movement of ammonia nitrogen and phosphorus in an alkaline irrigated soil

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The positional availability of fertilizer elements in the soil depends in part on the extent of their movement resulting from the movement of soil water. In the semi-arid regions of the West, the practice of adding N and P₂O₅ to irrigation water has raised questions concerning the movement of these fertilizer elements into the soil. In the popular mind the application of fertilizers in solution is frequently considered the logical way in which to deliver nutrients to the root zone of plants. However, studies on the mobility of nutrient elements (3, 4, 6, 7, 8, 10) have shown that, although NO₃-N can be expected to move into the soil with the water, NH₄-N and P₂O₅ can be found concentrated in the vicinity of the point of application. The extent of movement depends largely upon the nature of the fertilizer carrier, the pH of the soil, and soil texture (3, 10).

The present study is concerned with the movement into the soil of NH₄-N and P₂O₅ when applied in irrigation water. The soil used, Ritzville very fine sandy loam, is representative of the new lands coming under irrigation in the Yakima Valley and the Columbia Basin of Washington. It is of loessial origin and is noncalcareous in the surface, but calcareous in the subsoil. The surface soil at the experimental site had a pH of 7.8 and an exchange capacity of 11.5 m.e. per 100 grams.

The field studies, reported elsewhere in detail (2), clearly indicate that NH₄-N and P₂O₅ do not move with the irrigation water. The NH₄-N and P₂O₅ were applied at equal rates either as ammonium sulfate and treble superphosphate in a band beneath the furrow or as a mixture of aqueous NH₄OH and H₃PO₄ in the irrigation water itself. No NH₄-N or P₂O₅ could be detected beyond 6 to 8 inches from the furrow although the water moved to a depth of 3 feet. Although there were differences in the depth of penetration of NH₄-N and P₂O₅ associated with the two sources used and with the types of application, differences in effective rates of application made it impossible to determine whether the nature of the carriers of NH₄-N or P₂O₅ had any effect. The mobility of P₂O₅ was greater than that of NH₄-N however.

To obtain information on the comparative movement in soil of different forms of NH₄-N and P₂O₅, laboratory studies were initiated using soil columns made up from soil taken from the experimental site. The study, conducted as two separate experiments, was concerned with the effect of the carrier of NH₄-N upon its movement, the effect of initial moisture content upon movement of NH₄-N and P₂O₅, the relative mobilities of NH₄-N and P₂O₅, and the effect of fertilizers applied in irrigation water upon the distribution of native Ca. This report is concerned mainly with the movement in soil columns of NH₄-N supplied in four forms, and the distribution of native Ca as influenced by the form of NH₄-N supplied. Brief reference is made to the other factors studied.

PROCEDURE

For the first experiment, eight cellulose acetate tubes 1.32 inches in diameter, were filled to the 12-inch level with 360 grams of air-dry surface soil. Four columns were wet to a depth of 6 inches with distilled water and four columns were kept dry.

NH₄-N and P₂O₅ were applied in 4.66 inches (100 ml.) of water, more than enough to saturate the soil column. To each column receiving NH₄-N a total of 10 m.e. of NH₄-N was applied, as (a) NH₄OH, or as mixtures of NH₄OH and H₃PO₄ approximating (b) NH₄HPO₄ (10 m. mles NH₄OH and 11.6 m. mles H₃PO₄) and (c) (NH₄)₂HPO₄ (10 m. mles NH₄OH and 5.8 m. mles H₃PO₄). Two columns, one wet and one dry, received only H₃PO₄ (11.6 m. mles).

After three days the tubes were slit and the columns sampled by cutting the upper 6 inches into 1½-inch segments. The dry NH₄HPO₄ column was sampled for the full 12 inches. NH₄-N and P₂O₅ were extracted from each segment with acidified NaCl solution (9). Each segment stood overnight in 100 ml. of NaCl solution and was leached on a filter paper with small portions of NaCl solution until a volume of 250 ml. of extract was obtained. NH₄-N extracted from the H₃PO₄-treated column was used as a blank. In all essential details, phosphorus was determined by the vanadomolybdate method of Kitson with Mellon (5).

In the second laboratory experiment, tubes were filled to the 24-inch level with 720 grams of air-dry soil. An appropriate amount of each solution was added to a soil column in 214 ml. of distilled water to provide 20 m.e. of NH₄-N in a 10-inch application of water. Two columns received the NH₄-N as NH₄OH and two as (NH₄)₂SO₄. A fifth column served as a check. Two addi-