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Soil Rehabilitation Under Eastern Redcedar and Loblolly Pine[1]

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IN A STUDY in north central Mississippi, the litter and surface soil under even-aged eastern redcedar, loblolly pine, and adjacent herbaceous cover varied chemically, physically, and biologically. There are good grounds for belief that soil rehabilitation proceeds faster under redcedar than under herbaceous or loblolly pine cover.

Experimental Procedure

Two old fields, abandoned for 15 to 20 years, were selected. Loblolly pine (*Pinus taeda*) had been planted in one and eastern redcedar (*Juniperus virginiana*) had reseeded naturally in the other. The soils of both were loessial Loring silt loam which had apparently been protected from fire and grazing. A 15-year-old stand of trees was interspersed with herbaceous cover in each case.

The loblolly pine was approximately 30 feet tall and averaged 6 inches d.b.h. The redcedar was 15 to 20 feet tall and averaged 4 inches d.b.h. The herbaceous cover adjacent to the pines consisted of about 80 percent bluestem grasses (*Andropogon* spp.), whereas that adjacent to the redcedar trees was about 80 percent native legumes, common lespedeza, and white clover. The remaining composition of each was approximately the same.

Three randomly selected paired sets of samples were taken under loblolly pine and adjacent herbaceous cover, while seven were taken under redcedar and its adjacent herbaceous cover.

For each sample, one square foot of litter (organic debris down to mineral soil) was taken for the determination of the oven-dry weight and the nitrogen, calcium, and excess base content of the litter. An undisturbed core was cut from the surface 2 inches of mineral soil (*5*) for the determination of volume weight, water transmission rate, porosity, and moisture. Organic matter, pH, and exchangeable calcium were determined from a separate bulk sample from the surface 2-inch layer of soil. Organic matter coloration or development of a new A_1 horizon was measured separately at each sampling point. The litter and soil samples used for chemical analysis under loblolly and adjacent herbaceous cover were collected in December 1948; the soil samples used for physical determinations were collected during July and August, 1949. All the redcedar and herbaceous cover samples were collected during January 1950.

Immediately after collection, the samples were taken to the Mississippi Agricultural Experiment Station for laboratory analysis. Standard methods currently in use by the Association of Official Agricultural Chemists (*1*) were followed for all determinations except those of excess base and of physical properties.

Excess base content of the litter was determined by the method introduced by Frear (*3*). Expressed in milligram equivalent (m. e.) per 100 grams of material, it is defined as the excess of basic over acidic elements (*2*).

The soil cores were saturated and placed on a tension plate similar to the one described by Leamer and Shaw (*4*). The water column was adjusted to 60 centimeters and the amount of water passing through the core at this tension during measured periods of time was recorded. This amount, expressed in inches per hour, was called water transmission rate of the upper 2-inch layer of soil when subjected to 60 centimeters of negative pressure. After draining for 2 hours at this tension, the samples were removed from the table, weighed, oven-dried at 105 degrees C. for 24 hours, and reweighed. The percent moisture by volume, volume weight, total porosity, the volume of pores drained at a tension of 60 centimeters of water (called large pores), and the volume undrained at this tension (called small pores) were calculated from these data plus the known weight of the cylinders, the volume of the sample, and the density of the solid soil constituents.

The mean difference between paired samples (tree cover and adjacent herbaceous cover) were subjected to "t" tests, both in the case of litter and of surface soils. Because of the difference in number of samples, the number and level of significant differences detected should be somewhat greater for redcedar than for loblolly pine. Hence level or frequency of significance does not afford a fair comparison between redcedar and loblolly pine, but should be considered in conjunction with the magnitude of the differences.

Litter Properties

Obviously, there will always be more litter under loblolly than under comparable redcedar, but there are indications that loblolly litter is not quite so rich in nitrogen or calcium (Table 1). The difference in excess base between redcedar litter and adjacent herbaceous cover was 14 times that between the loblolly and herbaceous cover. Assuming complete decomposition of the litter, the relative acid neutralizing power per unit of redcedar litter would be slightly more than twice as much as that of the herbaceous cover composed principally of legumes; and 5 and 6 times respectively as much as loblolly pine litter and the herbaceous cover composed mostly of bluestem grasses. The high calcium content of the redcedar litter agrees with results reported for this species elsewhere. Although loblolly litter was low in calcium content, it was significantly higher than adjacent native herbaceous litter.

Soil Properties

The quality of the litter from the various types of cover is reflected in the chemical properties of the

[1]Special appreciation is extended to Russell Woodburn, soil conservation research project manager, State College, Miss., for his kind cooperation in the use of laboratory equipment.

TABLE 1.—DIFFERENCES IN PROPERTIES OF THE LITTER AND SURFACE TWO INCHES OF SOIL UNDER LOBLOLLY PINE, EASTERN REDCEDAR, AND ADJACENT HERBACEOUS COVER

Soil and litter property	Unit of measurement	Loblolly pine cover	Native herbaceous cover	Mean difference	Red-cedar cover	Native herbaceous cover	Mean difference
		2 degrees of freedom			6 degrees of freedom		
LITTER							
Dry weight	Tons per acre	10.04	4.44	5.60[1]	3.65	0.55	3.10[2]
Nitrogen	Pct. by wt.	.83	.71	.12	1.24	1.12	.12
Calcium	Pct. by wt.	.53	.37	.16[1]	4.02	.77	3.25[2]
Excess base	M.e. per 100 gm.	65.31	52.38	12.93	327.6	141.9	185.7[2]
SOIL							
Organic matter	Pct. by wt.	1.77	1.84	.07	5.34	3.17	2.17[2]
pH	——	5.40	5.30	.10	6.75	5.71	1.04[2]
Exchangeable calcium	M.e. per 100 gm.	3.14	3.04	.10	14.10	6.54	7.56[1]
Depth of new A_1	Inches	.55	.40	.15	1.71	1.32	.39[1]
Water transmission rate	Inches per hr.	.97	.51	.46[1]	3.32	.59	2.73[1]
Volume weight	——	1.31	1.36	.05	1.16	1.32	.16[2]
Total pore space	Pct. by vol.	50.7	48.7	2.0	56.4	50.2	6.2[2]
Small pores	Pct. by vol.	37.1	38.9	1.8	39.9	40.6	.7
Large pores	Pct. by vol.	13.6	9.7	3.9	16.5	9.6	6.9[2]
Moisture at sampling time	Pct. by vol.	23.0	25.0	2.0	34.9	39.4	4.5[1]

[1]Significant ($p. < 0.05$)
[2]Highly significant ($p. < 0.01$)

surface layer of soil underneath the covers. Organic content of the surface 2 inches beneath loblolly pine was almost 4 percent less than the organic content under adjacent herbaceous cover, while under redcedar it was 68 percent more than the organic content under adjacent herbaceous cover.

If the surface 6 inches of soil was homogeneous and well mixed by plowing at the time of abandonment (as is assumed), the ratio of percentage of organic matter in the 0-2 inch layer to percentage of organic matter in the 3-6 inch layer should have been about 1. Since it averaged about 1.8 under loblolly and adjacent herbaceous cover, there are grounds for inferring a build-up in organic matter since abandonment. Similarly, it seems likely that a large part of the organic material in the surface two inches under redcedar has accumulated recently.

A new A_1 horizon had developed under all types of cover. The depth was 0.15 inch greater under loblolly than under adjacent herbs, and 0.39 inch greater under redcedar than under adjacent herbs. This probably explains why the redcedar-herb contrasts were so much stronger than the loblolly-herb contrasts for other properties of the surface 2 inches of soil.

One of the more important advantages possibly attributable to redcedar cover was the greater alkalinity of soil under it. The pH of soil under loblolly was only 0.10 higher than under adjacent herbaceous cover, but it was 1.04 higher under redcedar than under adjajacent herbaceous cover. Although this does not establish the fact that cedar litter promotes soil alkalinity better than loblolly litter, it is consistent with such a proposition.

Other soil characteristics, such as amount of exchangeable calcium, water transmission rate, volume-weight, and certain pore relationships, tend to be consistent with the hypothesis that a redcedar cover creates a more desirable soil than a loblolly or a herbaceous cover.

The most obvious explanation of why soil under redcedar is superior to that under adjacent herbaceous cover is that redcedar litter far exceeds herbaceous litter in dry weight, percent calcium, and milligram equivalent of excess base per 100 grams.

Loblolly litter does not have redcedar's tremendous advantage over herbaceous litter. Soil under loblolly pine, however, is still much superior to that under adjacent herbaceous vegetation, probably because summer and winter surface soil temperatures are known to be less extreme under trees than under grass. This in turn should encourage a larger population of soil macrofauna (arthropods, molluscs, and annelids)—a surmise confirmed by sampling representative soil and litter units under each cover type.

There were over twice as many macrofauna under loblolly pine as under adjacent herbaceous cover. The advantage was over 3 to 1 when only saprophagous nonpredator arthropods and molluscs were considered, and over 4 to 1 when only predatory arthropods were considered.

Conclusion

Loblolly produces considerable litter in short periods of time, and the surface 2-inch layer of soil under loblolly stands absorbs water faster than the soil under adjacent herbaceous cover. Loblolly is therefore an excellent species for flood control planting. However, the data strongly suggest that surface soil beneath redcedar develops more desirable characteristics than surface soil beneath loblolly pine or native herbaceous cover. The use of redcedar should be seriously considered in planting programs where the objective is soil rehabilitation as well as flood control.

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