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RESEARCH NOTES

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THE ROLE OF ORGANIC MATTER AS A SOURCE OF NITROGEN IN DOUGLAS-FIR FOREST SOILS

By

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Functions of Soil Organic Matter

The organic material supplied the forest soil by deposits of needles, deadwood and roots, and soil insect remains, decomposes to form humus, defined as the plant and animal residues of the soil, fresh surface litter excluded, which are undergoing evident decomposition (2). This decomposition is necessary before the nutrient elements contained in the organic litter can become available for use by plants.

Organic matter in the form of humus has vitally important physical, chemical, and biological effects on the forest soil. It influences such physical soil properties as color, structure, consistency, moisture-holding capacity, and permeability to water and air. Forest soil humus increases the availability of nutrients to the plant, affects soil acidity or alkalinity, and provides certain growth-promoting hormones and vitamin-like substances. The humus layers of a forest soil also contain far greater numbers of microflora and microfauna than any of the underlying mineral soil horizons. In short, organic matter as humus is a key constituent of the forest soil (1, 2, 3, 4, 5).

Functions of Soil Nitrogen

In combination with carbon, hydrogen, oxygen, and to a lesser extent with other elements, nitrogen forms an essential constituent of all plant tissues and plays a major role in the development and functions of protoplasm (2, 5). Nitrogen affects plants both by encouraging

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1/ Full credit is given to Mrs. Edgel Skinner, Statistical Clerk, for the analysis of data.

above-ground vegetative growth and by aiding in the formation of strong root systems. Plants denied sufficient nitrogen have fibrous and underdeveloped roots--a real obstacle to the establishment of tree seedlings (2, 5). High contents of nitrogen are found especially in tissues concerned in growth and reproduction, and the element is regarded as a regulator in that it governs to a certain extent the utilization of potash, phosphoric acid, and other soil constituents through its profound influence on the development of the plant. Wilde (5) refers to nitrogen as "the balance wheel in plant nutrition."

Sources and Losses of Soil Nitrogen

Soil nitrogen, especially in humid regions, is carried almost wholly by the organic matter (2), and becomes available to plants only after the organic matter has decomposed to humus. In addition to this main source of supply, smaller amounts of the element are added to the soil in the snow and rainfall and through the action of nitrogen-fixing microorganisms.

Soil nitrogen is lost through removal of plant growth, through burning or other removal of organic matter, through the activity of denitrifying bacteria, and in solution in the run-off or seepage water of the soil.

The Study

The close relation between organic matter and the nitrogen supply of Douglas-fir region soils is shown quantitatively by a recent series of chemical analyses of Douglas-fir soils of varying site quality. Five different areas were sampled: The north, central, and south portions of the west slope of the Cascade Mountains in Oregon and Washington, coastal Oregon, and coastal Washington. Soil samples were taken in duplicate in the A_1, A_2, and B horizons[2/] where present, resulting in a total of 102 analyses of organic matter and total nitrogen.

Of these soils, those having high organic matter content always had high total nitrogen content (fig. 1); the correlation coefficient of this direct relation was .96, and the standard error .04.

2/ A_1 horizon: The layer of mixed humus and mineral soil. Generally found in the first 2 inches of Douglas-fir region soils but sometimes absent.

A_2 horizon: The leached mineral horizon developed immediately below the A_1 horizon or sometimes immediately below the humus layer of the soil. Generally found between 2 inches and 6 inches in Douglas-fir region soils.

B horizon: Commonly called "subsoil." Usually found between 8 inches and 18 inches in Douglas-fir region soils.

The analyses also emphasize the fact that most of the nitrogen-organic matter content is in the upper portion of a forest soil:

Soil horizon	Av. nitrogen content %	Av. organic matter content %	Ratio: % nitrogen / % organic matter
A_1	.40	14.80	.027
A_2	.18	6.75	.026
B	.10	3.50	.028
		Average	.027

The ratio, $\frac{\text{nitrogen}}{\text{organic matter}}$, shown in the table above can be used as a conversion factor to obtain a fairly accurate figure for total nitrogen when the value for organic matter is known. Wilde (5) states that when soil organic matter expressed as percent is multiplied by .025, an approximate measure of the percentage of soil nitrogen is obtained. This conversion factor is usually established on the basis of local experience due to variations in the carbon-nitrogen ratio in different soils. Results of this study show that when the organic matter percentage of mineral horizons of Douglas-fir region soils is multiplied by the conversion factor .027, a close estimate of the soil nitrogen is given. Since the laboratory determination of organic matter is much simpler than that for total nitrogen, this method of determining total soil nitrogen will facilitate nutrient determination when a close approximation will suffice.

Discussion

The importance of soil organic matter as a supplier of nitrogen in the soils of the Douglas-fir region has been shown. Since organic matter is concentrated near the soil surface and its chief source is the forest floor, any destruction of the litter and humus layers of a forest soil also destroys the greater portion of the organic matter and nitrogen supply. Once destroyed, soil organic matter cannot be restored until a succession of yearly plant growth has deposited a litter and dead root material and the slow process of breaking down coarse, raw organic matter into fine humus particles is accomplished.

Application of this knowledge in obtaining the best silvicultural practices is a difficult matter. The situation might be summed up this way: We know that humus in the soil is highly desirable but we don't know the minimum quantity required for satisfactory regeneration in a given locality. How far need we go in trying to maintain conditions which promote good soil organic matter relationships? Here are some of the questions we need to answer next.

Just what is the function of nitrogen in the life cycle of the tree species of this region? What is the effect of burning on the soil organic matter and available nitrogen? Is the effect the same on all soils and sites? How much of the area of a slash burn is burned severely enough to destroy organic matter incorporated in the mineral

soil? What are the quantitative nitrogen requirements of coniferous seedlings during the establishment period? What additions of nitrogen to the soil can be expected in this region from precipitation and the action of nitrogen-fixing cover plants? These and many other related questions must be answered before the full story of the effects of various silvicultural practices on the soil organic matter can be known. Studies are now under way and more are being planned to find the answers.

Summary

(1) A study has been made of the relation between organic matter and soil nitrogen in five areas of the Douglas-fir region in Oregon and Washington. The direct correlation between organic matter and soil nitrogen is shown for this region.

(2) Results of the study emphasize the fact that most of the nitrogen-organic matter content is in the uppermost portion of the forest soil.

(3) A rapid means of determining total soil nitrogen in Douglas-fir region soils is shown. When the percentage of organic matter of mineral horizons of Douglas-fir region soils is multiplied by the conversion factor .027, an approximate measure of the total soil nitrogen is obtained.

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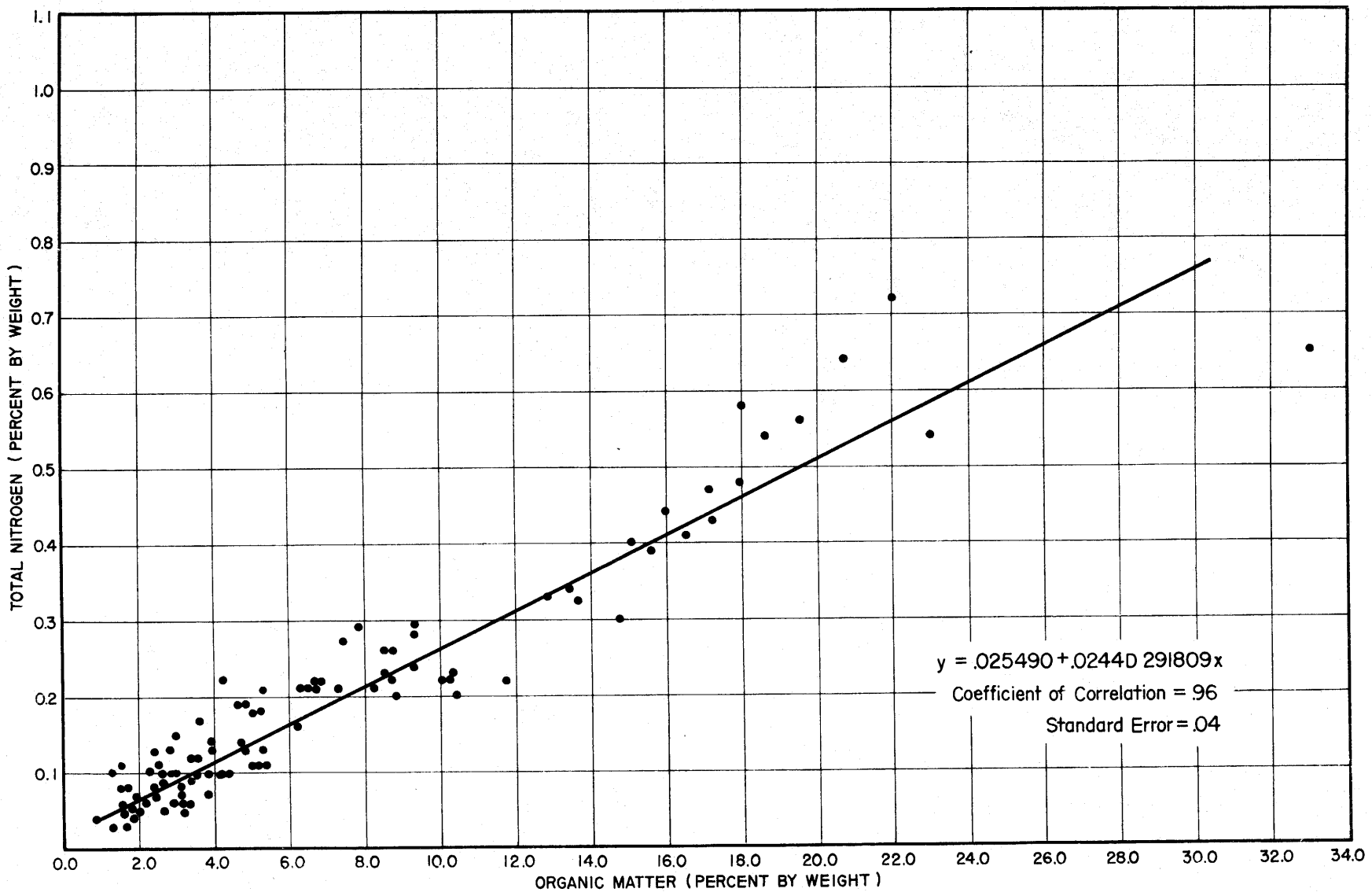

Figure 1. -- The relation between total nitrogen and the organic matter content of 102 Douglas-fir region soil samples