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NITROGEN AND PHOSPHORUS FERTILIZATION OF SUGARBEETS[1/]

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Nitrogen and phosphorus fertilization for sugarbeet production has been practiced in the United States for the past 30 to 40 years. During this period numerous studies have been conducted and summarized (5). Since nitrogen plays a dominant role in the production of high quality roots and maximum sucrose yields, its supply must be accurately controlled. Recent methods developed for predicting N fertilizer needs for sugarbeets in Washington and Colorado (4, 7) are based on the amount of NO_3-N in the root zone. However, mineralizable soil N can be a major source of N for plant growth and varies widely in Idaho from one area to another (2, 3). It must be considered if a general procedure for estimating N fertilizer needs is used over a wide area with many soil types and management conditions.

Phosphorus is also important in the nutrition of the sugarbeet. Low P levels depress root yields, whereas high levels generally maintain maximum root yields without lowering root quality. Methods have been developed for estimating P fertilizer needs based on the $NaHCO_3$-extractable soil P level (6). Soil test data from England and many U.S. areas suggest that the available soil P levels in many soils are sufficient for maximum root and sucrose production without additional P fertilization. Soil test correlation data establishing P fertilization guidelines for sugarbeets has been limited in Idaho until recently.

We conducted 30 field experiments in 1971 and 1972 dealing with N, and two field experiments in 1972 and 1973 dealing with the P fertilization needs of sugarbeets. Since much of this information is published elsewhere, this report summarizes only the soil test results as related to root and sucrose yields.

GENERAL EXPERIMENTAL PROCEDURES

The N fertilization experiments were established on growers' fields throughout southern Idaho. The fertilization treatments were applied in the spring and disked into the surface soil before seedbed preparation. The soils were sampled before fertilization in 6 in increments to the restrictive layer, or to 5 ft, and air-dried. The procedures used for determining soil NO_3-N and mineralizable N levels have been described by Carter, et al. (1). Briefly, the potentially available soil N was determined by incubating 50 g of soil for 21 days at 30° C with the soil moisture at approximately 1/3 atm. Soil NO_3-N levels, before and after incubation, were determined by the phenoldisulfonic acid method after extraction with a $CuSO_4 \cdot 5H_2O$ (2.5 g/liter) and Ag_2SO_4 (0.167 g/liter) solution. The difference between the initial NO_3-N level and that after incubation was considered the mineralizable N.

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Small amounts of NH_4-N normally found in these soils is included in the mineralizable N fraction.

The P fertilization experiments were established on locations where different residual P levels had been established. The P treatments were superimposed across all residual P levels. Soil samples were taken from each residual P plot in 9 in increments to 18 in before fertilizer application and air-dried. The soil test P level was measured by the method of Olsen, et al. (6). All other nutrients in both the N and P experiments were adequate for sugarbeet production.

The root yields were estimated by either hand- or machine-harvesting methods. The yields, beet tops, and crowns were measured from each plot and sampled for estimating total N or P uptake. The impurity index and sucrose content were determined by a sugar company on two randomly selected root samples from each plot.

RESULTS AND DISCUSSION

Nitrogen

The N used by the sugarbeet comes from three sources: (a) fertilizer, (b) residual soil NO_3-N, and (c) mineralizable soil N. The total N (N_T) available to the crops can then be expressed as:

$$N_T = E_f N_f + \alpha_n N_n + \alpha_m N_m + N_r \qquad [1]$$

where

E_f = efficiency of applied fertilizer N (N_f)

α_n = $\frac{\text{crop extractable } NO_3\text{-N from soil}}{NO_3\text{-N in soil depth sampled}}$

N_n = NO_3-N in soil depth sampled

α_m = $\frac{\text{crop extractable mineralizable soil N}}{\text{laboratory determined mineralizable N}}$

N_m = laboratory determined mineralizable soil N for depth sampled

N_r = N immobilized or added by residue incorporated.

Detailed studies in south central Idaho on the Portneuf silt loam soil have previously shown that $E_f = 0.65$, $\alpha_n = 1.2$, and $\alpha_m = 0.95$ (1); for straw, $N_r = -10\ R_s$, where R_s = tons straw/acre (8). The relationship between N_T and the total N uptake (N_{up}) by the sugarbeet crop is also linear (1).

The amount of N required per ton of sugarbeet roots varied from 10 to 12 lb. We used 12 lb N/ton to compensate for the N lost through over-irrigation. The potential root yield (Y_p), if limited by N, is defined by

$$Y_p = N_T/12 \qquad [2]$$

The potential root yield is determined by the environmental conditions and the climatic zone. The Y_p can be estimated for a grower by using his