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Comparative Effects of Soluble and Controlled Release (Sulphur-Coated Urea) Nitrogen on Phosphorous, Potassium, Calcium and Magnesium uptake by Corn (Zea mays)

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INTRODUCTION

In a previous investigation on the efficiency of the soluble N sources (ammonium sulphate (AS), area ammonium phosphate (UAP) and urea) and controlled release N sources, sulphur-coated urea (SCU-18, SCU-102 and SCU-183) of differing N release rates applied at 50, 100, and 200 kg/ha of N to an acidic soil, it was shown that N uptake, grain yield and apparent N recovery by corn were increased in the order: SCU-183 = SCU-102 = SCU-18 = Urea = UAP = AS. This order of N efficiency was found to be generally opposite to the nitrification rates, that is, the N fertilizers with slower nitrification rates were more efficient sources of N except that the performance of urea was better than other soluble N sources primarily because it has a smaller effect on soul pH and exchangeable Al (Dalal, 1974).

In this paper, the effects of soluble and controlled release N sources on phosphorous, potassium, calcium and magnesium uptake by corn (Zea mays) are reported.

MATERIALS AND METHODS

Fertilizers: Sulphur -coated urea fertilizers were supplied by Dr. G.L. Terman of T.V.A., Alabama. SCU-18, SCU-102 and SCU-183 contained 25.0, 30.3 and 30.4 per cent N respectively and all three had 30 per cent sulphur-coating with 5, 3 and 3 per cent wax, respectively. SCU-18 and SCU-183 did not contain microbicide; SCU-102 had 0.5% microbicide as coal tar. Conditioner (1.5%) was added to the sulphur coatings of SCU-102 and SCU-183. The dissolution rates of SCU-18, SCU 102 and SCU-183 were 8.9, 1.1 and 0.9 per cent, respectively, in first 24 hours. AS, UAP and urea contained 20.5, 33.8 and 45.5 per cent N and were soluble sources of N. The nitrification rates, evaluated by incubation studies (Dalal, 1974) were in the order: AS = Urea = UAP = SCU-18 = SCU-102 = SCU-183.

Soil: The soil, Fluventic Eutropept, had the following physico-chemical properties: pH, 5.1; clay content, 16%; organic C, 0.90%; total N, 0.13%, CEC, 6.8 meq/100g.

Field experiment: The field experiment was conducted on River Estate loam at the University Field Station, St. Augustine, Trinidad. Corn (cv. X-306) was planted on 11 Sept. 1972 at a plant density of 49,380 plants/ha (45 cm x 45 cm) in six rows, 5.5 m long. N fertilizers at the rate of 0, 50, 100 and 200 kg/ha of N and basal doses of P (50 kg/ha) as triple super-phosphate and K (100 kg/ha) as muriate of potash were placed, in a band furrow, 5 cm deep and 5 cm away from the seed on one side of the rows on 11 Sept. 1972. N treatments were replicated 4 times in a randomized complete block design. The crop was harvested on 14 Dec. 1972. The corn ears of the four inside rows were harvested for the grain yield and then 10 plants per plot were randomly selected, harvested and grouped. The plant and grain samples from each plot were dried at 80°C for 24 hours, weighed and analyzed for P, K, Ca and Mg. Apparent P and K recoveries were calculated by the differences in P and K uptake from the N treated plots as compared to that from the plots where no N was added.

The field was well provided with drains to prevent waterlogging. In addition, each plot was isolated from others by drains 30 cm wide and 10 cm deep. The insect pests and weeds were controlled by insecticide spray and hand weeding.

RESULTS AND DISCUSSION

In general, P, K, Ca and Mg uptake was increased by increasing the N rate; maximum increases in the uptake of nutrients by corn were obtained by SCU-102 and SCU-183 treatments. That is, the slower release rates of N from the N fertilizers (SCU-102 and SCU-183) resulted in not only greater N uptake (Dalal, 1974) but also greater absorption of other nutrients (P, K, Ca and Mg). However, AS and UAP applied at 200 kg/ha of N depressed the uptake of P, K, Ca and Mg, and Ca and Mg respectively. This was probably due partly to higher NH_4^+-N/NO_3^--N ratios in the soil in the early stages if corn growth and hence adversely affecting the uptake of other nutrients (Hansen, 1972; Cox and Reisenauer, 1973) and partly to greater increases in acidity and exchangeable Al as compared to slow release fertilizer (Dalal, 1974). The better performance of urea as compared to AS and UAP was primarily due to its insignificant effect on soild pH and exchangeable Al (Dalal, 1974).

Maximum P and K were recovered in SCU-102 and SCU-183 treatments. The maximum recoveries of P and K were 18.6 and 24.0 per cent, respectively, in SCU-183 treatment when it was applied at 200 kg/ha of N.

The decrease in exchangeable K, Ca and Mg due to cropping were found to be closely associated with K, Ca and Mg uptake respectively. The regression equations were:

$$\text{K uptake (kg/ha)} = 26.9 + 438.6\,\Delta \text{ exch. K (me/100g)}$$
$$r = 0.7566 \quad P < 0.001$$
$$\text{Ca uptake (kg/ha)} = 8.2 + 36.7\,\Delta \text{ exch. Ca(me/100g)}$$
$$r = 0.8387 \quad P \ 0.001$$
$$\text{Mg uptake (kg/ha)} = 8.7 + 66.1\,\Delta \text{exch. Mg(me/100g)}$$
$$r = 0.6626 \quad P < 0.01$$

Thus high NH_4^+-N/NO_3^+-N ratios would affect not only the absorption of K, Ca and Mg but also their release from exchangeable positions on the soil colloids to soil solution.

It appears that the controlled release of N from SCU-102 and SCU-183 considerably increases the uptake of P, K, Ca and Mg by corn as compared to the soluble N sources. The factors responsible for this effect on the acidic soil are small pH changes, less exchangeable Al, low NH_4^+-N/NO_3^--N ratios and slower release of N over longer periods.

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