavendish bananas reported a significant increase in bunches cut per acre when dolomitic limestone was applied to acid (pH 4.0) or mildly acid (pH 6.0) soils. This effect was probably a response to Mg rather than to liming. Cumba and Fraga (4) working in São Paulo, Brazil, found no response to liming when soil pH ranged from 5.2 to 6.0. Similarly, Gregory (5) and Osborne (8) report no beneficial effect on banana yields due to liming

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acid soils in Jamaica. On the other hand, Groucher and Mitchell (6), also working in Jamaica, reported a beneficial effect of lime applied to slightly acid soils which were low in K.

The present study determined the response of plantains and bananas to liming and the relationship between the soil acidity factors and yield components, and foliar composition of these crops on two Ultisols and one Oxisol.

MATERIALS AND METHODS

The experiments were carried out over 2 consecutive years in plots with widely varying levels of soil acidity resulting from differential applications of calcitic limestone over a period of years prior to these experiments.

The experiments were carried out on Corozal clay (Aquic Tropudults), Corozal clay subsoil (topsoil removed), and Coto sandy clay (Tropeptic Haplorthox). There were 30 4 × 4 m plots on each of the Ultisols and 42 on the Oxisol. The plots were surrounded by 15-cm-deep ditches to prevent runoff from one plot into another.

All plots were planted to plantains of the Maricongo cultivar at 2 × 2 m in February 1981 with corms weighing around 1.5 kg. All plots received 3 t/ha of 10-5-20 fertilizer containing 135 kg of Mg and 15 kg of a mixture of minor elements divided in four equal applications at planting and 4, 7 and 10 months later. Insects and nematodes were controlled by the application of 25 g of Temik 10G/plant at planting time and every 3 months thereafter. Plants were sprayed every 21 days with orchard oil to control Sigatoka leaf disease. Plots were maintained free of weeds by periodic hoeing. The bunches were harvested when they attained maturity, from 14 to 17 months after planting.

All plots on the two Ultisols were planted to bananas of the Gran Naine variety in July 1982, with corms weighing around 1 kg planted at 2 × 2 m. All plots were fertilized with 1.5 t/ha of 10-5-30 containing 135 kg of Mg and 15 kg of a mixture of minor elements divided into five equal applications at 1, 3, 5, 7 and 9 months after planting. Insects and diseases were controlled with the same pesticides as for plantains. Bunches were harvested when they were three quarters full.

For both crops the third leaf was sampled 7 months after planting and analyzed for N by the Kjeldahl method; P, colorimetrically as molybdate; K by flame photometry; Ca and Mg by the Versenate method (3); and Mn colorimetrically as permanganate.

The soil in each plot was sampled at planting by means of 10 borings at 0 to 15 cm depth. The samples were air dried and passed through a 10-mesh screen. Exchangeable bases (Ca, Mg, K), were extracted with *N* NH_4OAc at pH 7.0, and Ca and Mg were determined by the Versenate method (3), and K by flame photometry. Exchangeable Al was extracted with *N* KCl and determined by the double titration method (7). Aluminum saturation percentage was determined by dividing the exchangeable Al by the sum of exchangeable Ca, Mg, K, Al, and H. Soil reaction was measured with a glass electrode pH meter with a 1:1.5 soil-to-water ratio.

Yield components and foliar composition were related to soil acidity factors through regression analysis.

RESULTS AND DISCUSSION

PLANTAINS

Soil acidity factors had no effect on yield components or foliar composition of plantains growing in the two Ultisols or the Oxisol (table 1). In the Ultisols, yields averaged close to 30 t/ha with about 40 fruit/bunch weighing about 280 g each at soil pH ranging from 4.1 to about 6.0, and exchangeable Al from 0 to over 70% of the cation exchange capacity.

Chemical composition of the leaves was not affected by variations in soil acidity (table 1) except for a tendency of Ca content to decrease with increasing acidity.

In the Coto soil (Oxisol), yields and yield components were similar when pH ranged from 4.25 to 5.25 and exchangeable Al from 0 to 67% of the cation exchange capacity (table 1). Yield components were not affected by soil acidity factors. Neither was foliar composition affected by soil acidity except for a tendency of Ca content to decrease with increasing acidity (table 1).

In the Coto soil, plantain leaves had more than four times the Mn content than those of plantain grown in the Corozal soils (table 1). The higher absolute exchangeable Al values in the Corozal and the higher Mn content in the Coto may be responsible for these differences.

Plantain yields in the Coto soil were similar to those obtained in the Corozal soil and subsoil.

Plaintains apparently can tolerate very high levels of both Al and Mn in the soil and take up Mn in quantities that will represent toxic levels in other crops.

BANANAS

Bananas were grown only in the Corozal Ultisols. Bananas were extremely tolerant to soil acidity, producing high yields at acidity levels varying from pH 3.7 to 5.9 with exchangeable Al from 0 to 76% of the effective CEC of the soil. The marketable yields, averaging over 55 t/ha, bunch weight, fruits per bunch and hands per bunch were not affected by soil acidity levels (table 2).

Total marketable yield of both plantains and bananas were similar in both the Corozal clay soil and subsoil.

TABLE 1.—*Effect of soil acidity factors on yield components and foliar composition of the Maricongo cultivar of plantains grown in two Ultisols and one Oxisol*

Soil acidity factors			Yield components				Foliar composition					
pH	Al sat.	Ca sat.	Yields of marketable fruits	Fruit/bunch	Bunch weight	Fruit weight	N	P	K	Ca	Mg	Mn
	%	%	t/ha	No.	kg	g	%	%	%	%	%	p/m
Corozal clay (Aquic Tropudults)												
5.80	0	68	29.6	40.5	12.4	305	3.30	.20	4.00	.64	.30	237
4.90	9	66	28.9	41.4	12.1	293	3.35	.23	3.97	.64	.30	402
4.80	23	56	29.6	42.0	12.4	291	3.46	.23	3.70	.68	.30	373
4.70	37	40	27.7	40.6	11.6	287	3.40	.21	3.69	.60	.29	379
4.50	53	33	30.1	41.6	12.6	304	3.41	.21	3.65	.57	.28	250
4.20	64	24	27.7	41.9	11.6	278	3.43	.24	3.84	.53	.25	293
4.10	77	13	27.7	40.4	11.6	288	3.76	.21	4.36	.51	.30	280
Corozal clay subsoil (Aquic Tropudults)												
6.00	0	72	25.8	39.1	10.8	276	3.38	.21	3.85	.61	.39	145
4.90	11	64	26.8	39.4	11.2	285	3.31	.21	3.97	.64	.29	176
4.70	24	54	29.9	40.6	12.5	307	3.30	.21	3.79	.56	.33	123
4.60	34	47	28.0	41.0	11.7	285	3.29	.23	3.70	.55	.31	160
4.40	53	31	29.6	40.8	12.4	329	3.31	.20	3.97	.47	.28	208
4.10	73	13	26.1	38.9	10.9	280	3.44	.21	4.07	.52	.24	276
Coto sandy clay (Tropeptic Haplorthox)												
5.25	0	67	31.3	43.1	13.1	305	4.04	.21	2.44	.72	.42	1345
4.90	7	65	27.0	39.3	11.3	288	4.05	.20	2.54	.82	.41	1370
4.75	17	53	29.6	42.2	12.4	295	3.87	.21	2.72	.77	.43	1368
4.55	27	47	27.7	42.3	11.6	275	3.98	.21	2.53	.71	.40	1364
4.35	36	45	28.7	42.7	12.0	280	3.93	.21	2.73	.70	.41	1429
4.25	48	35	27.7	41.1	11.6	283	4.02	.21	2.52	.70	.40	1472

TABLE 2.—*Effect of soil acidity factors on yield components and foliar composition of the Gran Naine variety of bananas grown in two Ultisols*

Soil acidity factors			Yield components					Foliar composition					
pH	Al sat.	Ca sat.	Marketable yields	Fruit/bunch	Bunch weight	Hands/bunch	N	P	K	Ca	Mg	Mn
	%	%	t/ha	No.	kg	No.	%	%	%	%	%	p/m
					Corozal clay soil							
5.45	0	69	55.8	111	18.9	7.7	3.32	.23	3.05	.45	.29	192
4.90	10	61	58.2	114	19.7	7.7	3.18	.26	2.94	.49	.29	310
4.65	23	42	58.7	112	19.9	7.2	3.24	.24	2.91	.45	.32	210
4.40	40	31	53.8	108	18.2	7.3	3.34	.23	2.96	.36	.32	326
4.00	53	24	54.2	109	18.3	7.3	3.25	.24	2.93	.39	.26	345
3.80	73	12	55.1	110	18.6	7.4	3.34	.24	2.86	.31	.23	133
					Corozal clay subsoil							
5.90	0	69	62.8	117	21.2	7.8	3.44	.25	3.25	.45	.30	132
4.90	10	55	59.7	110	20.2	7.3	3.61	.24	2.96	.41	.30	125
4.70	22	48	56.6	110	19.2	6.9	3.44	.24	3.20	.42	.32	120
4.50	35	32	58.2	109	19.7	7.3	3.30	.23	2.97	.37	.29	120
4.35	52	25	55.0	101	18.6	6.9	3.31	.23	2.90	.35	.26	128
3.70	76	15	61.0	108	20.6	7.6	3.26	.24	3.13	.34	.27	148

Leaf composition was not significantly affected by soil acidity except for Ca content, which tended to decrease with increasing acidity.

The tolerance of plantains and bananas to soil acidity is much greater than that of tolerant root crops such as cassava and sweetpotatoes (1).

RESUMEN

Se estudió el efecto de grados de acidez sobre la producción de plátanos de la variedad Maricongo y guineos de la variedad Grand Naine en dos Ultisol y un Oxisol.

En los Ultisol se lograron producciones similares de plátanos a valores de pH que variaron de 4.1 a 6 y saturaciones del complejo coloidal con Al que fluctuaron entre 0 y 70%. En el Oxisol la producción fue similar a pesar de que el pH varió de 4.25 a 5.25 y la saturación con aluminio cambiable de 0 a 48%. Los factores de acidez no modificaron ni el peso de los racimos ni el número de frutas por racimo. Tampoco se afectó la composición química de las hojas, excepto que el contenido en calcio disminuyó según aumentó la acidez en los Ultisol.

Los guineos produjeron altos rendimientos de fruta comercial en todos los grados de acidez. Estos no afectaron los componentes del rendimiento. El grado de acidez no afectó la composición química de las hojas, excepto que el contenido en calcio disminuyó según aumentó la acidez.

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