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Physical and chemical properties of surface soil beneath eastern redcedar trees in pine plantations in Connecticut were found to be different from those beneath adjacent pines. Properties of the surface soil beneath redcedars were apparently influenced by the specific chemical nature of the cedar leaflitter, its decomposition products, and subsequent incorporation in the soil by earthworms.

IT IS A COMMON observation that certain plants grow only in soils of specific chemical and physical nature. Many plants, however, adapt themselves to a wide range of soil conditions, and once established, some of these through their own influence, alter the chemical as well as physical properties of the soil in which they grow. Thus, some plants increase soil acidity while others decrease it. Spurr (*8*) states that both eastern redcedar (*Juniperus virginiana* L.) and common juniper (*J. communis* L.) alter the pH of old field soils. The first species raises the pH of the upper part of the mineral soil and lowers it at a depth of 6 inches, while the latter lowers the pH at both depths. Coile (*2*) also, found that soils under redcedar were less acid than soils of certain hardwood types.

It is a common belief throughout the central and southeastern states that the occurrence of eastern redcedar is indicative of soils high in lime. Arend (*1*), however, presents evidence that eastern redcedar in the Ozarks may become established in acid soils of low calcium content, and actually bring about a decrease in acidity and an increase in calcium content of the upper soil layer concomitant with subsequent tree growth and development. Although soils of the Ozark highlands are derived mainly from limestone of various degrees of purity, the surface layers at least are generally low in calcium and distinctly acid.

Porosity tests on the Calhoun Experimental Forest near Union, S. C., indicate that soil under young redcedar trees has three times the volume of open pores and twenty times the permeability of adjacent soil in the open (*7*).

Demont (*3*) compared certain physical and chemical properties of soils under 25 year-old red pine plantations with those of old fields of comparable soil type in the vicinity of New Haven, Conn., but no consistent significant differences in any properties could be established.

Eastern redcedar trees occur within the red and white pine (*Pinus resinosa* Ait., and *P. strobus* L.) plantations of the Eli Whitney Forest near New Haven. These individuals were present in the old fields at time of planting, and have grown up with the pines. In the older plantations, redcedars have nearly disappeared from the stand because of their slow growth rate and consequent overtopping by the pines. Soil conditions within the pine plantations are fairly uniform, particularly with respect to surface litter and humus layer.

The plantations, especially those over 35 years old, have a thick mat of pine-needle litter and a thin F layer distinctly delimited from the mineral soil. It was observed, however, that the litter and humus layers directly beneath the redcedar trees differed considerably from the prevailing condition. This difference was accentuated by the fact that earthworm work was more extensive under the redcedars than under the pines. The litter and humus layers beneath the redcedars appeared to be thinner than beneath the pines, and incorporation of organic material with the mineral soil was evident. Accordingly, it was decided to investigate the apparent differences by sampling and analyzing the surface soil beneath each species in two different plantations.

The Investigation

Description of plantations.—Two plantations in the Eli Whitney Forest were studied: (A) a level site adjacent to Lake Saltonstall, and (B) a level site on a ridgetop about 400 feet above the same lake. Plantation A was on Branford sandy loam, a moderately deep, well-drained, brown podzolic soil of glaciofluvial origin. Parent materials are diabase mixed with Triassic sandstone and shale with some granite and gneiss. The forest cover was 35-year-old red pine of approximately 630 trees per acre, averaging 6 inches d.b.h. and 50 feet tall. Redcedar trees, 3 to 5 inches d.b.h., were sparsely scattered within the stand. Herbaceous vegetation was absent. The unincorporated organic layer throughout the plantation was approximately 2.5 to 3 inches thick, except under the redcedars where it was 0.5 to 1 inch thick. This location was used as a public recreation area 40 to 50 years ago, hence compaction of the surface soil may have occurred.

Plantation B was on Holyoke sandy loam, a moderately shallow, stony, well-drained, brown podzolic soil developed from glacial till. Parent material is predominantly diabase (traprock). The forest cover was 25-year-old mixed red and white pine of approximately 800 trees per acre, averaging 5 inches d.b.h. and 30 feet tall. Redcedars, 3 to 5 inches d.b.h., were scattered throughout this stand, but in greater abundance than in plantation A. Herbaceous vegetation was absent. The unincorporated organic layer throughout was somewhat thinner than in planta-

[1] The study was made while both authors were doing graduate work at the School of Forestry, Yale University. Acknowledgement is given to H. J. Lutz, professor of forestry, for suggesting the study and to D. R. M. Scott for valuable aid in the laboratory analyses.

tion A, and the contrast under the two tree species was less pronounced.

Field methods.—The method of paired sampling was employed, one redcedar tree and one pine tree constituting a pair. Trees with large crowns were intentionally selected in order to emphasize the influence of leaf litter on soil conditions.

Five of the largest-crowned redcedars in each plantation were selected. These were reasonably well distributed on each area. Each redcedar was paired with a pine selected from among those trees 15 to 20 feet distant with large crowns and without redcedar litter near the base of the tree. Beneath each tree and not over three feet from its base, five soil samples were obtained *in situ,* in 1,000-cc. metal cylinders for volume weight and pore volume determinations. Five loose samples were also obtained for measurements of moisture equivalent, pH, calcium, and organic matter. In addition, five tests of infiltration rate by the cylinder method gave data on the time required for a litter of water poured into the cylinder to percolate into the soil. All samples in Plantation A and samples for three pairs in Plantation B were obtained in November 1948. Samples for the two remaining pairs in Plantation B were obtained in March 1949.

Laboratory methods. — Loose samples were stored in paper bags and allowed to dry thoroughly. Without being ground the aggregates were crushed in a mortar with a rubber-tipped pestle and passed through a 2 mm. mesh sieve. All samples were analyzed individually.

Volume weight and pore volume were determined using pycnometer methods described by Lutz (*4*); moisture equivalent by the method outlined by Veihmeyer, Israelsen, and Conrad (*9*); and air capacity by substracting the moisture equivalent, as an estimate of field capacity, from pore volume.

Calcium, organic matter content, and pH values were determined using methods described by Peech *et al.* (*6*). Exchangeable calcium was measured by analyzing an ammonium acetate extract of soil. Using a 1:1 soil-water mixture, soil pH values were determined with a Beckman meter equipped with glass electrode. Organic matter in samples ground to pass a 0.5 mm. sieve was determined by wet combustion with potassium dichromate and sulphuric acid.

In analysis, individual samples were averaged to give a separate estimate of soil conditions beneath each tree. The average difference between species for the five pairs in each plantation was subjected to a "t" test which indicated whether or not such a difference might have occurred by chance. The data were also subjected to split pair analysis of variance to show differences between plantations and interaction of species and plantation. In the following discussion, any reference to differences or effects implies statistical significance.

Results and Discussion

There were striking differences in physical and chemical properties of the surface soil beneath redcedar and pine in both plantations, as indicated by the data in Table 1. Differences in soils between plantations were expected, owing to unlike inherent physical and chemical properties of the two soil types on which the study was conducted. This apparently resulted in somewhat different effects of the two tree species. Volume weights of soil under pine averaged higher in Plantation A than in Plantation B, for example, but under redcedar there was no difference. The soil under both species in Plantation A had lower moisture equivalents, less organic matter, and less calcium than in Plantation B. The pH values under pine were lower in Plantation A than in Plantation B, but under redcedar there was no difference.

In Plantation A, all physical and chemical soil properties studied were different under the redcedar and pine. In Plantation B, although differences were demonstrated with respect to all chemical properties, only one physical property, moisture equivalent, proved to differ under the two species. Considering both plantations together the split-pair analysis showed that soil under redcedar compared to that under pine was consistently different in all properties studied. Differences in air capacity and infiltration were just significant, but all other properties were highly significant.

This study has shown real differences in both physical and chemical properties of the soil beneath the two species. These dif-

TABLE 1.—COMPARISON OF PHYSICAL AND CHEMICAL SOIL PROPERTIES UNDER EASTERN REDCEDAR AND RED PINE IN TWO PINE PLANTATIONS ON THE ELI WHITNEY FOREST

Property	Dimension	"t" tests of differences between individual means: Plantation A Redcedar	Plantation A Pine	Plantation B Redcedar	Plantation B Pine	Split pair analysis significant factors: Plantation	Species	Interaction	Split pair pooled standard error of stratified means (within plantation and species)
		4 dfs				8 dfs			
Volume weight	—	0.920	1.092**	0.890	0.947	*	**	n.s.	± .026
Pore volume	*Percent*	64.6	58.0**	65.8	63.6	**	**	*	± .888
Moisture equivalent	*Percent*	15.9	14.0**	27.6	22.8**	**	**	**	± .393
Air capacity	*Percent*	49.9	42.8**	41.3	42.0	**	*	*	± 1.349
Infiltration	*Seconds*	123.	806.*	170.	220.	*	*	*	±112.8
Organic matter	*Percent*	4.72	3.06**	8.21	5.59**	**	**	*	± .193
Calcium	*Percent*	0.108	0.014**	0.187	0.045**	**	**	n.s.	± .011
pH	—	4.76	4.08**	4.92	4.38**	*	**	n.s.	± 0.78

* Significant (p. 0.05). ** Highly significant (p. 0.01).

ferences are doubtless associated with the chemical composition of the tree foliage. Lutz and Chandler (*5*) recognizes three groups of tree species based on calcium content of the foliage. Eastern redcedar falls in the highest group whose mature leaves contain more than 2 percent calcium, whereas the red and white pines fall into the lowest group whose leaves contain less than 1 percent calcium. Redcedar leaf litter, through its influence on calcium content and pH of the surface soil, has either brought about or maintained favorable conditions for earthworm activity. As a secondary influence, earthworms have incorporated the leaf litter in the upper 2 to 3 inches of surface soil, greatly increasing its organic matter content; this has resulted in lower volume weight, and an increase in pore volume, moisture equivalent, air capacity, and infiltration rate.

In the older pine Pantation A, earthworm activity was confined to the area directly beneath the few redcedars in the stand. No evidence of earthworms could be found beneath pines. On the other hand, in the younger Plantation B, where redcedars were more abundant, earthworm work was noted beneath pines as well as redcedars. Perhaps this is why no real differences in volume weight, pore volume, and air capacity could be found. Moreover, differences in chemical properties even though significant, may not yet be pronounced enough, owing to the age of plantation, to restrict the worms to the soil area beneath redcedars.

It was apparent that physical and chemical properties of the surface soil were more favorable for earthworms in the younger plantation than in the older one. The number of redcedars in the younger plantation can be expected to decrease with age, and as a result the influence of their leaf litter on chemical properties of the surface soil will be diminished. Conversely, the influence of pine leaf litter will become stronger, and doubtless bring about chemical changes in the surface soil which may be unfavorable for earthworms. This has apparently occurred in the older pine plantation.

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Some Factors Affecting Lumber Requirements on Western Oregon Farms[1]

Improved conservation practices in the woods have resulted in an increase in the production of the lower grades of lumber in the Douglas-fir region of western Oregon. Prevalent high freight rates to the mid-west and eastern markets make it desirable to market these lower grades in the producing regions. A strong farm market would materially aid in solving the problem of economically marketing these lower grades.

A survey was made of farmers in the area to devise a plan for evaluation of the farm market and to classify some of the factors which should be considered in marketing lumber for farm use. The major lumber producing areas of the state closely coincide with the principal farming areas. Of the total number of farms in the state, 76 percent are located in the nineteen western counties which comprise the Douglas-fir region.

It was found that 50 percent of the major farm buildings are over 20 years old; barns were older as a group than other buildings. Less than half of the buildings surveyed were considered satisfactory; 17 percent needed replacement for efficient use. Most farmers preferred to do their own construction work and serve as their own contractors. They are generally quite familiar with lumber grades and half of those surveyed stated they usually purchased direct from the mill. There was no general feeling of prejudice toward the lower grades, although many farmers believed that most grades were not as good as prior to the war.

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[1] Abstract of Master's Thesis.