Response of Irish Potatoes to Various Levels of N and Time of N Application in an Ultisol[1, 2]

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ABSTRACT

An experiment with Irish potatoes was started at Cidra, Puerto Rico, March 29, 1976, in a Torres clay, an Ultisol (Orthoxic Palehumults, clayey, mixed isohyperthermic), with the purpose of studying the effect of N levels and time of N application on tuber yields.

The pooled tuber yields of two cultivars, i.e., Chieftain and Kennebec, showed that there was a strong response to N when increased from 0 to 56 kg/ha, all at planting. Tuber yield was drastically reduced when N at the highest level was applied all at planting. The highest yield of potatoes was obtained with one application of 56 kg/ha. There appears to be a better utilization of N when split in two applications, but only at high levels. A mean yield increase of 23% over the preplant treatments was obtained when N was split; however, at the 56 kg N/ha level no benefit resulted from splitting applications.

When yield of cultivar Kennebec was considered by itself, again depressed yields were observed with the highest N level applied all at planting. In contrast, no beneficial effect was observed when N was increased from 0 of 56 kg/ha, as was the case when yield of the two cultivars was pooled together. There was no benefit by splitting 56 kg N/ha in two applications, although the highest yield was recorded with this treatment. A mean yield increase of 19% over the preplant treatments was evidenced.

INTRODUCTION

Irish potato is one of the major staple foods in the Puerto Rican diet. Because of their high energy (316 Kcal/lb) and short growing season, Irish potatoes can supplement as an energy source rootcrops such as cassava and yam, which require a longer growing season. The possibilities of producing in the tropics a high yielding crop in 120 days from apparently pest- and disease-resistant cultivars adapted to warmer areas—these possibilities have aroused interest for additional research on an Irish potato crop in Puerto Rico.

Research with Irish potatoes in Puerto Rico dates back to 1928–30, when mean yields of 13.5 tons/ha were obtained (7). Variety trials were conducted by Rodríguez et al. in the 1940's in which Kennebec outyielded all other cultivars included in the tests. It was also observed that, with

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rational fertilization, yields of 16.8 t/ha could be obtained in the northwest in an Oxisol, when close planted during the winter season (9). More recently, Badillo et al. studied the performance of 11 cultivars in northwestern Puerto Rico in a Coto soil (Tropeptic Haplorthox, clayey, kaolinitic, isohyperthermic). Yields between 14.0 and 22.4 metric tons/ha were obtained when planted by mid-December (1). Only a limited study of the fertilization of this crop has been conducted in Puerto Rico. Results available from three NPK and plant spacing experiments during 1953–54 in three different soil types, including an Ultisol (Lares clay) and an Oxisol (Coto clay), revealed a response to N but no response to K (5).

There are extensive areas (about 1.5 billion acres) of Ultisols and Oxisols in the humid tropics which are potentially arable yet mostly under-fertilized or uncultivated (10). They are generally low in available P and N and can be highly productive under intensive fertilization and good management (1, 2, 3, 4, 6, 10, 11, 12). The yields obtained by Badillo et al. (1) revealed the potential for growing Irish potatoes on a deep, well-drained, acidic and relatively infertile Oxisol, and suggested interest in whether similar yields could be obtained in an Ultisol in the hilly central region of Puerto Rico.

The ever present possibilities of large leaching losses of N in Oxisols and Ultisols in the humid tropics, where this nutrient must be applied for high yields, and the high price of fertilizer N make it essential that N fertility be managed as efficiently as possible.

This paper reports the results of an experiment on N levels and time of N application conducted in the central, hilly region of Puerto Rico.

MATERIALS AND METHODS

An experiment was begun at Cidra, Puerto Rico, on March 29, 1976, at 450 m above sea level with the purpose of studying the effects of N levels and time of application on yields. The soil is a Torres clay, an Ultisol, one of the Orthoxic Palehumults, clayey, oxidic, isohyperthermic. Average summer maximum and minimum temperatures are approximately 29 and 21° C, respectively. Average winter maximum and minimum temperatures are approximately 3° C lower than in the summer. Solar radiation ranges from an average of 300 langleys/day in the winter to 500 langleys/day in the summer. Average yearly precipitation is between 1,650 and 2,000 mm, with only two mo (February and March) receiving less than 100 mm/mo. Evaporation from a class A pan in the summer is of approximately 5 mm/day (4). Analysis of soil samples taken to a 15 cm depth revealed a mean pH of 4.98. The mean P content, as determined by the Bray No. 2 method of soil extract, was 9.9 p/m. The experiment followed a 3 x 3 balanced lattice design with nine treatments replicated four times. The treatment differentials are listed in table 1. Ammonium sulphate was used as the source of fertilizer N.

Plots consisted of four ridges 0.91 m apart, 0.46 m high and 3.05 m in length. There were four rows in each plot. Distance between plants in the row was 30.4 cm (10/row and 40/plot) for a density of 35,864 plants/ha. The potatoes were cut into seedpieces which ranged in weight from 50 to 57 g. Because of lack of sufficient seed, the two middle rows were planted with cultivar Kennebec (white skin) while the two outside rows (borders) were planted with cultivar Chieftain (red skin).

Desanit 15g[4] (Terracurr P.) was applied at the rate of 37 kg/ha for soil insect and nematode control and disced into the soil before planting. A blanket application consisting of 112 kg/ha of K_2O as sulfate; 44 kg/ha of P as triple-superphosfate and 56 kg of Mg as sulfate, was applied at planting, mixed thoroughly in the planting hole. All the preplant N applications were mixed with the soil. The postplant N treatments were applied 1 mo afterward in circular bands approximately 20 cm radius around the stems of the young plants.

TABLE 1.—*Effects of N levels and time of application on yield of Irish potatoes in a Torres clay at Cidra, Puerto Rico*

Treatment	Yield (total tubers)	Mean yield
	t/ha	
1. 0 N	3.60	
2. 56 kg N/ha, all pre-plant	6.66	
3. 112 kg N/ha, all pre-plant	4.15	
4. 224 kg N/ha, all pre-plant	5.30	4.68
5. 448 kg N/ha, all pre-plant	2.59	
6. 28 kg N/ha at pre-plant + 28 kg N/ha post-plant	5.56	
7. 56 kg N/ha at pre-plant 56 kg N/ha post-plant	5.71	
8. 112 kg N/ha at pre-plant 112 kg N/ha post-plant	5.95	5.75
9. 224 kg N/ha at pre-plant 224 kg N/ha post-plant	5.78	

Preventive insect and disease control was attempted by weekly applications of a mixture of Endosulfan 50W.P. (Thiodan) + Dithane M-45 or Dithane M-22 (Maneb 80W.P.) throughout the growing season at the rate of 454 gr + 681 g per 379 liters of water, respectively. Dithane M-45 and Dithane M-22 were alternated weekly in order to prevent development of resistance to the chemicals. Disease incidence was observed throughout the growing period and recorded. When the plants became infected with disease (*Rhizoctonia* and *Fusarium spp.*). Daconil W 75W.P. at the rate of 1.7 kg/ha was used every 7 to 10 days. The crop received two rounds of supplemental irrigation 2 and 7 weeks after sowing. The experiment was harvested on July 22, 1976, 115 days after planting.

[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.

RESULTS AND DISCUSSIONS

Plant population among the plots was reduced probably by the lack of sufficient soil moisture and seed quality. There was some variation in the size and number of eyes in the seed, and some had sprouted before planting, while others remained in a less advanced stage. Rainfall at this site during February and March was less than 100 mm/mo (4). Premature leaf abscission, stem and root damage diseases caused by *Rhizoctonia* and *Fusarium* spp. adversely affected the crop 2.8 mo after planting, causing considerable variation in spite of the weekly applications of Daconil. Very little control was obtained. Table 1 shows the yield data of

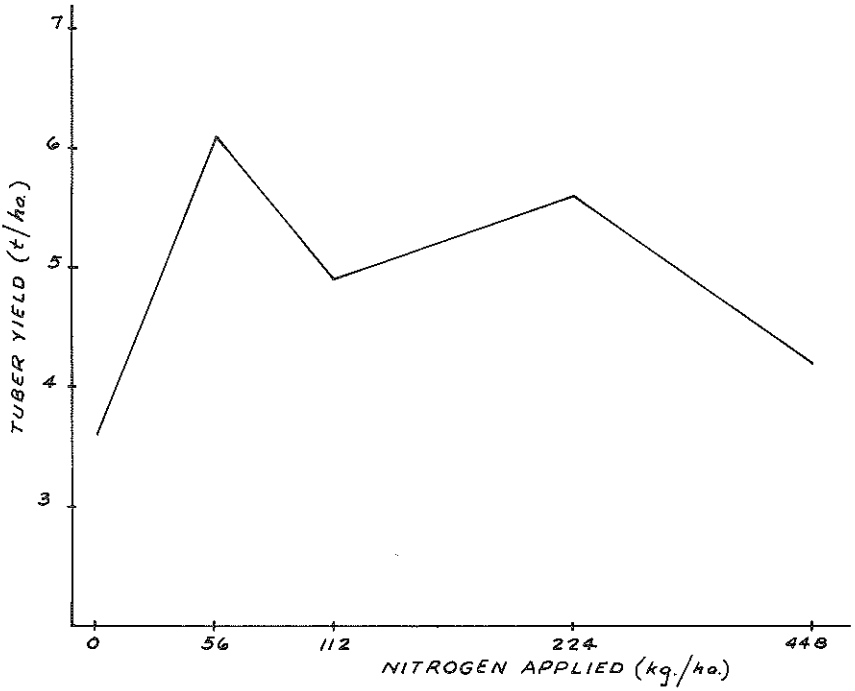

FIG. 1.—Effect of nitrogen applications on potato yields in Puerto Rico.

the two cultivars pooled together. There was a strong response to N when increased from 0 to 56 kg/ha, all at planting. In fact the highest yield of potatoes was obtained with this treatment. Tuber yield was drastically reduced when N at the highest level was applied all at planting. There appears to be a better utilization of N when split into two applications but only at high levels. A mean yield increase of 23% over the preplant treatments was obtained when N was split; however, at the 56 kg/ha level no benefit resulted from splitting applications. When yield data of both preplant and split applications are pooled together and the mean yields plotted (fig. 1), data show a reduction of yields as the N levels are

increased beyond the 56 kg/ha level. Thus it appears that about this amount is the optimum needed to obtain maximum yields at Cidra, Puerto Rico.

Varied results were obtained with the cultivar Kennebec when considered by itself (table 2). Again depressed yields were obtained with the highest level of N when applied all at planting. The highest yield of potatoes was obtained when 56 kg N/ha was split. The difference in yield ascribable to splitting 56 N/ha in two applications was not significant. Again, the curve of the yields of both preplant and split applications pooled together (fig. 2) follows the same pattern of reduced yields beyond the 56 kg N/ha level as observed with the data of the two cultivars together (fig. I).

Even though yields were much lower than those reported by Badillo et al. (1), these are relatively good yields considering that the crop grew through the hot summer months which could have affected tuberization.

TABLE 2.—*Effect of N levels and time of application on yields of Irish potatoes, cv Kennebec, in a Torres clay at Cidra, Puerto Rico*

Treatments	Yield (total tubers)	Mean
	t/ha	
1. 0 N	4.65	
2. 56 kg N/ha, all pre-plant	7.76	
3. 112 kg N/ha, all pre-plant	6.60	
4. 224 kg N/ha, all pre-plant	7.28	6.27
5. 448 kg N/ha, all pre-plant	3.45	
6. 28 kg N/ha pre-plant + 28 kg N/ha post-plant	8.96	
7. 56 kg N/ha pre-plant + 56 kg N/ha post-plant	7.14	
8. 112 kg N/ha pre-plant + 112 kg N/ha post-plant	6.88	7.46
9. 224 kg N/ha pre-plant + 224 kg N/ha post-plant	6.86	

It has been reported that the best planting time for growing Irish potatoes in Puerto Rico is the end of October and November and December (8). The average summer maximum and minimum temperatures at Cidra are approximately 29° and 21° C while those for winter are about 3° C lower (4).

These results not only show that there appears to be a marked response to N but also suggest that potatoes have a good production potential in the highly leached tropical soils of low fertility when a sound program of crop soil management, including fertilization, is followed.

RESUMEN

En un suelo Ultisol (Torres) en Cidra, Puerto Rico, se estudió el efecto de niveles de nitrógeno y época de aplicación en el rendimiento de papas. Se Utilizó un diseño 3 × 3 reticulado compensado con 9 tratamientos y 4 repeticiones. Los tratamientos fueron como sigue: 0, 56,

112, 224 y 448 kg N/ha (como sulfato amónico) al momento de sembrar y las mismas 4 candidades divididas en partes iguales, i.e., al momento de sembrar y un mes más tarde. Los análisis de muestras del suelo tomadas antes de la siembra reverlaron un pH medio de 4.98 y un contenido en P, de 9.9 ppm según el método de Bray Núm. 2.

Los datos de rendimiento de las dos variedades utilizadas (Chieftain y Kennebec) se combinaron para el análisis de varianza. Los resultados revelaron que hubo una señalada respuesta a N cuando el nivel de éste se aumentó de 0 a 56 kg/ha al momento de sembrar; de hecho, se

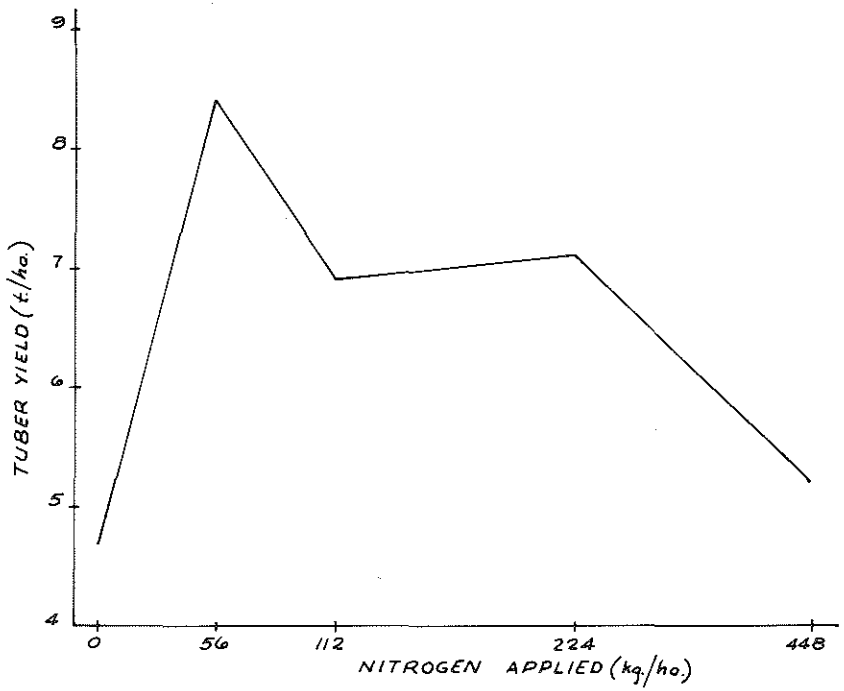

FIG. 2.—Effect of nitrogen applications on potato cv. Kennebec yields in Puerto Rico.

obtuvo el rendimiento más alto con este tratamiento. Por otro lado, el rendimiento bajó drásticamente cuando se aplicó el nivel más alto de N, todo al momento de sembrar. Los resultados parecen indicar que existe una mejor utilización del nitrógeno cuando éste se aplica dividido. Cuando el nitrógeno se dividió en partes iguales se obtuvo un aumento en el rendimiento de 23% sobre los tratamientos aplicados al momento de sembrar; sin embargo, cuando se aplicaron 56 kg N/ha divididos, no fue tan beneficioso.

Cuando se analizó separadamente, el rendimiento de la variedad Kennebec nuevamente se observó una merma en el rendimiento cuando

se aplicó el nivel más alto de N todo al momento de sembrar. En contraste con los resultados obtenidos cuando los datos de rendimiento de ambas variedades se combinaron, no se encontró respuesta algun a N cuando éste se aumentó de 0 a 56 kg/ha. No se observó ningún beneficio cuando se aplicaron 56 kg N/ha divididos en partes iguales a pesar de que el rendimiento más alto fue obtenido con este tratamiento. Cuando el nitrógeno se dividió en partes iguales se obtuvo un aumento de 19% en el rendimiento sobre los tratamientos aplicados al momento de sembrar.

Estos resultados no tan solo muestran una señalada respuesta a N, sino que también sugieren que existe un buen potencial para la producción de papas en estos suelos tropicales, muy meteorizados y de baja fertilidad, si se implantan prácticas mejoradas de cultivo incluyendo el abonamiento racional.

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