Minnesota Forestry Research Notes

No. 273
June 1979

EMERGENT SEEDLINGS ON SOIL FROM BURNED AND UNBURNED RED PINE FOREST

Clifford E. Ahlgren*

ABSTRACT

Intact soil blocks from an unburned, old red pine forest and comparable soil burned by wildfire were placed in a greenhouse. Seed was extracted from other soil samples on the same area. The ratio of number of seedlings on the soil blocks to number of seeds extracted from the soil was much higher for the burned area than for the old forest. Factors other than increased light and removal of competition during emergence are responsible for the increased numbers of herbaceous plants which emerge following fire.

INTRODUCTION

Previous studies have shown that of the plants which emerge after fire, one-third originate from seeds and the rest from vegetative sprouts (Ahlgren 1960). Among the seed-reproducing species are the typical pioneers which often dominate burned areas for several years after fire. Evidence exists that seeds responsible for this growth are present in the soil 10 years or more before fire (Ahlgren 1979). This study compares under greenhouse conditions seedling emergence on soil lifted from a recently burned area with that on soil taken from an adjacent, unburned forest. The amount and type of seed extracted from soil samples from each area are also reported.

* Director, Wilderness Research Foundation and Research Associate, College of Forestry, University of Minnesota.

STUDY AREA

Three years after fire, soil was obtained from a 270-year-old red pine (*Pinus resinosa* Ait.) stand located in the Boundary Waters Canoe Area of the Superior National Forest in northeastern Minnesota. This stand was burned in 1971 in the 6,000 ha Little Sioux wildfire. Soil was also obtained from an adjacent, unburned portion of this old red pine stand.

METHODS

Intact soil blocks 30 cm square to a depth of 5 cm into mineral soil, or a total depth of 7.5-12.5 cm, were placed in perforated wood flats. Three blocks were obtained from each area. These were gathered in late summer, stored in a cold frame until March, and then placed in the greenhouse and kept moist for three months (Figure 1). As plants appeared, they were allowed to grow until identifiable and then removed in order to determine whether they were of seed or vegetative origin.

Seed was extracted by hand from sieved, composite soil samples from each area. Each composite consisted of three cylindrical cores, 13.2 cm in diameter, sampled from surface litter to a depth of 2.5 cm into mineral soil. Plant frequencies given in Table 1 were obtained from 30 10-m^2 circular plots placed 30 m apart within each area. The seeds and seedlings reported do not necessarily represent total viable seed content of the soils, since ideal germination and growth conditions for all species could not be supplied. However, the species found are among the most common in the areas studied.

Published by the College of Forestry, 1530 North Cleveland Avenue, St. Paul, Minnesota 55108. E. Sucoff, editor.

RESULTS

Figures 1 and 2 show typical flats from the two areas. Table 1 summarizes the quantitative data.

Seedlings of two species typical of the older forest, false lily of the valley (*Maianthemum canadense* Desf.) and violet (*Viola* spp.) were found only on the unburned soil; no seeds of these species were found during seed extraction. Similar quantities of vetch (*Vicia americana* Muhl.) seeds and seedlings were found in both burned and unburned soil.

Cranesbill (*Geranium bicknellii* Britt.) and sedge (*Carex* spp.) seed were present in both burned and unburned soil, but seedlings appeared only in soil flats from burned land. Grass (*Gramineae* spp.) and bedstraw (*Galium triflorum* Michx.) seed were not identified from either soil sample, possibly because of the small seed size. However, their seedlings were strikingly more abundant in flats from the burned area. Raspberry (*Rubus* spp.) seeds and seedlings were also present in soil from both areas, although, in nature, seedlings do not generally appear in the old forest. In the greenhouse, flats from both burned and unburned forest received equal light, so the results may suggest that increased light either stimulated germination or increased survival of raspberry seedlings. The larger number of raspberry seeds on the burned area was undoubtedly from vegetative sprouts which fruit heavily after fire.

No big-leafed aster (*Aster macrophyllus* L.) seedlings were found on the burned land, since the numerous aster sprouts in this area had not recovered sufficiently to produce seed. Aster seedlings were found, however, on the unburned soil, probably coming from windblown seed of older vegetative sprouts which flowered nearby. Seedlings of other species with wind-disseminated seeds--sow thistle (*Sonchus arvensis* L.), Canada thistle (*Cirsium arvense* (L.) Scop.), and dogbane (*Apocynum androsaemifolium* L.), typical plants of open areas--were found only on the burned area and probably developed from seed blown in after fire.

The total number of seedlings, all species combined, was noticeably higher on soil flats from the burned tract (Figures 1 and 2). Birch (*Betula papyrifera* Marsh.) seed blown in after fire accounted for the quantities of birch seedlings on both sites. Omitting these birch seedlings, the difference in number of seedlings between the two areas is more striking: 21,344,400/ha on the burned area, 1,524,600/ha on the unburned area. The number of seeds was also greater on the burned tract, but these were mostly raspberry seeds from the heavily fruiting vegetative sprouts on the burned land. If these were omitted, the total number of seeds of all species would be lower in the burned soil than in the unburned forest soil.

CONCLUSION

The stimulus of increased light is often assumed to be a major factor in post-fire vegetational response. These results suggest that other, unidentified factors may also be important for the appearance of some species characteristic of early post-fire vegetation. The flats from both burned and unburned areas received similar light, temperature, and moisture. Seedlings were more numerous, however, on the burned soil. This was particularly true for cranesbill, where 10 times more seed was found in the unburned area, and for sedge where twice as much seed was found in the unburned area. Grass species and bedstraw, were also more numerous on soil from the burned area. Species with seeds wind disseminated after fire (sow thistle, Canada thistle, and dogbane) also germinated only in soil from the burned area. Therefore, factors other than light and seed availability are involved in the appearance of at least seven species on burned soil and their absence in older forests. Not all species were similarly affected. One species, vetch, appeared to be unaffected by fire since it was similarly present in both areas. Still other species, false lily of the valley and violet, were favored by conditions present in the old forest soil.

LITERATURE CITED

Ahlgren, C. E. 1960. Some effects of fire on reproduction and growth of vegetation in northeastern Minnesota. Ecology 41:431-445.

Ahlgren, C. E. 1979. Buried seed in the forest floor of the Boundary Waters Canoe Area. Minn. Forestry Res. Note. 271, 4 pp.

Table 1. Emergent seedlings and seed extracted from soil beneath burned and unburned red pine forests.

	Recent Burn			Unburned		
	Plant frequency (percent)*	Seedlings/ha (thousands)	Seed/ha (thousands)**	Plant frequency (percent)	Seedlings/ha (thousands)	Seed/ha (thousands)
Geranium bicknellii	90	1,198	4,114	0	0	12,584
Carex spp.	67	109	2,662	90	0	4,840
Rubus spp.	83	871	99,462	57	218	6,292
Gramineae spp.	7	4,356	0	73	109	484
Galium triflorum	40	10,890	0	93	218	0
Maianthemum canadense	40	0	0	93	218	0
Viola spp.	17	0	0	73	109	0
Sonchus arvensis	0	109	0	0	0	0
Cirsium arvense	33	3,485	0	0	0	0
Apocynum androsaemifolium	0	109	0	0	0	0
Aster macrophyllus	83	0	0	97	436	0
Vicia americana	63	218	3,388	57	218	5,566
Betula papyrifera	0	2,940	0	80	2,396	0
TOTAL		24,285	109,626		3,922	29,766

* Figures based on 30 plots.
** Each seed found is equal to 242,000 seed per hectare.

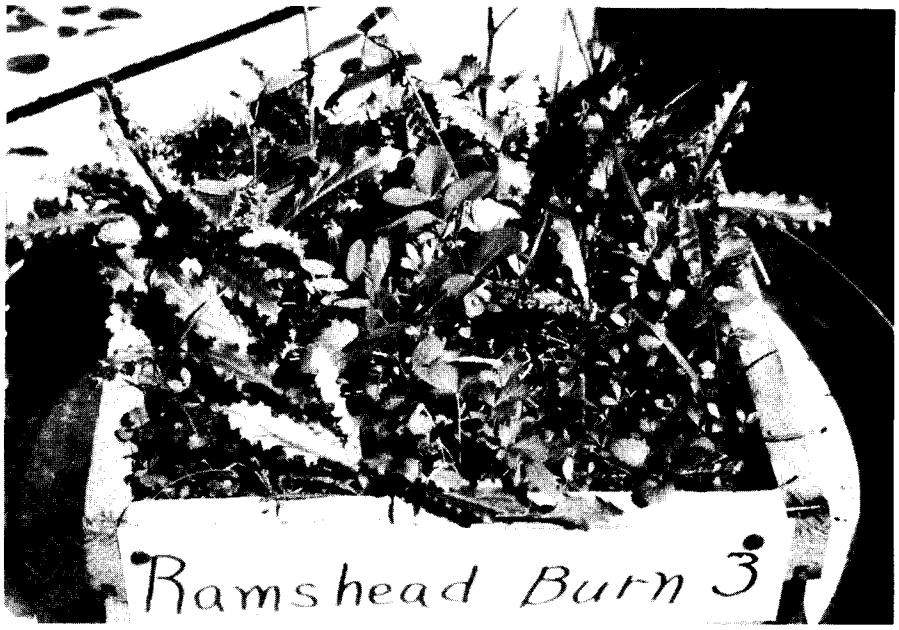

Figure 1. Intact soil flat from a 270-year-old red pine forest severely burned in the Little Sioux wildfire, after 8 weeks in the greenhouse.

Figure 2. Intact soil flat from an unburned 270-year-old red pine stand adjacent to the Little Sioux wildfire area, after 8 weeks in the greenhouse.

Published as Minnesota Agricultural Experiment Station Scientific Journal Series Paper No. 10930