COMPETITION CONTROL IN CHRISTMAS TREE PLANTATIONS

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Scalping and handweeding, combined, worked a little better than herbicides. Frazer fir benefited more than Scots pine.

Newly planted tree seedlings must often compete for moisture, plant nutrients, and light with herbaceous vegetation growing on planting sites. Competition is particularly severe on better sites; and unless vegetation is controlled, survival and growth of trees may be greatly reduced. Shading by herbs may also cause sparse foliage and incomplete whorls of limbs, reducing the value of trees grown for Christmas trees and ornamentals.

Purposes of the study reported here were: (1) to investigate survival and growth of seedlings of two Christmas tree species, Fraser fir (*Abies fraseri* (Pursh) Poir.) and a south-French seed source of Scots pine (*Pinus sylvestris* L.), planted on areas having different densities and types of herbaceous cover and (2) to relate those differences in ground cover to variations in available soil moisture.

Methods

The site used is level to gently sloping (0 to 5 percent) and was covered with dense vegetation consisting of a mixture of broad-leaved herbaceous and grass species. Soils are well drained with a deep (22 to 30 cm) A_p horizon of silt loam texture and a B_2 horizon of silty clay loam texture. Total soil depth exceeds 90 centimeters.

In spring of the year prior to planting, the study area was divided into five replicates, each containing four plots. One of four treatments was randomly assigned to each plot: (1) competing vegetation controlled using scalping and handweeding, (2) competing vegetation controlled with herbicide, (3) broad-leaved ground cover, and (4) grass-sod ground cover. Plots assigned to broad-leaved cover were sprayed with dalapon to kill all grasses, while plots designated for grass were sprayed with 2,4-D to kill broad-leaved herbs; during that summer, moderately dense stands of annual and perennial broad-leaved herbs and grasses, respectively, became established on those plots.

In early April of the following year, plots designated for complete vegetation control were scalped and chemical weed control plots were sprayed with a mixture of aminotriazole-simazine. Plots were subdivided into two subplots and each was planted with six seedlings of either 2-2 Fraser fir or 2-0 Scots pine seedlings. Root-shoot balance was good for all planting stock.

Bouyoucos soil-moisture blocks were buried at 10 and 15 centimeter depths in soil on all plots after seedlings were planted. Soil moisture readings in ohms resistance were taken from mid-May to mid-September over the next 3 years of the study. Scalped plots were handweeded to keep plots weed free throughout the study. In spring of the second and third growing seasons, chemical weed control plots were resprayed using a directed spray of aminotriazole-simazine, while plots having broad-leaved cover and grass sod were given light applications of dalapon and 2,4-D, respectively.

Survival, total height, and annual height growth were measured at the end of each growing season; additional survival counts were made at the beginning of the second and third growing seasons. At the end of the study, seedlings were carefully dug up to prevent substantial loss of root systems and soil was washed from roots. Tops and roots were separated, ovendried at 80° C, anal weighed. Samples of tops of herbaceous vegetation were collected from all plots, ovendried at 80° C, and weighed to provide estimates of relative intensities of herbaceous competiton.

After completion of field work, soil was collected from A_p and B_2 soil horizons on plots and calibration curves were constructed relating resistance readings in ohms to percent moisture by weight using the method described by Bouyoucos and Mick (*1*). Field capacity (-1/3 bar matric potential) and wilting point (-15 bar matric potential) values were determined for A_p and B_2 soil horizons using porous plate apparatus.

Data were analyzed for a split-plot experimental design, with the weed control method and vegetation type as the main-plot, the species as subplot, and five replications.

Results and Discussion

There were significant differences in average survival and growth of Fraser fir and Scots pine seedlings from the effects of weed control and vegetation type treatments. Seedling weights also differed significantly between the two species depending on the treatment used on plots; species X treatment interactions were not significant for survival and height growth. For both species, top and root weights were similarly affected by different treatments and there were no significant differences between years in annual height growth attributable to treatment.

Survival and growth of seedlings were generally closely related to cover treatments on plots, which, in turn, were related to soil moisture. Height growth and seedling weights were greatest on scalped plots where soil moisture was consistently highest during periods of high moisture stress. On plots where vegetation was controlled with aminotriazole-simazine, small amounts of vegetation survived or reinvaded plots, moisture was slightly but not significantly lower, and height growth of trees was reduced by approximately 10 percent and seedling weights by approximately 20 percent. After 3 years, survival of trees on scalped and herbicide plots averaged 90 percent. All mortality of seedlings occurred during the first summer or winter after planting. Field observations indicated that seedlings were well established and little or no additional mortality would have occurred (tables 1, 2; figures 1, 2). Where weed control was used, soils were never below the wilting point and only about one-fourth of soil moisture readings were less than 16 percent (table 2).

On plots where mechanical or chemical weed control was not used, moisture was significantly lower during dry periods and survival and growth of Fraser fir and Scots pine seedlings were significantly reduced. There were con-

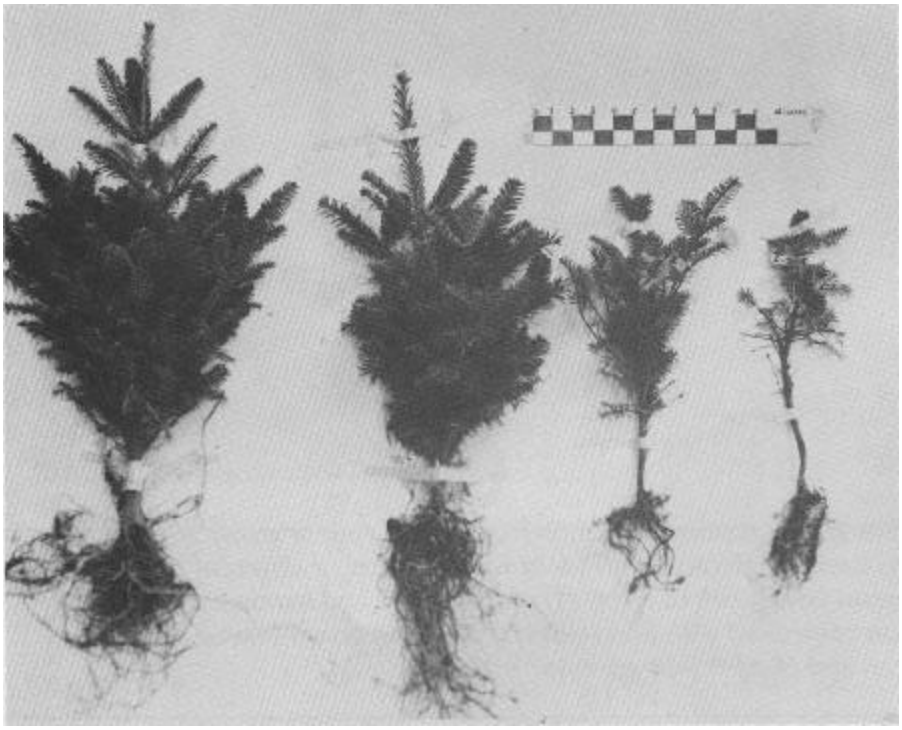

Figure 1.—*Fraser fir seedlings grown for 3 years on plots having different methods of weed control or different types of herbaceous cover. Left to right: (1) plot scalped and handweeded, (2) vegetation controlled with herbicide, (3) plot with broad-leaved herbaceous cover, and (4) plot with grass-sod cover.*

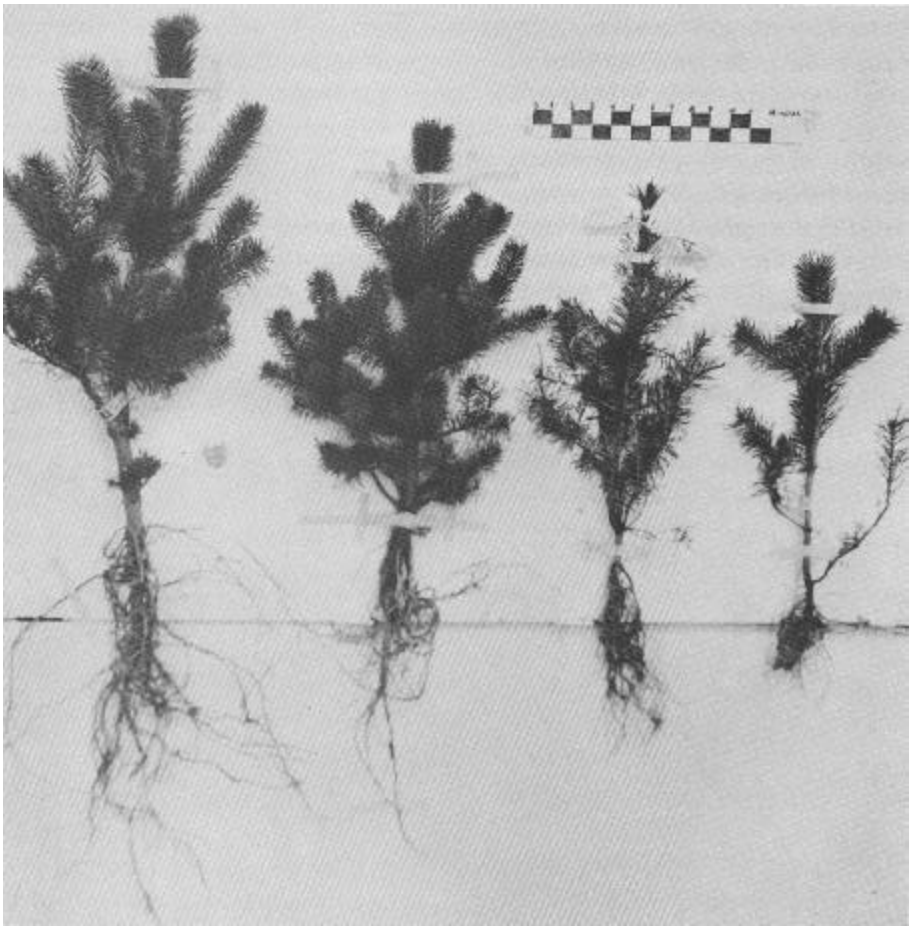

Figure 2.—*Scots pine of a south-French seed source grown for 3 years on plots having different methods of weed control or different types of herbaceous cover. Left to right: (1) plots scalped and handweeded, (2) vegetation controlled with herbicide, (3) plot with broad-leaved herbaceous cover, and (4) plot with grass-sod cover.*

sistent differences between areas having broad-leaved herbs and grass sod, with moisture, as well as survival and growth, being higher on plots having broad-leaved cover. On areas with broad-leaved herbs, survival averaged 67 percent for Scots pine and 60 percent for Fraser fir; on areas with grass sod, survival of the two species was 60 and 47 percent, respectively. Mortality of seedlings generally occurred over the 3 years of the study and field observations indicated that additional trees of both species would have died if the study had continued. Average height growth was approximately 40 percent less on broad-leaved herb and grass plots than on plots where vegetation was controlled by scalping and handweeding. Average seedling weights were approximately 50 to 60 percent lower, with Fraser fir seedlings being more affected by vegetative competition than seedlings of Scots pine (tables 1, 2; figured 1, 2). On plots covered with broad-leaved herbs or grass, soil moisture was in the 11 to 15 percent range on approximately one-third of the measurement dates and was below the wilting point on numerous occasions (table 2).

Differences in soil moisture were partly related to weight of competing herbaceous vegetation on plots. There was no vegetation on scalped and weeded plots where moisture was highest and only small amounts on herbicide-treated areas where moisture was almost as favorable. However, weight of herbaceous vegetation on plots having broad-leaved cover was nearly 50 percent greater than on grass-sod areas and approximately 300 percent greater than on plots sprayed with herbicide, despite the fact that moisture was generally lowest on grass plots. This can be explained in part by differences in rooting habit of grasses and broad-leaved herbs growing on study plots.

Table 1.—*Survival and growth of Fraser fir and Scots pine seedlings on plots having different types of weed control or herbaceous cover*

Type of cover or weed control treatment	Species	Survival					Cumulative 3-year height growth	Total plant weight
		1st Year	2d Year		3rd Year			
		fall	spring	fall	spring	fall		
		percent					*cm*	*gm*
Scalp and weed	Fraser fir	100	93	93	93	93	30	148
	Scots pine	93	87	87	87	87	51	274
	Treatment average	96	90	90	90	90	41	211
Herbicide	Fraser fir	100	93	93	93	93	26	117
	Scots pine	87	87	87	87	87	46	220
	Treatment average	93	90	90	90	90	36	168
Broad-leaved herb	Fraser fir	80	73	73	60	60	18	64
	Scots pine	80	73	73	67	67	35	151
	Treatment average	80	73	73	63	63	26	107
Grass sod	Fraser fir	74	60	53	47	47	16	49
	Scots pine	80	73	60	60	60	31	111
	Treatment average	77	66	53	53	53	23	80
	Fraser fir average	88	80	78	72	73	22	95
	Scots pine average	85	80	77	75	75	41	189
$LSD_{.05}$ (Treatment)		11	10	11	10	10	6	10
$LSD_{.05}$ (Species)		NS	NS	NS	NS	NS	3	9
$LSD_{.05}$ (Species within treatment)		NS	NS	NS	NS	NS	NS	19
$LSD_{.05}$ (Between treatment for same species)		NS	NS	NS	NS	NS	NS	14

Field examination indicated that the grasses had a mat of fine fibrous roots which thoroughly occupied the upper 10 to 15 centimeters of soil. Broad-leaved herbs had root systems consisting of numerous large tap and lateral roots, with smaller masses of fine roots which reached to greater depths (15 to 20 cm) but did not occupy the soil completely.

Differences between species in survival and growth were apparently related to rooting habit of tree species, number and concentration of roots of herbaceous vegetation, and corresponding differences in soil moisture. Rooting of Fraser fir seedlings was confined almost exclusively to zones where competition for moisture

was most severe. Seedlings were strongly lateral-rooted and few roots had reached below the 15-to 20-centimeter level after three growing seasons. Scots pine seedlings had distinct tap roots; and, although the majority of lateral roots were confined to the upper 20 centimeters of soil, the tap and some laterals usually reached below that level. On areas where competition had been controlled, survival of Fraser fir was equal to or better than that of Scots pine; on areas covered with broad-leaved herbs or grass, survival of Fraser fir seedlings was consistently lower (table 1).

Table 2.—*Summary of soil moisture over three growing seasons on plots having different methods of weed control or types of herbaceous cover*

Depth in soil (cm)	Type of cover or weed control	Percent of measurement dates when soil moisture was:[1]			
		> 20%	16-20%	11-15%	< 10%[2]
10	Scalp and weed	51	23	26	0
	Herbicide	47	27	26	0
	Broad-leaved herb	41	16	30	13
	Grasssod	39	13	32	16
20	Scalp and weed	54	29	17	0
	Herbicide	49	20	31	0
	Broad-leaved herb	33	24	35	8
	Grass sod	37	20	43	16

[1]Soil moisture measurements made at weekly intervals from mid-May to mid-September over a 3-year period.

[2]Values in this range were below the wilting point (See below.):
Field capacity of soils (-1/3 bar matric potential):
A_p Horizon = 26.5 percent by weight, ovendry soil
B_2 Horizon = 27.5 percent by weight, ovendry soil
Wilting point of soils (-15 bar matric potential):
A_p Horizon = 10.5 percent by weight, ovendry soil
B_2 Horizon = 9.5 percent by weight, ovendry soil

Conclusions and Recommendations

Results showed that survival and growth of planted tree seedlings can be increased significantly on good sites through use of weed control practices. Benefits were most pronounced for Fraser fir, a species generally considered to have relatively high moisture requirements. However, significant increases in growth and survival were also obtained for Scots pine, a species usually considered to have relatively low moisture requirements.

Although best results were obtained using scalping in combination with handweeding to control all competing vegetation, survival and growth were nearly as good where vegetation was controlled with herbicides. Cost of control using herbicides would be considerably less than that for mechanical control. In addition, dead mulch created by herbicide kill and small amounts of vegetation, which commonly reinvade herbicide treated areas, should help decrease frost heaving, which is often a problem on bare sites.

Literature Cited

1. Bouyoucos, G. J., and A. H. Mick. 1940. An electrical resistance method for the continuous measurement of soil moisture under field conditions. Mich. State Col. Agric. Exp. Stn. Tech. Bull. 172.