Effect of Five Levels and Three Sources of N on Sweetpotato Yields on an Ultisol[1,2]

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ABSTRACT

The effect of N levels and sources on sweetpotatoes (*Ipomoea batatas*) was investigated on an Ultisol in the central, hilly, interior region of Puerto Rico at about 450 m above mean sea level. Treatment differentials were: Broadcast, preplant applications of 0, 10, 20, 40 and 50 kg/ha of N from urea and 40 kg/ha of N from two sulfur-coated urea compounds (slow-releasing N sources) containing 39.6 and 37% N in each case. The soil had a pH of 4.7 in the top 25 cm of the profile but it apparently supplied enough Ca for a sweetpotato crop. There was no evidence of Al injury to the crop even though exchangeable Al levels were high, i.e., more than 50% of the sum of cations in the 25–50 cm layer. Maximum marketable yields were 14.6 tons/ha (130 cwt/acre). These were obtained with the application of 40 kg/ha (35.6 lb/acre) of N as ordinary urea. Evidently there was no advantage in using slow-releasing N sources. In fact, a slight yield depression was observed. The Capó fertilizer-yield equation was applied to the mean yield data obtained from the urea treatments, and a coefficient of determination of 0.99 was obtained. This equation appeared to be useful in predicting sweetpotato yields in terms of the N fertilizer applied in this experiment.

INTRODUCTION

Sweetpotatoes are a valuable source of human energy, producing 968 kcals/kg in the fresh state with 1.3% protein and 70% water. They produce more energy per pound than Irish potatoes, yams, and taniers. In this respect, among the starch food-crops they are second only to cassava, which produces 1085 kcals/kg (6). The feasibility of an economic sweetpotato production in the Tropics has long been known. It recently

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has been confirmed by Badillo that, despite seasonal fluctuations in yield, good yields can be obtained year round with some cultivars of sweetpotatoes (1). Badillo et al. also have found several white- and yellow-fleshed sweetpotato cultivars capable of producing more than 28 tons/ha (250 cwt/acre) (2). Furthermore, a sweetpotato crop can be obtained in only 5 months. Thus, more than one crop can be produced per year if the climatic conditions are favorable.

In addition, sustained high crop yields in Oxisols and Ultisols of the humid Tropics requires the use of N fertilizer (4, 7). In these soils, large leaching losses of inorganic N are likely to occur. Furthermore, the relatively high price of fertilizer N and its possible shortage, emphasize the need of efficient N management.

The main objective of this work was to determine the effect of various levels of N fertilizer upon sweetpotato yields on an Ultisol. An auxiliary objective was to determine the efficiency of sulfur-coated urea compounds as sources of N.

MATERIALS AND METHODS

The experiment was located on a private farm near Cidra in the central hilly interior region of Puerto Rico at about 450 m above sea level. The average annual temperature of this site is 23° C (73.5° F). Solar radiation ranges from an average of 300 langleys/day in the winter to 500 langleys/day in the summer. The mean annual rainfall is about 2000 mm (78 in) with only 2 months (February and March) receiving an average of less than 100 mm/month. The evaporation from a Class A pan is approximately 5 mm/day during the summer and 3 mm/day during the winter. The soil at the experimental site was classified as Torres, one of the Orthoxic Tropudults, clayey, mixed, isohyperthermic. The site had been used previously for N fertility experiments with corn. Prior to this, it had been in fertilized pangolagrass pastures. Soil samples were taken at 0-25 and 25-50 cm and analyzed for organic matter, N, pH, cation exchange capacity and exchangeable Ca, Mg, K, and Al by well-known standard methods.

The experiment followed a randomized block design with three replications. Plots were 4.9 × 9.8 m (15 × 30 ft). The experiment included seven treatment differentials, as follows: 0, 10, 20, 40, 50 kg/ha of N from urea (46% N) and 40 kg/ha of N from two sulfur-coated urea compounds, one with 39.6% N and a dissolution rate of 31.0% in 7 days; the other, with 37% N and a dissolution rate of 21.5% in 7 days. The N fertilizer was broadcast as a preplant application and then plowed and disced into the soil. All plots also received a blanket preplant fertilizer application, as follows: 100 kg/ha of P from triple superphosphate, 100 kg/ha of K as sulphate, 100 kg/ha of Mg as sulphate, 5 kg/ha of Zn as sulphate and 2 kg/ha of B from borax.

The experimental field was prepared originally for rice. The rice was sown, but germination was very poor and, therefore, the rice trials were discontinued. Then, sweetpotato vines were planted on November 30, 1972. A white-fleshed variety, Blanquita, was planted at 91 × 46 cm (3 × 1½ ft) on the flat beds originally prepared for the rice crop.

For soil insect and nematode control, Dasanit[4] was applied at the rate of 100 kg/ha during land preparation. Rats were controlled with Warfarin baits. Weeding was by hand three times during the crop cycle at considerable expense.[5]

On April 30, 1973, the two center rows of each plot were harvested using hand forks. Data on marketable yields were recorded for each plot and analyzed statistically.

RESULTS AND DISCUSSION

Data on selected chemical properties of Torres clay, an Ultisol, are given in table 1. Although the pH appeared somewhat low for sweetpotatoes, Ca accounted for more than 70% of exchangeable cations. Al was rather high in the lower 25–50 cm layer but apparently did not harm the crop. The soil was well supplied with organic matter in the upper 25 cm layer, which could be attributable, at least in part, to the long time that the land had been used for pastures. The soil apparently had a fairly high N-supplying power (4, 5) but it was somewhat low in exchangeable K.

Data on mean yields per hectare are given in the following tabulation:[6]

N, kg/ha	*Source*	*Marketable yields Tons/ha*
0	Urea	7.9
10	Urea	9.2
20	Urea	11.4
40	Urea	14.5
50	Urea	14.2
40	(Sulfur-coated urea, 39.6% N)	10.1
40	(Sulfur-coated urea, 37% N)	11.7

[4] Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty by the Agricultural Experiment Station of the University of Puerto Rico or an endorsement over other materials not mentioned.

[5] Since this work was conducted, Enide has been duly registered as a suitable herbicide for this crop.

[6] To convert kg/ha and tons/ha to lb/acre and cwt/acre, multiply by .892 and 8.92, respectively.

TABLE 1.—*Organic matter, N, cation exchange capacity and exchangeable Ca, Mg, K, and Al of Torres clay.*

Characteristics	Depth	Value
	Cm	
Organic matter	0–25	3.6%
	25–50	.9%
N	0–25	.23%
pH	0–25	4.7
	25–50	4.5
CEC (NH_4OAc)	0–25	13.0 meq
	25–50	9.8 meq
Sum of cations	0–25	7.4 meq
	25–50	6.8 meq
Exchangeable Ca	0–25	5.6 meq
	25–50	2.0 meq
Exchangeable Mg	0–25	1.2 meq
	25–50	.4 meq
Exchangeable K	0–25	.4 meq
	25–50	.4 meq
Exchangeable Al	0–25	.2 meq
	25–50	4.0 meq

The highest yields were obtained from applications of 40 kg/ha of N as ordinary urea. A recent literature review indicates that, based on world-wide experience, moderate amounts of N (in the order of 40 to 60 kg/ha) produce positive sweetpotato yield responses. Excessive amounts of N, however, increase the top:root ratio and decrease tuber yield (7).

The fertilizer-yield equation developed by Capó (3) was applied to the mean yield data obtained from urea treatments. The equation is as follows:

$$Y = \frac{A}{1 + B\,(C - X)^2}$$

where,

Y = Yield,

A = 14.4896, is the maximum yield obtainable in the given field with the optimum fertilizer application;

B = 0.00045, is another parameter related to this equation;

C = 44.28309, is the optimum fertilizer application with regard to crop yield under prevalent conditions; and

X = amount of N applied.

A coefficient of determination of 0.99 was obtained. Thus the equation would be useful in predicting sweetpotato yields in terms of the N fertilizer applied within the range used in the present experiment.

The mean yield differences between plots receiving N at the level of 40 kg/ha and those not receiving N were statistically significant. The mean yield differences at those two levels of N (0 and 40 kg/ha) amounted to almost 6.7 tons/ha (60 cwt/acre) which, at current farm prices, could bring a substantial additional income to farmers. It is evident that, in spite of the high N content of this soil (table 1) and its apparently high N-supplying power, as reported by Fox et al. (4, 5), sweetpotato yields could be significantly enhanced by additions of 40 kg/ha of N. On the other hand, there appeared to be no advantage in using slow-releasing N sources such as sulfur-coated urea for sweetpotatoes as compared to ordinary urea. This confirms the work of Fox et al. (4) with field corn and sorghum in similar soils. In fact, yields were slightly depressed. The maximum yields of almost 14.6 tons/ha (130 cwt/acre) obtained in this soil are considered to be good, especially since yields were totally rainfall dependent.

In view of consumer preference for white-fleshed sweetpotatoes, their high economic value and particularly their high energy supply per kilogram, vast areas of acid, low fertility soils of the hot, humid tropics offer considerable potential for their production. In only 5 months over 13.6 million kcals/ha can be produced in Ultisols, based on a yield of only 14.6 tons/ha.

RESUMEN

Se realizó un experimento en un suelo Ultisol en Cidra, en la zona montañosa central del interior de Puerto Rico para evaluar el efecto de varios niveles de N (0, 10, 20, 40 y 50 kg./Ha. y tres fuentes de N (urea y dos compuestos de urea recubierta con azufre, uno con 39.6 y otro con 37 por ciento de N) sobre el rendimiento de batatas. Se utilizó un diseño de bloques distribuidos al azar con tres replicaciones. Se sembró un cultivar de tipo blanco, Blanquita, el 30 de noviembre de 1972 y se cosechó el 30 de abril de 1973. Los datos obtenidos de los análisis qufmicos de muestras de suelo tomadas en el predio experimental indican que el suelo, aun a un pH de 4.7 en los primeros 25 cm. del perfil, podrıa quizás suministrar suficiente Ca para una cosecha de batatas. Aunque el suelo tenıa un alto contenido de Al intercambiable entre 25 y 50 cm. de profundidad, no se observaron daños atribufbles a dicho factor. Se obtuvieron rendimientos máximos de casi 14.6 T./Ha. (130qq./acre) de batatas con la aplicación de 40 kg. de N, (35.6 lb/acre) procedente de urea corriente. Las diferencias de casi 6.7 T./Ha. (60qq./acre) entre la producción de las parcelas que no recibieron N y las que lo recibieron a razón de 40 kg./Ha. fueron estadfsticamente significativas. No parece haber ventaja alguna en el uso de fuentes de N que hagan este nutrimento disponible lentamente como lo son los dos compuestos de urea recubierta con azufre que se utilizaron en este experimento. Se aplicó la ecuación abono-rendimiento desarrollada por Capó a los rendimientos medios obtenidos por la aplicación de los tratamientos N de urea, con el cual se obtuvo un coeficiente de determinación de 0.99.

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