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An Attempt to Evaluate the Effect of Varying Time Intervals Between Liming and Cropping on an Oxisol[1, 2]

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ABSTRACT

Field experiments were conducted on an Oxisol with pH 5.0 in northwestern Puerto Rico in an attempt to determine whether the time interval between liming and cropping affected yields, yield components, and other plant characters. Six lime-cropping interval treatments were tested with two cultivars of succeeding crops of fieldbeans and corn in a split plot design. Two cultivars were used as indicator crops in each case. The liming-cropping intervals ranged from planting immediately after liming to planting 10 months after liming (liming on a bimonthly basis). No significant yield differences attributable to treatments could be detected for either crop. In the same fashion, no significant differences were obtained on the various yield components and plant characters studied except for the fact that the 27R fieldbeans from plots limed 10 months prior to planting were smaller than those from plots limed just before planting. The effectiveness of liming Oxisols with pH 5.0 seems not to depend on the time interval that elapses between liming and planting.

INTRODUCTION

Pearson (5) recently reviewed the literature concerning soil acidity and liming in the humid tropics. Although he found differences in response to lime, there is no doubt that liming is a basic input for the most effective use of acid tropical soils. Relatively low rates of application are usually adequate for maximum crop production. His analyses of the data indicate that lime requirements should be based on exchangeable A1 rather than soil pH per se. In many cases, remarkably low rates of lime are adequate for efficient crop production.

Pearson further indicates that the effects of lime are probably dissipated more rapidly in tropical than in temperate region soils. Thus, he

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concludes that it is logical to apply lime lightly and more frequently in tropical soils.

This paper reports on an attempt to evaluate the effects of varying time intervals between lime applications and planting on an Oxisol in northwestern Puerto Rico.

MATERIALS AND METHODS

The experiments were conducted at the Isabela Substation farm on a Coto soil, a Tropeptic Haplorthox, clayey, kaolinitic, isohyperthermic (1) with pH 5.0, CEC 13 meq, and Ca saturation, 25%. It is high in Mn and low in available P. Mean annual rainfall is about 1658 mm. Evaporation from a Class A pan is approximately 6 mm/day during the summer and 4 mm/day during the winter. The mean annual maximum temperature is 29.4° C while the mean minimum temperature is 18.9° C. Solar radiation ranges from an average of 300 langleys/day in the winter to 600 in the summer. The elevation is about 122 m above sea level.

The experiments followed a split-plot design with four replications. The main plots were assigned to time of lime application and the subplots to the cultivars used as indicator crops. The lime was applied on a bimonthly basis starting July 1975 and ending May 1976 for a total of six lime applications. The plot, with an original pH 5.0, received 4.7 kg ground limestone with a 94% $CaCo_3$, content. The plot size was 4.57 m × 4.57 m with 1.52 m alleys. Two sets of experiments were conducted.

First experiment: White field beans cv. Bonita, a selection of a native bean, and 27R, a red kidney type, originally from Turrialba, Costa Rica, introduced to Puerto Rico from seedstock from Trinidad were planted May 19, 1976, after the last liming-planting interval treatment. Each subplot consisted of 4 rows 60 cm apart with plants spaced at 7.62 cm in the row. The whole field received a blanket application of 1121 kg/ha of a 10-10-10 fertilizer prior to planting. A mixture of preemergence herbicides Lasso[4] (4.68 L/ha) and Lorox (1.75 kg/ha) was applied at planting time. Data were taken on plant height and diameter, weight of 100 seeds and yield. Dry beans were harvested August 2, 1976, at 76 days of age. All data reported was obtained only from the two inner rows.

Second experiment: Residual lime treatments from the plots where the previous bean crop was grown were assigned as main plots. The subplots were assigned to the corn cultivars. Pioneer X-306B, a high-yielding hybrid, and Diente de Caballo, an almost neglected native cultivar, were used as indicator crops. They were planted August 13, 1976, soon after

[4] Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

harvesting the fieldbeans. Each subplot consisted of three rows spaced at 75 cm. The plants were spaced 23 cm apart in the row. Prior to planting, the whole field received a blanket application of the following fertilizer mixture, in kg/ha: N, 56 as urea; K_2O, 168 as chloride; P_2O_5, 224 as triple superphosphate; Mg, 56 as sulfate and Zn, 10 as sulfate. The corn crop was sidedressed with N as ammonium sulfate at the rate of 112.1 kg/ha 35 days after planting. Crop protection was provided by alternate spraying

TABLE 1.—*Yield, weight of 100 seeds, plant height and plant spread of fieldbeans from the liming-cropping time interval experiments*

Time of liming	Weight of 100 seed	Plant height	Plant spread	Grain yield[1]
	Gm	*Cm*	*Cm*	*Kg/ha*
		Red Kidney 27R		
July 75	30.68 a[2]	42.02 a	46.50 a	1033.80 a
September 75	33.13 a	39.90 ab	45.32 a	875.39 a
November 75	31.73 a	40.82 ab	48.10 a	1090.57 a
January 76	32.55 a	41.90 ab	50.55 a	1202.61 a
March 76	29.90 a	40.27 ab	45.17 a	1103.97 a
May 76	28.39 a	45.75 b	50.82 a	1071.83 a
		White Bonita		
July 75	15.46 a	59.67 a	60.72 a	1471.28 a
September 75	16.97 a	60.57 a	58.10 a	1934.19 a
November 75	16.91 a	61.57 a	58.07 a	1933.80 a
January 76	17.27 a	59.30 a	58.92 a	1598.07 a
March 76	14.99 a	61.02 a	58.10 a	1433.79 a
May 76	16.66 a	62.65 a	60.20 a	1707.72 a

[1] Adjusted to 11% moisture.

[2] Means followed by one or more letters in common do not differ significantly.

TABLE 2.—*Leaf nutrient uptake of fieldbeans from the liming-cropping time interval experiments*

Time of liming	N		P		K	
	White	Red Kidney	White	Red Kidney	White	Red Kidney
				%		
July 75	4.78	4.43	.50	.39	3.52	3.76
September 75	4.55	4.55	.49	.33	3.53	4.00
November 75	4.50	4.40	.49	.34	3.54	3.91
January 76	4.45	4.38	.44	.39	3.63	3.71
March 76	4.40	4.50	.42	.39	3.88	3.99
May 76	4.17	4.55	.45	.39	3.75	3.96

of Lannate at the rate of 2.47 qt/ha and Sevin at the rate of 2.24 kg/ha. Supplemental irrigation was applied as needed. Data were taken on ear length, weight of 100 grains, cob weight and grain yield. The corn crops were harvested at approximately 120 days of age.

RESULTS AND DISCUSSIONS

Table 1 gives data on grain yields of fieldbeans (cultivars Bonita and 27R), weight of 100 seeds and plant height and diameter. Mean differences are not significant except that height of cultivar 27R in plots that were planted May 19, 1976, immediately after liming, were taller than those from plots limed on July 15, 1975, i.e., some 300 days prior to planting. Table 2 shows that the leaf nutrient uptake of fieldbeans was not affected

TABLE 3.—*Mean yield, ear length, weight of 100 seeds, and grain/cob ratio of corn from the liming-cropping time interval experiment*[1]

Time of liming	Grain yield	Stover yield	Ear length	Weight 100 grains	Grain/cob ratio
	Kg/ha	*Kg/ha*	*Cm*	*Gm*	
		Diente de Caballo			
July 75	7605.40	5386.85	13.85	37.57	0.83
September 76	8590.79	6085.92	14.22	40.85	.81
November 75	7524.97	6044.79	14.35	40.84	.77
January 76	7418.42	5661.57	14.17	40.72	.80
March 76	6860.44	5921.43	14.17	37.29	.81
May 76	8321.99	6250.40	15.00	41.20	.81
		Pioneer X-306B			
July 75	8089.62	6373.73	13.32	38.46	.77
September 75	9056.34	7072.78	13.52	39.00	.79
November 75	8359.17	6702.55	13.24	38.34	.78
January 76	8397.57	6209.10	12.82	40.00	.78
March 76	8949.17	8141.61	13.52	41.19	.81
May 76	8237.04	6908.34	13.72	40.77	.79
		Both cultivars, combined			
July 75	7849.49	5880.29	13.59	38.01	.80
September 75	8823.56	6565.85	13.87	39.92	.80
November 76	7942.05	6378.67	13.80	39.59	.78
January 76	7907.99	5935.34	13.50	40.36	.79
March 76	7904.81	7031.52	13.85	39.24	.81
May 76	8279.52	6579.37	14.36	40.98	.80

[1] Mean differences were not significant at the 5% probability level.

by the treatments. Data on soil analysis, after harvesting the fieldbeans, are not presented here since they are erratic and no definite trends were evident.

Differences between treatments as to mean grain yields of corn (cultivars Pioneer X-306B and Diente de Caballo), ear length, weight of 100 grains and grain/cob ratio are not significant (table 3). Table 4 gives data on the chemical analysis of the corn cobs and the grain. Mean differences attributable to treatments are not significant. Diente de Caballo appears to be as efficient in N uptake as Pioneer X-306B. Data on corn leaf analysis at tasseling failed to reveal any significant differences attributable to intervals between liming and planting (table 5).

Data on analyses of soil samples collected after harvesting the corn crop show slight decreases in pH with time (table 6). The pH of the May 1976 limed plots was around 5.27, while that of the July 1975 limed plots dropped to 4.90. In general, pH values were slightly lower after harvesting the corn (pH 5.0) than after harvesting the fieldbeans (pH 5.3) within a

TABLE 4.—*Chemical analyses of corn cobs and grain from the liming-cropping time interval experiments*

Time of liming		N	P	K	Ca	Mg	Mn
				%			*P/m*
			Cobs				
July 75	A[1]	0.62	0.05	0.64	0.02	0.04	18.5
	B[2]	.75	.06	.92	.02	.04	17.5
September 75	A	.64	.06	.97	.02	.05	5.0
	B	.49	.03	.71	.01	.03	6.5
November 76	A	.59	.05	.84	.02	.04	6.0
	B	.55	.04	.84	.02	.04	7.5
January 76	A	.59	.05	.72	.02	.05	17.5
	B	.64	.04	.98	.02	.06	10.0
March 76	A	.40	.02	.55	.02	.03	9.0
	B	.52	.03	1.11	.02	.04	8.0
May 76	A	.54	.05	.68	.02	.04	16.0
	B	.48	.03	.84	.02	.04	16.0
			Grain				
July 75	A	1.58	.44	.63	.01	.11	8
	B	1.76	.33	.85	.01	.17	15
September 75	A	1.64	.48	.80	.01	.14	12
	B	1.78	.52	.76	.01	.14	13
November 75	A	1.58	.34	.59	.01	.09	8
	B	1.74	.55	.90	.01	.15	17
January 76	A	1.76	.50	.76	.01	.14	11
	B	1.78	.56	.83	.01	.16	18
March 76	A	1.58	.43	.78	.01	.13	10
	B	1.76	.51	.83	.01	.14	16
May 76	A	1.78	.43	.63	.01	.11	12
	B	1.70	.41	.60	.00	.10	9

[1] Diente de Caballo.
[2] Pioneer X-306B.

time interval of some 4 months. It is well known that after lime is applied, soil pH often tends to rise temporarily and then to drop to near the original level within a few months (5).

The commonly expected beneficial effects of liming acid soils on P availability do not appear to be important on an Oxisol, from the data herein reported. This is in agreement with Pearson's report (5). It must be recalled that the original soil pH of the soil where these experiments were conducted was approaching 5.0. This fact might have masked to some extent possible differences. Pearson (5) reports that attempts to maintain pH levels above 5.6 to 6.0 are futile. He indicates that Al rather than pH should be the basis for liming.

Several investigators have shown that the effects of liming are generally dissipated more rapidly in tropical soils than in temperate region soils (2, 5). In Brazil, it has been shown that the effect of liming to pH 5.5 an acid

TABLE 5.—*Corn leaf analyses at taselling time*

Time of liming		N	P	K	Ca	Mg	Fe	Mn
				%			*P/m*	
July 75	A[1]	3.37	0.32	2.64	0.38	0.18	187	117
	B[2]	3.40	.32	2.68	.38	.17	170	132
September 75	A	3.35	.30	2.52	.42	.18	188	121
	B	3.45	.32	2.76	.37	.17	173	113
November 75	A	3.48	.31	2.61	.42	.19	196	132
	B	3.33	.31	2.70	.37	.18	183	105
January 76	A	3.37	.31	2.53	.41	.19	178	101
	B	3.39	.32	2.76	.38	.16	172	122
March 76	A	3.22	.29	2.36	.41	.18	213	108
	B	3.44	.33	2.81	.37	.18	162	128
May 76	A	3.60	.31	2.57	.40	.20	173	115
	B	3.46	.32	2.72	.35	.16	176	118

[1] Diente de Caballo.
[2] Pioneer X-306B.

TABLE 6.—*Soil analyses after harvesting the corn*

Time of liming	K	Mg	Ca	P	Mn	Al	pH
			P/m			*Meq/100 g*	
July 75	66.3	112.0	2037	19.3	2.8	0.18	4.90
September 75	69.0	128.0	2351	24.3	0	0	5.11
November 75	66.5	122.5	2340	47.3	0	0	5.12
January 76	69.8	106.8	2021	26.8	19.5	.58	4.71
March 76	82.5	121.5	2298	21.8	2.2	.12	5.14
May 76	99.5	141.0	2628	23.8	4.0	.12	5.27

Cerrado soil did not diminish during a 6-year period (3). In Colombia, yield increases from the application of lime diminished but little after 12 crops (4). For forages growing on acid soils under conditions in Puerto Rico, one surface application of lime every 2 years was as effective as split annual applications, even with the use of high rates of residually acid N fertilizers (6).

The data herein reported from two successive crops of fieldbeans and corn show that the effectiveness of lime applications on Oxisols with pH values around 5.0 seems to be independent of the time interval (within 2 yr) that elapses between liming and cropping. No yield differences attributable to the liming-planting interval could be measured whether the crop was planted immediately after liming or 10 months afterwards. Under farm conditions in Puerto Rico, lime is applied usually during land preparation (generally after the first harrowing and prior to the second plowing). The evidence obtained from these experiments confirms that this is a sound practice and that lime could also be applied at earlier periods before planting—even 10 months—without handicapping the crops to be grown.

RESUMEN

En este trabajo se informan los resultados de experimentos de campo realizados en el noroeste de Puerto Rico en un Oxisol con un valor pH de 5.0, en un intento por determinar si el intervalo de tiempo que transcurre entre el encalado del suelo y el ciclo de desarrollo de las cosechas afectan el rendimiento, los componentes del rendimiento y otras características indicativas del desarrollo de la planta. Los tratamientos consistieron de seis intervalos de tiempo entre el encalado y la siembra (siembra inmediatamente después del encalado y 2, 4, 6, 8 ó 10 meses después del encalado) de dos cosechas consecutivas de habichuelas y maíz. Se utilizó un diseño de parcelas subdivididas, ya que se probaron dos cultivares en cada caso. No se obtuvieron diferencias significativas en rendimiento que se puedan atribuir a los tratamientos. Tampoco se obtuvieron diferencias significativas en los diversos componentes del rendimiento ni en los caracteres agronómicos de las cosechas, con la excepción del hecho de que las plantas de habichuelas de la cultivar 27R en las parcelas encaladas 10 meses antes de la siembra eran de menor altura que las de las parcelas encaladas justamente antes de la siembra. El efecto de encalado de Oxisols con pH 5.0 parece ser independiente de los intervalos de tiempo utilizados entre el encalado y el ciclo de desarrollo de las cosechas, dentro de un periodo de 2 años.

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