Release of Nonexchangeable Potassium as Influenced by Weathering, Soil Mineral Type, Soil Reaction, and Potassium Fertilization

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Various soils throughout the United States have been recognized as being deficient in exchangeable potassium (3, 5, 6, 7, 8, 9), but the potassium content of soils of the Southeast is exceptionally low in nonexchangeable, as well as in exchangeable, potassium. For example, Savannah fine sandy loam, a Coastal Plain soil, generally contains approximately 70 pounds of exchangeable and 7,000 pounds of nonexchangeable potassium per acre of 2,000,000 pounds, whereas Miami silt loam, a grey brown podzolic soil may contain 250 pounds of exchangeable and 30,000 pounds of nonexchangeable potassium per acre. As the exchangeable potassium in many Southern soils is too low to grow the crops that are grown on them, it is a reasonable assumption and has recently been demonstrated (6) that the potassium supplying power of these soils, as well as others in the United States, is dependent upon their capacity to supply potassium from the nonexchangeable forms (1, 2, 4, 5).

The purpose, therefore, of this investigation was to determine to what extent the release of potassium from nonexchangeable forms was influenced by weathering, soil mineral type, soil reaction, and potassium fertilization. Soils of the same type which had been fertilized and limed differently in the field, soils which differed markedly in their capacity to supply potassium to cotton, and surface and subsoil samples of the same type were brought into the greenhouse and subjected to eight successive croppings with millet in a manner described by Gholston and Hoover (6). The exchangeable potassium in the soil was determined initially and after the harvest of each millet crop. The potassium taken up by the plants was likewise determined and nonexchangeable potassium was calculated by subtracting the decrease in exchangeable potassium in the soil from that amount which was removed by the crop.

Weathering Affects Nonexchangeable Potassium Release

The influence of weathering on the release of potassium was investigated by comparing the amount of nonexchangeable potassium released from the surface 6 inches of a virgin Ruston sandy loam with that released from the 8 to 18 inch layer, which will hereinafter be referred to as the subsoil. A Ruston soil was used to study the influence of weathering on nonexchangeable potassium release because it is one of the leading soil types of the warm and humid South, and represents some of the intensely weathered soils of the United States.

For 405 days of cropping this surface soil released 30% more nonexchangeable potassium than did the subsoil (Fig. 1). After 405 days of cropping the surface soil became depleted and the subsoil continued to release potassium to the millet so that at the end of 545 days of cropping the subsoil had released a total amount equal to that released by the surface. The subsoil was of a finer texture and contained 94% more exchangeable and 55% more total potassium than did the surface soil.

The influence of weathering was further investigated by comparing the release of nonexchangeable potassium from a cropped Ruston surface soil with that from its subsoil. At the end of 545 days of cropping the nonexchangeable potassium released from the surface soil was 140 pounds per acre, whereas from the subsoil it was 100 pounds per acre. This difference of 40 pounds per acre was found to be due to the greater release of nonexchangeable potassium from the surface soil, since the exchangeable potassium content of the surface soil was only 40 pounds per acre, while that of the subsoil was 300 pounds per acre.

Fig. 1.—The nonexchangeable potassium released from a cropped Ruston surface soil compared to the amount released from its subsoil when both were cropped successively in the greenhouse with millet.