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EFFECT OF SLASH BURNING ON SOIL pH

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Evaluating the effects of slash burning on regeneration and tree growth is one of the most pressing forest soil problems in the Douglas-fir region. Extensive literature concerning burning and soils is available for other parts of the world, but conclusions are not directly applicable to the Pacific Northwest. Here several studies are under way or planned to determine the effects of slash burning on soil quality, regeneration, and tree growth. This research note covers only the effect of slash burning on soil pH; this information will eventually be combined with findings from related studies.

The Problem

Thousands of acres of logging slash are burned annually in the Douglas-fir region for purposes of fire protection. But whether or not the heating associated with slash burning is injurious to soil has long been a subject for conjecture. We know that "Slash burning tends to change, temporarily at least, the duff and surface soil from an acid to an alkaline condition, but how long this change continues is not known." 1/ Also, we know that up to 900° F., temperature and duration of exposure to heat affect the amount of soil pH change but that higher temperatures do not result in further alteration. 2/

1/ Isaac, L eo A. 1943. Reproductive habits of Douglas-fir. Charles Lathrop Pack Forestry Foundation. Washington, D. C. 107 pp.

2/ Tarrant, Robert F. Effect of heat on color and pH of two forest soils. Pacific Northwest Forest and Range Experiment Station, Research Note No. 90, 5 pp. October 1953.

We need next to answer for the Douglas-fir region the following questions:

(1) Are there real differences in pH between severely burned, lightly burned, and unburned forest soils?

(2) Is there any change in soil pH with various lengths of time since burning?

(3) Is change in soil pH since burning related to severity of burn?

(4) Is there any real difference between pH of unburned soil within a clear-cut area and pH of undisturbed soil in timber immediately adjacent?

Method of Study

The study consists of two phases: one based on records taken yearly from one pair of burned and unburned plots; the second based on 1953 records from cuttings previously burned in different years.

Yearly observations of paired plots were made on the Cascade Head Experimental Forest near Otis, Oregon. This forest is typical of low-elevation Coast Range conditions. On one plot logging slash was burned; on the other, slash was left unburned. The two plots are immediately adjacent within a single cutting unit and are similar in aspect, elevation, and soil. On each plot, sample points were located in areas severely burned, lightly burned, and unburned, and were marked with numbered stakes. Severe burn was defined as that condition in which fire had removed all organic litter from the ground surface and in addition had baked the mineral soil to a highly colored crust. Light burn was defined as that condition in which fire had charred the surface of organic litter but had not removed all litter from the soil. Annual observations were begun immediately after burning in the fall of 1948, and except in 1951, were continued through 1952. Soil samples were taken in October to exclude seasonal variation in soil reaction and were air-dried prior to analysis. pH measurements were made with a glass electrode.

The second phase, observation of cuttings of various ages since burning, was done in two areas: The Wind River Experimental Forest in southern Washington, and the H. J. Andrews Experimental Forest in the Cascade Range of Oregon. At each place, clear-cut areas freshly burned, and burned one, two, and three years previously were studied.

Samples of severely burned, lightly burned, and unburned soil were taken on each cutting area. An additional set of samples was taken in adjacent timber to obtain an indication of soil reaction before logging. Unburned and lightly burned samples were taken at the juncture of forest floor and mineral soil. Severely burned samples were taken in the first surface inch because no organic litter remained.

Results and Discussion

1. Significant differences in soil pH were found between unburned and light burn, unburned and severe burn, and between light and severe burn. The amount of change in soil pH is evidently related to severity of burn (table 1). This finding substantiates an earlier laboratory study.[3/] To minimize change in pH during slash burning, the fire should apparently be light enough so that only part of the litter is consumed.

2. pH decreased significantly with an increase in time since burning. One year after burning, pH of burned soil was neutral or slightly acid. Three years after burning, the soils had not returned to their original level of acidity, but even severely burned soils were well within the acid range found naturally in the Douglas-fir region. Perhaps a new humus layer will have to form before severely burned soils will fully regain their original pH value. One investigator[4/] found that the raised pH value after burning "...will remain stationary for several years, at least for a normal regeneration period.... It is, however, gradually reduced." In this study no distinction was made between different severities of burn. The present study shows that severity of burn affects the time required for soil pH conditions to ameliorate.

3. Change in soil pH after burning is related to severity of the burn. With increasing time after burning, pH decreased more on lightly burned than on severely burned areas.

4. No significant differences in pH were shown between unburned soil in the clear cut and undisturbed soil in adjacent timber. On 6 of 8 areas studied (table 1) average pH was lower (more acid) in the undisturbed soil of adjacent timber than in unburned soil in the clear cut.

3/ See footnote 2.

4/ Eneroth, O. 1928. Contribution to the knowledge that we have of the effect on the soil from burning of clearings. U.S. Forest Service translation No. 61. From Journal of the Swedish Forestry Society No. 26, 1928. pp. 685-758.

Table 1. --Average pH on clearcuttings in Douglas-fir by time since slash burning and intensity of burn

Time since burning		Severe burn	Light burn	Unburned	Adjacent timber
			Cascade Head Experimental Forest		
Fresh burn	1948	7.2	7.1	4.4	--
One year	1949	5.8	5.6	4.5	--
Two years	1950	5.8	5.2	4.4	--
Four years	1952	5.0	4.6	4.3	--
			Wind River Experimental Forest		
Fresh burn	1953	7.6	6.8	5.3	4.2
One year	1952	7.0	6.0	5.2	4.8
Two years	1951	6.4	5.5	5.2	4.8
Three years	1950	6.0	5.0	4.8	4.0
			H. J. Andrews Experimental Forest		
Fresh burn	1953	7.4	7.1	5.2	4.5
One year	1952	7.1	6.5	5.2	4.9
Two years	1951	6.1	5.5	5.0	5.0
Three years	1950[1/]	6.5	6.0	5.1	5.1

1/ This clearcutting was included in the study because it was the only 3-year-old burn in the locality. The soil is derived from andesite and is less acid than the agglomerate soils which characterize other areas studied on the H. J. Andrews Experimental Forest. Nevertheless, the basic relationship among the three intensities of burn remains the same.

This relationship supports findings of other research.[5/] Because of wide variations among the 33 separate observations which make up each of the 8 averages, however, these data are not significant. Significant differences might possibly be found for the Douglas-fir region if larger samples of the two conditions were taken.

5. Intensity of burning is not uniform over a clear-cut area, nor is the entire area directly affected by the fire. Although this finding was incidental to the results given above, it merits consideration wherever the influence of slash burning on soil is evaluated. As an example, the slash fire on the Cascade Head cutting was regarded as exceptionally hot, having taken place in August. However, a careful sampling revealed that less than 1 percent of the area was severely burned. The remainder was lightly burned or not burned at all.

Another intensive sampling of 354 acres of burned slash on the H. J. Andrews Experimental Forest shows that only 4 percent was severely burned, 47 percent lightly burned, and 49 percent unburned. These figures are generally substantiated in other parts of the Douglas-fir region. This means that slash burning affects pH and other soil properties on only about half the area of burned clear cuts. Effects of severe burning, which represent the most drastic changes that can be expected, are confined to a very small portion of the areas that are clear cut and burned.

5/ Lutz, Harold J., and Robert F. Chandler, Jr. 1946. Forest soils. 514 pp. John Wiley & Sons. New York, N. Y.