Burning and Soil Fertility

greenhouse tests with lettuce and barley indicate nutrient content of forest soils increased by prescribed burning

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Effects of prescribed burning on soil fertility were studied on two California forest soils—Salminas at Hobergs in Lake County and Holland at the Teaford Forest in Madera County.

Salminas soil—similar to the Aiken series—is a residual soil, reddish in color, moderately acid, and ranges from 3′ to 4′ in depth. The Holland soil is derived from granite, slightly acid, brown in color, and about 3′ deep. This series is quite extensive in the foothills and mountains of California. Ponderosa pine forest with brush is a characteristic natural vegetation on both soils.

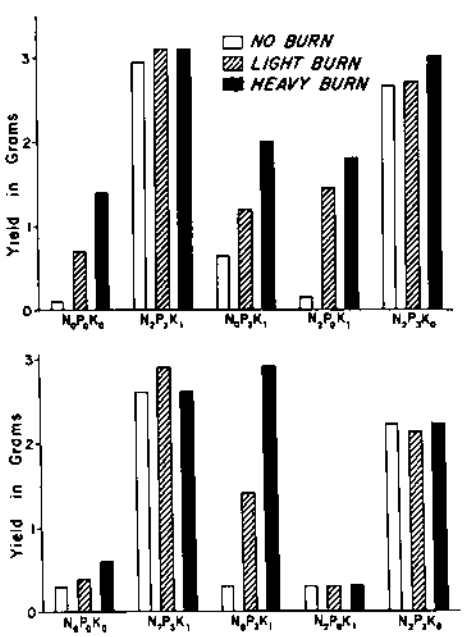
The technique of prescribed burning, as used in these investigations, results in two soil treatments which are quite different in nature. Broadcast burning—light-burn—produces a relatively light fire, because the fuel consists of the uppermost dry layer of pine needles, the finer twigs and limbs, and coarse material lying flat on the ground. Usually about one half of the total weight of litter on a given area is burned. On the experimental areas the amount burned was about 50 grams of needles per square foot with an equal amount remaining to protect the soil. The low intensity of heat generated is reflected in the fact that one could rest his hand on the soil surface immediately after the fire passed over the spot.

Cleanup burning—hot-burn—consists of piling and burning, and results in more intense fires but over smaller areas than are light-burned only. The fuel piles are seldom over 12′ in diameter, and depending upon the density of dead brush and trees, from 10 to 15 such piles might be scattered over an acre, although as many as 53 have been burned on a single acre. All the litter is dried out and consumed. Ashes and charcoal lie directly on the mineral soil. Whereas broadcast burning is done with fuel in its natural amounts and distribution, the fuel piles in cleanup burning are concentrations of organic material produced on a much larger area.

Samples of mineral soil only were taken from two depth classes—0″ to 8″ and 8″ to 16″—in unburned areas, from light-burns and hot-burns. All litter and ashes were carefully swept off before taking the soil. One set of such samples had one winter season—a period of leaching—between the time of burning and sampling, while another set had two seasons intervening.

The fertility levels of the soils were measured by using lettuce and barley in greenhouse pot tests. The technique of testing has been used for many years to assay the nutrient levels of agricultural soils. Correlation between the greenhouse pot yields and field results permits good estimates of what fertilizers are needed to grow crops successfully. Whether this correlation obtains in the case of forest soils and tree growth is not known; nevertheless, the method provides an index to evaluate relative changes in soil nutrient levels resulting from burning.

The nutrient treatments were as follows: full treatment with elemental nitrogen equivalent to 200 pounds per acre, phosphorus 300 pounds, and potassium 100 pounds—$N_2P_3K_1$; no nitrogen—$N_0P_3K_1$; no phosphorus—$N_2P_0K_1$; no potassium—$N_2P_3K_0$ and the control—untreated. Omission of an element one at a time tests the supplying power of the soil for that element when the other two are adequate. Lettuce and barley were harvested after growing for six weeks in 6″ pots.



Average dry weights of lettuce grown in pots of Salminas—*lower graph*—and in Holland—*upper graph*—soils. Soil samples taken from 0″–8″ depth one year after burning. $N_0P_0K_0$, control, untreated; $N_2P_3K_1$, full treatment; $N_0P_3K_1$, no nitrogen; $N_2P_0K_1$ no phosphorus; $N_2P_3K_0$, no potassium.

Yields shown in the graph are dry weights of individual lettuce plants grown on the top 8″ of soil with one season of leaching. Data for barley are very similar. The yields on the 8″–16″ layer of soil and for the second season of leaching followed the same pattern, but the differences were not as pronounced.

Without burning, both soils are low in nitrogen and phosphorus while potash appears to be present in adequate amounts. But when fertilized with the standard rates, the soils are as productive as many agricultural soils.

As a result of hot-burning, a highly significant increase occurs in regard to the nitrogen-supplying power of these soils. In the case of the Holland soil, this increase was threefold, and for the Salminas eightfold. The light-burning showed intermediate increases, twofold for the Holland soil and fourfold for the Salminas.

Phosphorus presents a varied picture. On the Holland soil, either intensity of burning increased the phosphorus content of soil so that yields were ten times as great as those of the unburned control. The Salminas soil fixes phosphorus, however, and here the burning did not add sufficient phosphorus for plant use.

In practice, prescribed burning would result in no more than about 5% of the total area receiving the hot-burn treatment. Although the light-burn gives less spectacular fertility increases over no burning, it would be the effect which is most important on a given forested area. On soils similar to those in the experiment, available nitrogen could be expected to increase as a result of burning, as could phosphorus on the non-prosphorus-fixing soils.

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