LOSS OF NITROGEN FROM THE FOREST FLOOR BY BURNING¹

By H. KNIGHT²

ABSTRACT

Burning experiments conducted in the laboratory indicated a 25-64 per cent loss of nitrogen from the forest floor at temperatures of 300-700°C. Burning increased the nitrogen concentration of the residual material, but the total amount of nitrogen decreased. This may explain the frequent reports of an increase in nitrogen after burning.

INTRODUCTION

It is generally acknowledged that burning of the forest floor results in a loss of nitrogen through volatilization (Lutz and Chandler, 1947, Ovington, 1962). However, there are frequent reports (Ahlgren and Ahlgren, 1960) that burning increased soil nitrogen. Some of these reports attributed the increases to biological fixation of nitrogen. However, it has been estimated that only 35-70 pounds of nitrogen per acre per year may be fixed by organisms in forest soils (Lutz and Chandler, 1947). Even if this figure were doubled it would be small compared with the reported increases.

In the coastal Douglas fir region of British Columbia slash-burning is a common forest management practice. Yet information is lacking on the amount of nitrogen lost through burning. As nitrogen is an essential element for plant growth and its reserve in the soil is a key to forest productivity, it is imperative to know the effects of slash-burning on soil nitrogen.

The object of this study was to determine the effect of slash-burning on the nitrogen content of the forest floor. This surface organic layer of the soil has a high reserve of nitrogen, and of all the soil horizons it is changed the most after slash-burning.

METHOD

An indication of nitrogen volatilization from burning the forest floor can perhaps best be demonstrated under controlled laboratory conditions, which would approximate conditions in the field.

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² Research Officer, Canada Department of Forestry, Forest Research Laboratory, Calgary, Alberta.

Samples of forest floor (L + F + H organic layers) from an old growth western hemlock - Douglas fir forest were the test material used. Six random, 4 gm samples of air dried forest floor material of approximately the same volume were weighed out for each of seven burning treatments and placed in the oven at 70 C for 24 hours. The samples were removed from the oven six at a time, and each group of six placed in a muffle furnace at different temperatures for 20 minutes. The temperatures were 70, 75, 100, 200, 500 and 700 C. The highest of these were much lower than the following temperatures reached by slash fires in the field: 1750 F (Beaufait, 1960), 2300 F (Countryman, 1964), and 1600 F (Davis and Martin, 1960). After 20 minutes in the furnace the samples were placed in a desiccator and the loss of weight determined. The samples were then ground with a mortar and pestle and the nitrogen content of each determined by the Kjeldahl method (Jackson, 1958).

RESULTS AND DISCUSSION

The total nitrogen and loss of weight of forest floor samples after heating in muffle furnace at temperatures of 70-700 C are presented in Table 1. Each weight loss and nitrogen figure represents a mean of six samples.

The dry weight of the old growth hemlock - fir forest floor based on 12 one-foot square samples was estimated to be 46,470 lbs per acre (Knight, 1964). Table 1 shows the nitrogen content of the forest floor was 1.26 per cent (100 C treatment) or a total of 586 lbs of nitrogen per acre. Therefore it is estimated that 149 lbs of nitrogen per acre would be lost at 300 C and 367 lbs per acre at 700 C. This represents a 25-64 per cent loss of nitrogen from the forest floor by volatilization. These values are reasonably close to the estimate of nitrogen loss from light to moderate burning in the field (Knight, 1964).

Nitrogen values given in Figure 1 use two different bases for calculation. Curve A is based on the weights after the samples were muffled. No standard weight basis is used for the calculation and no allowance is made for the differences in the loss of weight among samples. It can be seen that at temperatures from 100-500 C the nitrogen increases, while at 700 C a large loss occurs. Curve B is based on a standard oven-dry weight and takes into

TABLE 1
TOTAL NITROGEN AND MEAN LOSS OF WEIGHT OF THE FOREST FLOOR
AFTER HEATING IN A MUFFLE FURNACE AT VARIOUS TEMPERATURES

Temperature Celsius	Weight Loss (Per cent)	Nitrogen		
		No standard weight basis (Per cent)	Oven-dry weight basis (Per cent)	Loss by treatment (lbs per acre)
70	Nil	1.28±0.09	1.28	
75	Nil	1.21±0.04	1.21	
100	Nil	1.26±0.10	1.26	
200	14.05	1.47±0.18	1.26	
300	38.52	1.57±0.18	0.94	149
500	60.56	1.70±0.16	0.67	
700	62.98	1.23±0.08	0.46	367

FIGURE 1. Total Nitrogen in the Forest Floor After Heating to Various Temperatures

account the change in weight of the forest floor material after muffling. This curve shows there is little loss of nitrogen until 200 C is exceeded. At 300-700 C large losses of nitrogen are indicated.

The results indicate that burning can increase the nitrogen concentration of the residual material. However, the total amount of nitrogen decreases. This suggests that increases in nitrogen after burning that have been reported in the literature, are increases in the nitrogen concentration of the residual material as one might expect, and not increases in total amount.

It would appear that slash-burning may appreciably reduce the nitrogen content of the forest floor. Thus it is imperative to consider how this will affect future forest productivity.

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