REGENERATION BY PLANTING

HERBACEOUS COMMUNITIES REDUCE THE JUVENILE GROWTH OF NORTHERN RED OAK, WHITE ASH, YELLOW POPLAR, BUT NOT WHITE PINE[1/]

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Abstract. -- Initial survival and growth responses to herbaceous stress were obtained for tree seedlings planted in three recently harvested oak stands in Pennsylvania. Planted bareroot seedlings of northern red oak, white ash, yellow-poplar and white pine were grown in the presence and absence of two herbaceous communities-hayscented fern and poverty oat grass. First and second year results showed no detrimental effects of herbaceous communities on survival but showed significant effects on height growth -- particularly second year height growth of the three hardwood species. At the end of the second growing season, the total heights of the three hardwood species were significantly greater in the absence of either herbaceous type. The magnitude of the response was species dependent. Yellow-poplar showed the greatest response to release from herbaceous stress while white pine did not respond.

Keywords: hardwoods, bareroot seedlings, herbaceous stress.

INTRODUCTION

Intensive culture of hardwood stands will require greater control in matching species with site conditions and crop tree distributions than we can accomplish by natural regeneration methods. Studies by Johnson (1976, 1981 and 1984) with northern red oak and Francis and Bivens (1985) with yellow-poplar and black cherry have demonstrated the potential for hardwood plantings to control hardwood regeneration in forested stands. Unfortunately, previous plantings of hardwoods have not routinely resulted in acceptable survival and growth rates when compared to naturally regenerated hardwoods or conifers. The "failure" of these plantings has frequently been attributed to stresses from excessive undesirable vegetation (Sander 1971, Russell 1984, von Althen 1977, Loftis 1979, Johnson 1981 and McGee 1981). Competition from herbaceous vegetation has traditionally been a problem in old field plantings of hardwoods. This may also become true for forest plantings as many of the harvested hardwood sites in the Northeast are being rapidly invaded by persistent herbaceous vegetation. To assess the potential importance of this problem a study was initiated to examine the effect of herbaceous stress on the survival and growth of bareroot seedlings planted in oak stands of Pennsylvania. Four species, northern red oak (*Quercus rubra* L.), white ash (*Fraxinus americana* L.), white pine (*Pinus strobus* L.) and yellow poplar (*Liriodendron tulipifera* L.) were grown in the presence and absence of two herbaceous communities, hayscented fern (*Dennstaedtia punctilobula* L.) and poverty oat grass (*Danthonia spicata* (L.) Beauv.). The initial results of this study are presented in this paper.

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MATERIALS AND METHODS

Three oak stands located about 16 km south of University Park were selected as study sites. The stands referred to as Harry's Valley, Laurel Run and Sand Knob were on lands managed by the Pennsylvania Bureau of Forestry. These even-aged oak stands of about 100 years and site index 70 had received shelterwood cuts 5 to 15 years prior to 1984. For a variety of reasons (including deer, seed crop failure and gypsy moth) the stands were accumulating desirable advanced regeneration at unacceptabably slow rates. Numbers of stems of advanced regeneration by species group and study site, are given in Table 1. Slopes for each of the study sites ranged from level to 20% and the aspects were southeast for Harry's Valley and Sand Knob, and northwest for Laurel Run. The soil classification and chemical properties for each site are given in Table 2.

Table 1. Numbers of advanced regeneration stems[1] by study site and species.

Species	Harry's Valley	Laurel Run	Sand Knob
	(number of stems per hectare)		
Red maple	9,000	1,700	900
Yellow-poplar	100	400	0
Ash	1,900	200	0
Red oaks	900	0	100
White oaks	300	100	0
Total	12,200	2,400	1,000

[1] Based on 6, 10.5 m^2 circular plots per study site.

Late in the 1983 growing season, four replications at each site were selected in hayscented fern and in poverty oat grass communities. The hayscented fern canopy was about 50 cm tall with 90 ovendry (OD) g/m^2 of August herbage and the poverty oat grass was about 40 cm tall with 70 OD g/m^2 of August herbage. Within each replication of each community, 80 m^2 was assigned for weed free conditions and 80 m^2 was left in a weedy state. The weed free subplots (Fern Free or Grass Free, depending on prior herbaceous community dominance) were sprayed with glyphosate (1.7 kg/ha) in late August 1983. At each study site about 6 ha was clearcut in the following dormant season and about 4 ha containing the subplots was enclosed in a five strand electric fence to exclude deer. All weedy and weed free subplots were planted with 20 individuals of four study species in a randomized block arrangement. All seedlings (1-0 northern red oak, white ash and yellow-poplar; 2-0 white pine) were planted in early May. All hardwood seedling shoots were cut back to a 10 cm length prior to planting. Average total height of the white pine seedlings was about 10 cm. Over all treatment combinations and replications, a total of 960 seedlings per species were planted. Annually in June-July each Fern Free and Grass Free treatment unit was hand weeded around the individual seedlings and the remaining vegetation controlled by spraying with glyphosate (1.7 kg/ha) to maintain weed free conditions.

Survival and total height values were measured at the end of one and two growing seasons. These data were analyzed by analysis of variance and Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Average survival at the end of the first growing season ranged from 88 to 98% among the four species. At the end of the second

Table 2. Soil classification and chemical properties[1] of the study soils.

Origin	Soil	pH	P	K	Mg	Ca	CEC
			kg/ha	(- - - - meq/100g - - - -)			
Sand Knob	Typic Dystrochrept	4.6	20.1	0.33	0.2	0.2	8.5
Laurel Run	Aquic Fragiudults	4.6	14.2	0.33	0.3	0.37	11.3
Harry's Valley	Typic Fragiaquults	4.6	7.8	0.34	0.7	0.85	13.3

[1] Soil tests performed at Merkle Laboratory, The Pennsylvania State University. Samples collected from the upper 5 cm of the mineral soil profile.

growing season, survival values averaged 81, 83, 93 and 95% for white pine, yellow-poplar, northern red oak and white ash, respectively. There were no significant differences in either the first or second year survival values due to study site, herbaceous community or weed level factors.

Total height growth at the end of the first growing season appeared to be more a function of seedling and planting quality than the effects of site conditions or weed induced stresses. Over all treatment combinations, the first year white pine, northern red oak and yellow-poplar seedlings averaged 18, 22 and 32 cm in total height. Although there were some study site, herbaceous community and weed level significant difference in the first year total height values for northern red oak and yellow-poplar, there were no consistent patterns and the differences were small (Table 3). White ash averaged 33 cm in total height at the end of the first growing season. There were no statistical differences among study sites for white ash but the first year total height values were dependent on herbaceous community and weed level (Table 3). The first year total height growth of the study species did not reflect a major stressing effect of the hayscented fern or poverty oat grass communities. Visually, the first year seedlings of all species growing in weed free areas were more vigorous than those growing in weedy areas. Compared to the weed free seedlings, leaves of the seedlings growing in the weedy areas were restricted to the upper levels of the weed canopy, individual leaves were smaller and more chlorotic, and stem diameters and terminal buds were smaller.

The second year total height values for white pine averaged 37 cm and there were no differences due to study site, herbaceous community or weed level. The hardwood species demonstrated a growth response to herbaceous stress in the second growing season. The hardwoods also displayed significantly greater second year total height values among the three study sites but there were no consistent trends among the three species and there were no significant study site x herbaceous community or study site x weed level interactions. When averaged over the three study sites, there were significant herbaceous community weed level interactions for northern red oak and white ash but not yellow-poplar. The second year total height values for all species are presented in Table 3.

At the end of the second growing season, each of the three hardwood species were significantly taller in the weed free areas than in the weedy areas. There were no significant differences in the second year total height values for each of the three hardwood species when they were growing in either the hayscented fern or poverty oat grass communities (Table 3). However when released from the herbaceous stress, the northern red oak and white ash were

Table 3. Average[1] first and second year total height values for bareroot seedlings[2], by species and herbaceous treatment.

Herbaceous Treatment	White Pine	Northern Red Oak	White Ash	Yellow-poplar
	Species			
	(- - - - - - - - - - - - - - total height (cm) - - - - - - - - - - - - - -)			
First Year				
Grass	18 a	21 a	31 b	31 b
Fern	19 a	22 ab	29 a	36 c
Grass Free	18 a	21 a	34 c	29 a
Fern Free	18 a	23 b	39 d	31 b
Second Year				
Grass	38 a	41 a	51 a	63 a
Fern	36 a	43 a	53 a	63 a
Grass Free	36 a	48 b	89 b	117 b
Fern Free	37 a	65 c	101 c	120 b

[1] Based on living trees in four replications of each treatment at each of 3 study sites; there were a maximum of 240 trees/species/herbaceous treatments. Means with same letter per species and age were not significantly different at the 0.05 level.

[2] All seedlings were about 10 cm tall at planting.

significantly taller in the Fern Free areas than in the Grass Free areas. There were no significant differences in the average second year total height values for the Fern Free and Grass Free yellow-poplar seedlings.

Most of the treatment differences for the second year average total height values among the three hardwood species were due to growth differences in the second year. The second year height increments are presented in Figure 1. Averaged over herbaceous communities, the second year height growth of the northern red oak, white ash and yellow-poplar was, respectively, 1.3, 1.8 and 3.0 times greater in the weed free than in the weedy areas. There were no differential second growing season height increments for white pine among any of the herbaceous community-weed levels; between hayscented fern and poverty oats grass for the three hardwood species; or between the Fern Free and Grass Free yellow-poplar. However, the second growing season height increments for northern red oak and white ash were greater in the Fern Free areas than in the Grass Free areas.

SUMMARY AND CONCLUSION

Herbaceous communities can stress invading tree seedlings in many ways. Water, nutrients, sunlight and allelopathy based stresses are frequently cited as explanations for reduced tree growth in herbaceous communities. This study was not designed to evaluate stress mechanisms. The study was designed to determine the effect of herbaceous communities on the survival and growth of bareroot seedlings planted in oak sites of Pennsylvania. From our two year database, neither hayscented fern nor poverty oat grass influenced survival rates for northern red oak, white ash, white pine or yellow poplar. Survival rates were high for all treatments.

The presence of herbaceous communities did have an effect on seedling height growth. Treatment difference in total height were most apparent after the second year. In the absence of herbaceous stress, northern red oak, white ash, and yellow-poplar averaged 57, 95 and 118 cm, respectively, in total height compared to an average 42, 52 and 63 cm, respectively, in total height in the absence of herbaceous stress. The two herbaceous communities had no effect on the second year height values of white pine. Differential effects of the two types of herbaceous communitites on species height growth also occurred. Northern red oak and white ash responded with the greatest second year total height growth in the Fern Free areas, whereas the second year total height growth of yellow-poplar was the same for the Fern Free and Grass Free areas.

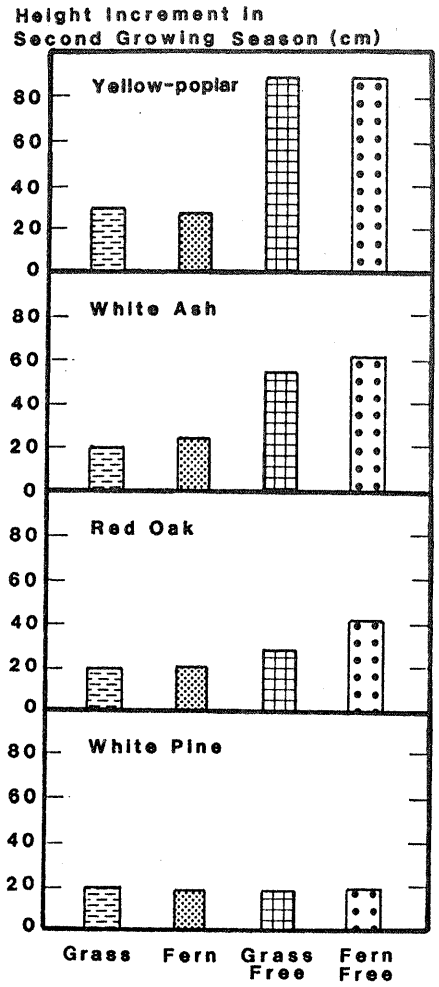

Figure 1. Average height increment in the second growing season for yellow-poplar, white ash, northern red oak and white pine by herbaceous community and weed level.

LITERATURE CITED

Francis, J. K. and D. L. Bivens.
1985. Yellow-poplar and black cherry grow well after underplanting and release. Tree Planters Notes 36:8-9.

Johnson, P. S.
1976. Eight-year performance of interplanted hardwoods in southern Wisconsin clearcuts. USDA Forest Service Res. Pap. NC-126, 9 pp.

Johnson, P. S.
1981. Nursery stock requirements for oak planting in upland forests. Proc. Northeast. Area Nursery. Conf. (Springfield, Missouri), pp. 2-19.

Johnson, P. S.
1984. Responses of planted northern red oak to three overstory treatments. Can. J. For. Res. 14:536-542.

Loftis, D. L.
1979. Northern red oak performs poorly in North Carolina planting. USDA Forest Service Res. Note SE-277, 3 pp.

McGee, C. E.
1981. Planting results on the Cumberland Plateau. USDA Forest Service Gen. Tech. Rep. NC-62, p. 24.

Russell, T. E.
1974. Weeding northern red oak plantations on the Cumberland Plateau. USDA Forest Service Res. Note SO-184, 2 pp.

Sander, I. L.
1971. Height growth of new oak sprouts depends on size of advanced reproduction. J. For. 69(11):809-811.

von Althen, F. W.
1977. Hardwood planting in Ontario. Forest. Chron. 53(4):1-6.