Some Plant Nutrient Losses in Gravitational Water from Monolith Lysimeters at Coshocton, Ohio

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Lysimeter investigations have been in progress for a number of years at the Coshocton, Ohio, Soil Conservation Service project. Although these lysimeters were established primarily for a study of the hydrologic balance of the soil, a study of some of the nutrient losses in the drainage water has also been made. These lysimeters were built around blocks of soil in situ, as nearly as possible undisturbed, to ensure natural conditions of percolation (9). Because a knowledge of plant nutrient losses in gravitational water is so important in soil and water conservation studies and in response to the widespread interest in the results obtained from this elaborate installation of modern design, a brief report of data obtained during the years 1940-45, inclusive, is presented.

REVIEW OF LITERATURE

A summary and review of plant nutrient losses through erosion, leaching, and cropping was made by Lipman and Conybeare (10), stressing the importance of these losses from a national viewpoint. Kohlke, et al. (9) have reviewed two and a half centuries of research in lysimetry, including all available references to analyses of percolates of interest in fertility investigations. In this review, as well as in the papers by Kilmer, et al. (7), by Stauffer (12), and by Hendrick and Welsh (6), attention has been called to the shortcomings of many lysimeter investigations because of the unnatural conditions under which percolation took place. Lysimeters of the filled-in type or those having no provision for runoff have generally caused the most serious objections. However, lack of runoff provision in localities where rainfall intensities are low, should not be considered objectionable.

There have been no lysimeter data reported from areas representing the North Appalachian Region. Reports of nutrient losses from only a small number of lysimeter installations of the monolith type with runoff provision have been made in this country. Noteworthy among the recent ones are the reports of Kilmer, et al. (7) in Wisconsin and Stauffer (12) in Illinois. Using cylindrical soil monoliths of Fayette silt loam, 3 feet in diameter and 44 inches deep, Kilmer, et al. (7), reported the plant nutrients in the percolate in decreasing order were calcium, magnesium, sulfur, potassium, and phosphorus.

Stauffer (12) using the same type of lysimeter reported nutrient losses from eight Illinois prairie soils. The constituents determined were N, Ca, Mg, K, Na, S, Si O₂, and R₃O₃H. The results show a wide variation in the amounts of plant nutrients removed from the different soils by percolation. For example, the Muscatine soil in a period of 44 months lost 311.4 pounds of calcium per acre, while the Cisne soil lost only 11.5 pounds for the same period.

Data from the Coshocton lysimeters previously reported included hydrologic data only (3, 5).

EXPERIMENTAL CONDITIONS AND PROCEDURES

SOIL TYPE DESCRIPTIONS

Muskogum silt loam (shale origin).—This soil belongs to the Gray-Brown Podzolic group, is residual and occurs extensively in the North Appalachian Region. There is no mottling in the profile and the drainage is good. A description of the profile located near Lysimeter 1 follows:

Depth, in. Description
0-7 Brown, to yellowish brown, silt loam, plow layer.
7-14 Yellowish brown silt loam. Slightly heavier than surface soil. Occasional shale fragments.
14-24 Yellowish brown silt loam to fine sandy loam containing frequent sandy shale fragments.
24-39 Partly decomposed shale in various stages of decomposition; fragments increasing in size with depth.
39-60 Layer of shale in various stages of decomposition, containing layers of ferruginous material with some shale undecomposed.
60-96 Bedrock consisting of undecomposed shale." Some shale in first stages of decomposition present.

Keene silt loam.—This soil type occurs extensively in the vicinity of the Coshocton, Ohio, Soil Conservation Service project. It belongs to the same group of upland soils as the Muskingum series but differs distinctly from the latter in hydrologic characteristics. The subsoil of the Keene silt loam is characterized by a heavy, relatively impermeable loam while the Muskingum silt loam subsoil is a rather pervious silt loam or silt loam. A description of the profile near Lysimeter 103 follows:

Depth, in. Description
0-7 Gray brown silt loam. Plow layer.
7-15 Yellowish brown silt loam, unmothered, slightly heavier than surface soil.
15-27 Yellowish brown silt loam to silty clay loam, slightly mottled with gray.
27-41 Mottled gray, yellowish brown and rust brown, heavy silty clay containing frequent sandy shale fragments.
41-76 Gray heavy silty clay containing shale fragments.
76-96 Partly decomposed clay-shale to decomposed clay-shale.

The chemical analysis of typical soil profiles at the lysimeters is given in Table 1. The complete profile to a depth of 8 feet. The mechanical analysis of these soils were presented previously (3).

CLIMATE

The climate is characterized normally by abundant precipitation, well distributed throughout the year. The annual precipitation is about 40 inches (1). Summertime temperatures are rather high but not unduly oppressive, while winter temperatures are not severe and snowfall is moderate. The maximum and minimum temperature for a 23-year period for Coshocton are 106° and 15°F respectively (4). The average period between killing frosts are 39-60 Layer of shale in various stages of decomposition containing layers of ferruginous materials and some shale undecomposed.
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