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EFFECT OF PONDEROSA PINE NEEDLE LITTER ON GRASS SEEDLING SURVIVAL

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ABSTRACT

Hard fescue survival rates were followed for 6 years on four different pine needle treatment plots. Needle litter had a significant effect on initial survival of fescue seedlings, but subsequent losses undoubtedly resulted from the interaction of many factors.

Keywords: Pine needles, litter, grass seedlings, ponderosa pine, *Pinus ponderosa*.

Introduction

Ponderosa pine (*Pinus ponderosa*)[1/] often regenerates in dense patches with a sparse understory of shrubs and herbaceous vegetation. Needle litter is only one of many factors influencing understory vegetation in such cases, but its general importance on native species is well documented (Pase 1958 and Moir 1966). The present study was conducted to determine the effect of pine needle fall and accumulation on the emergence and survival of planted grass seedlings.

Methods

The study was conducted near Winthrop, Washington, about 2,000 feet above sea level. Temperature extremes vary from 110° to -30° F., with average July temperature of about 70° F.; and the frost-free growing season extends from May until late September. Approximately 60 percent of the 14.5 inches of average annual precipitation falls between October and February and includes about 70 inches of snow. The soils are well drained, moderately coarse-textured Western Brown Forest Soils, integrated to regosols developed from granitic ablation till.

The study plots were located in dense ponderosa pine poles and saplings (3,000-4,000 stems per acre) with a canopy closure of about 90 percent as measured with a spherical densiometer (Lemmon 1956). The trees were about 55 years old and originated from natural seeding in 1911 after logging and fire. Surviving trees of the original stand, unmerchantable at the time of logging, indicated an above average site IV. Needle litter was from 1 to 4 inches deep, with accumulations of about 10.5 air-dry tons per acre. Needle fall varied significantly between years but averaged about 0.5 air-dry ton annually. The area was not used by livestock, but it received light deer use.

Hard fescue (*Festuca ovina* var. *duriuscula*) was hand seeded on individual 3- by 3-foot treatment plots at a rate of 6 pounds of live seed per acre. The experimental design consisted of the following four litter treatments replicated five times in randomized block design (see fig. 1 for photograph of a typical block layout):

[1/] The source for scientific nomenclature is Hitchcock et al. (1955-69).

1. Remove original litter, plant grass seed, remove new needle fall each spring.

2. Remove original litter, plant grass seed, allow new litter to accumulate.

3. Remove original litter, plant grass seed, replace original litter, and allow new needle litter to accumulate.

4. Broadcast grass seed on undisturbed litter and allow new litter to accumulate.

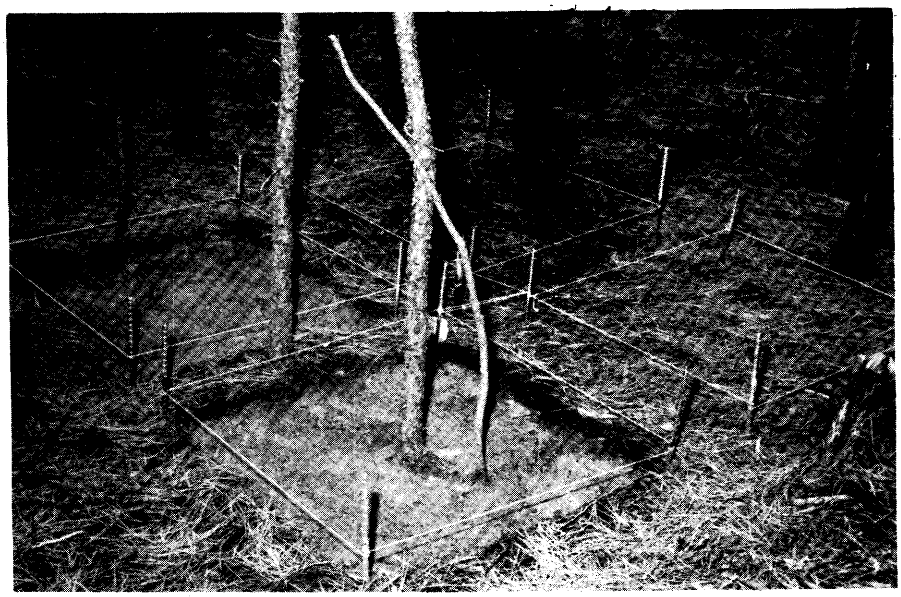

Figure 1.--Typical layout of one block of treatment plots at the start of the study.

The effects of the litter treatments were evaluated by counting all hard fescue plants on each treatment plot at approximately the same stage of growth each spring for a 6-year period. Summer and fall counts were impractical because of the difficulty of distinguishing mature fescue leaves from pine needles. Hard fescue was used because it is somewhat shade tolerant and is probably as adaptable to growth under dense ponderosa pine as most other grass cultivars.

Emergence and survival data were tested with split-plot analysis of variance with treatments considered as whole plots and years as subplots. Separate analyses of variance were also made for individual years.

Results

The overall analysis of variance indicated that there were highly significant effects for litter treatments, years, and the interaction between treatments and years. The analyses of variance by individual years showed that responses of fescue plants to litter treatments were significantly different at the 0.01 probability level during the first 3 years. During the fourth year, treatment differences were significant at the 0.05 level, and by the fifth and sixth years none of the differences between treatments were significant.

Tukey's test (Snedecor 1961, p. 251) was used to compare all treatment means during years when significant differences between survival rates were found. Thus, during the first and second years after planting, all treatment means were significantly different except treatments 1 and 2. During the third and fourth years, only treatments 1 and 4 differed significantly; and by the fifth and sixth years none of the treatment means differed significantly.

Survival curves (fig. 2) emphasized the impact of early losses between fall planting and seedling emergence the following spring on

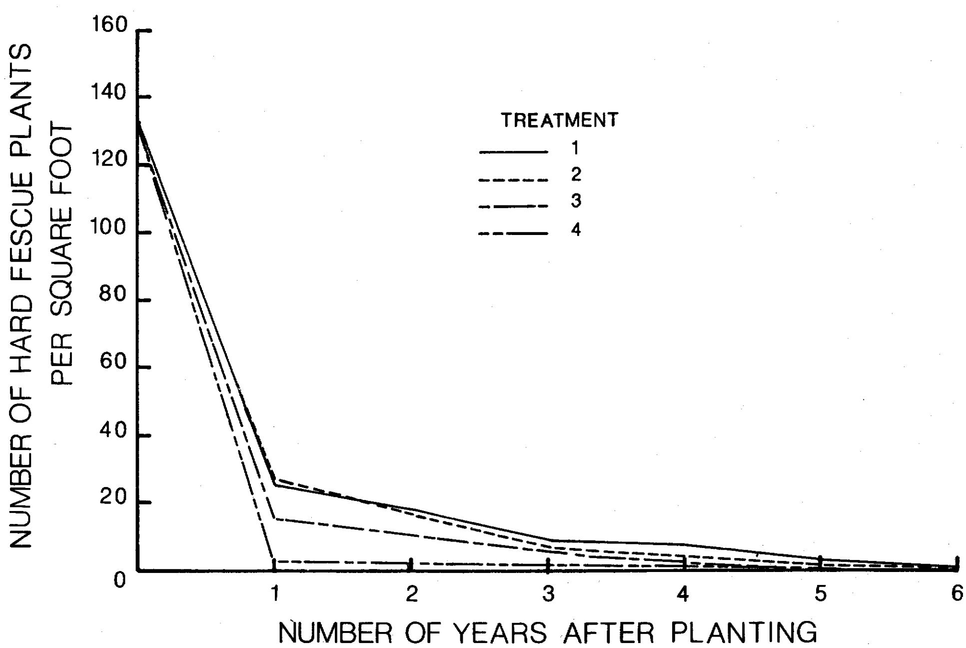

Figure 2.--Number of living hard fescue plants per square foot from seed planting through the 6-year period under four levels of ponderosa pine needle accumulation.

initial inputs of fescue plants into the experimental populations. These early losses ranged from a low of 77 percent of the potential seedling population of 133 plants per square foot in treatment 2, to losses of 80, 88, and 98 percent, respectively, in treatments 1, 3, and 4. The potential seedling populations were determined by finding average seed weight, and thereby the total number of seeds planted per square foot--after corrections for purity and viability--at a seeding rate of 12 pounds per acre.

Discussion

Figure 2 shows that all survival curves for the four experimental hard fescue populations were characterized by heavy mortality in the youngest age groups; this is the most common type of survival curve found in natural populations. There are plausible explanations for the high initial mortality rates of treatments 3 and 4, but possible causes of losses in treatments 1 and 2 are much less obvious. For example, in treatment 4 the thick litter layer might contain considerable water that never penetrates to mineral soil, and these layers could dry out so quickly that germinating seedlings desiccate before their radicles can reach more permanent water supplies in the soil below (Daubenmire 1959). Germinating seedlings in treatment 3 may have had difficulty growing up through the thick litter layer before their food reserves were depleted and they could reach light for photosynthesis.

As previously indicated, no attempt was made to assess the effects of any possible mortality factors except pine needle litter. Undoubtedly, however, seedlings on all treatment plots were also adversely affected by the generally unfavorable growing conditions that characterize the forest floor under dense ponderosa pine canopies. For example, numerous studies have shown that competition between trees and understory plants for moisture, nutrients, etc. is important. Other studies have shown that low light levels on the forest floor contribute to plants with low vigor and reduced growth potential. However, Anderson et al. (1969) found that light levels were apparently above minimum thresholds for species comprising the herb understory in Wisconsin pine forests, and that this layer was more responsive to differences in throughfall precipitation than to differences in light. Also, even though hard fescue plants tolerate mild soil acidity (the pH on the study plots was about 6.0), there can be indirect influences such as soil-borne plant diseases sometimes associated with acid soils. Ponderosa pine needles also contain acid-forming compounds and resins which resist decay and are low in essential nutrients. The ease with which this material dries and the limited involvement of invertebrates in its decay often causes humification characterized by deficient nitrogen. Thus, as Moir (1966) concluded, the trend in herb suppression under dense ponderosa pine canopies is often toward virtual extinction as the effects of shading and soil-nitrogen depletion intensify.

Our results indicate that needle litter had a significant effect on initial survival of fescue seedlings but that subsequent losses undoubtedly resulted from the interaction of many factors. These initial losses are important, however, because they suggest that thick accumulations of needle litter (and its by-products) under dense ponderosa pine canopies may exert a strong selective influence on the eventual composition and cover of understory vegetation.

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