ESTABLISHMENT AND EARLY RELEASE OF UNDERPLANTED JAPANESE LARCH WITH SOIL-APPLIED FENURON

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Japanese larch *(Larix leptolepis,* Sieb. and Zucc.) has been used for afforestation on a wide variety of sites and climatic regions throughout the Northeastern United States. This species was first planted in Pennsylvania in 1909 (2). The majority of early larch plantings was confined to abandoned farmlands, although in recent years Japanese larch has been one of the fastest growing species when planted on strip mine spoil areas (4). Because of its high yield of wood per acre, acceptable pulping characteristics, and suitability for genetic improvement, this species will undoubtedly be planted more extensively in the future.

In spite of their desirable characteristics, the exotic larches have developed a reputation for being temperamental and difficult to establish (6). However, in a species comparison test made in New York State, Japanese larch, after seven growing seasons, showed greater resistance to frost heaving, better growth and site adaptability than red pine *(Pinus resinosa* Ait.), jack pine *(Pinus banksiana* Lamb.), white spruce *(Picea glauca* (Moench) Voss, white cedar *(Thuja occidentalis L.),* and European larch *(Larix decidua* Mill.). Japanese larch will tolerate a wide range of soil conditions, though it appears to grow best on a deep, well-drained, sandy loam having a pH of approximately 5.0 (2).

In another study in New York State, Japanese larch outgrew its near relatives, European *(Larix decidua* Mill.) and Dunkeld *(Larix eurolepis* Henry) larches, by producing a maximum growth of 15.5 feet in 5 years and an average height of 9.9 feet during the same period (1).

The effects of scrub oak competition on the height growth and survival of Japanese larch have been demonstrated by McNamara and Reigner (5). This species grew best when planted under the most intensive site preparation treatments and declined in growth as the native vegetation recovered. According to these investigators, the results support the theory that competition is a chief inhibiting factor and that Japanese larch is noted for its inability to withstand competition.

Nonliquid, pelleted, and granular herbicides may be for the land manager a valuable new method for partial or complete elimination of low-grade hardwoods to establish forests of more rapidly growing coniferous trees (7). Although pelleted and granular herbicides are ordinarily considered nonselective, by "suitable choices of ingredient, dosage, method and time of application, a wide range of effects from total (non-selective) to selective control may be achieved" (8).

The key to efficiency and economy in applying these materials largely depends upon a knowledge of their crown defoliation effects under various methods, herbicide rates, and spatial distribution.

In the successful conversion of native northeastern hardwood stands to pine, or other coniferous species, provision must be made for creation of favorable environmental conditions, adequate growing space, and reduction of competing vegetation to allow near maximum growth of newly planted or

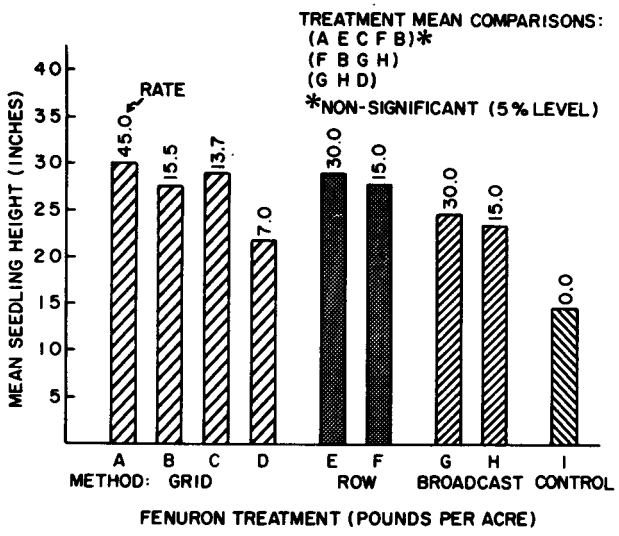

Figure 1.—Mean seedling heights by fenuron rate and method of application (after three growing seasons).

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seeded trees. During the early stages of plantation establishment, the physiological tolerance of the underplanted seedling to changing defoliation levels in the overstory is a critical factor.

This experiment studied the ecological effects of hardwood overstory and shrub defoliation created by various applications of pelleted fenuron herbicide, and the relationship of defoliation to early height response of underplanted two-year-old Japanese larch seedlings (fig. 1). The results show that the choice of herbicide, its method and rate of application, and spatial distribution are controlling factors in the creation of favorable defoliation levels in harmony with the silvical requirements of the newly established seedling.

Procedure

In May 1965, two-year-old Japanese larch seedlings were planted beneath a canopy of a low-grade mixed oak-hickory stand located on State Forest lands near Philipsburg, Penn. The seedling stock of known geographic seed source was grown at the Penn Nursery, Centre County, Pa.

The dominant hardwood overstory vegetation on the experimental area consisted of pole-sized white, scarlet, red, and chestnut oaks with occasional hickories and sassafras. The principal understory shrubs were witch hazel and dogwood. Seedlings were underplanted with a planting bar at a 6 by 6-foot spacing. Elevation above sea level at the planting site is approximately 1,900 feet, and locally, the topography is gentle-to-rolling. The soils are highly acid, well-drained, sandy loams and loam, derived from underlying sandstone and shale.

To test the conversion method, nine duplicate one-tenth acre plots, including controls, were assigned at random on the experimental site. Each plot was designated as a treatment (method per rate) combination. Approximately, 1 month following planting, all plots were treated with 25 percent active pelleted formulation of fenuron (3phenyl-1, 1-dimethylurea). The herbicide was applied directly to the soil surface by hand at varying rates per acre for each treatment as follows: Grid (7.0, 13.7, 15.5, and 45.0 lbs.), row (15.0 and 30.0 lbs.) and broadcast (15.0 and 30.0 lbs.). Two plots, untreated and planted, were designated as controls.

On year after treatment, a complete inventory of overstory competing hardwood trees and understory shurbs was made. Trees and shrubs were tallied individually for each treatment according to species, number, crown class, basal area, and percent of crown defoliation.[2] The distribution of overstory and understory vegetation by treatment, species, number, and basal area per one-tenth acre plots is presented in table 1. Likewise the planted Japanese larch seedlings were inventoried by number surviving and height (fig. 2). Seedling height measurements were obtained 28 months after planting, or at the termination of three growing seasons.

Results

Crown defoliation related to species and treatment.-An analysis of variances of the mean crown

[2] **Percent crown defoliation is here defined as an ocular estimate of the proportion of total crown per tree or shrub defoliated.**

Figure 2.—Height growth of underplanted Japanese larch after treatment of competing hardwoods with pelleted fenuron herbicide.

TABLE 1.—*Distribution of overstory and understory vegetation by treatment and species composition*

Treatment method and rate (lbs./acre) [1]	Species												Mean treatment	
	White oak		Red oak		Chestnut oak		Red maple		Hickory		Witch hazel			
	Number and basal area in square feet per plot [2]													
Grid														
45.0	(45)	4.458	(37)	8.925	(15)	1.310	(11)	0.951	(6)	0.247	(66)	0.273	(90)	8.082
15.5	(71)	6.883	(30)	6.893	(5)	0.539	(13)	0.832	(2)	0.027	(86)	0.551	(103)	7.862
13.7	(54)	5.067	(43)	10.064	(3)	0.041	(2)	0.698	(7)	0.140	(68)	0.236	(89)	8.123
7.0	(54)	6.123	(23)	6.402	(21)	2.205	(3)	0.512	(1)	0.054	(90)	0.317	(96)	7.806
Row (Band)														
30.0	(20)	2.144	(48)	13.047	(15)	1.443	(11)	0.695	(12)	0.210	(85)	0.441	(95)	8.990
15.0	(67)	5.392	(35)	7.574	(2)	0.545	(10)	0.815	(4)	0.119	(49)	0.131	(84)	7.288
Broadcast														
30.0	(72)	4.761	(37)	10.847	(6)	0.321	(3)	0.207	(4)	0.272	(69)	0.422	(95)	8.415
15.0	(56)	6.509	(23)	6.251	(2)	0.403	(15)	0.247	(4)	0.544	(53)	0.196	(77)	7.075
Control														
0.0	(48)	4.776	(28)	7.329	(0)	—	(3)	0.294	(7)	0.079	(54)	0.212	(70)	6.345
Mean-species	(54)	5.124	(34)	8.592	(8)	0.756	(8)	0.583	(5)	0.188	(69)	0.309	—	—

[1] 25 percent active ingredient (Fenuron).

[2] Mean values of duplicate one-tenth acre plots.

defoliation by treatment, species, and crown class indicated that highly significant differences existed for treatment and species. A highly significant interaction between treatment and species was found, indicating that differences in crown defoliation of individual treatments were the result of differences in species susceptibility.

Of the six species represented in the total experiment, chestnut oak *(Quercus prinus L.)* was defoliated at the highest level for combined treatments (table 2). There were no significant differences in crown defoliation between or among chestnut oak *Quercus prinus,* red maple *(Acer rubrum L.),* white oak *(Quercus alba L.),* and red oak *(Quercus* spp.). All the foregoing species, however, were significantly different from witch hazel *(Hamamelis virginiana L.)* and hickory *(Carya spp.)* .

Among the eight treatments, high rates of fenuron for a given method of application showed increased levels of defoliation with increased rates. This' relationship held true for increased rates within treatments as well. The mean crown defoliation per pound of herbicide applied by the broadcast method was slightly less than that obtained with grid or row methods; however, the difference was not significant.

Treatment related to seedling height.-The height response of Japanese larch seedlings at the termination of three growing seasons showed significant differences due to fenuron treatment. Mean seedling heights were computed by dividing the total seedling heights per treatment by the number of surviving seedlings. An analysis of the mean seedling heights indicated that all treatments significantly produced greater heights than the untreated controls (fig. 1). Among the four grid applications, there were no significant differences in height between the 45.0, 15.5, and 13.7 pound per acre rates, and all three rates were significantly superior to the 7.0 pound rate. For row applications, no differences in height growth were apparent between the 15.0 and 30.0 pound rates. Since no significant difference existed between the grid-13.7 pound application and the 15.0-pound row application, these two treatments appeared to be the most effective in terms of height development at this stage of stand establishment. The 3-year height growth of a Japanese larch seedling, after treatment of competing hardwoods with 15.0 pounds of pelleted fenuron applied by the grid method, is illustrated in figure 2.

Fenuron rate and placement related to seedling

TABLE 2.—*Percent crown defoliation by treatment, species, and crown class*

Species and crown class[2]	Method: lbs./acre:	Grid[1] 45.0	Row 30.0	Broad-cast 30.0	Grid 15.5	Row 15.0	Grid 13.7	Broad-cast 15.0	Grid 7.0	Mean crown class	Mean species[3]
Chestnut oak											
Dom.		93	67	—	80	20	—	100	44	61	
Int.		88	94	60	50	—	—	90	34	62	65
Supp.		80	80	30	65	—	77	—	63	68	
Red maple											
Dom.		63	95	90	90	63	0	52	25	56	
Int.		10	90	90	32	90	—	40	100	54	59
Supp.		80	40	90	68	26	—	80	—	62	
White oak											
Dom.		75	75	81	67	37	57	63	34	60	
Int.		73	70	58	65	57	57	48	35	55	58
Supp.		64	52	64	59	56	60	62	51	60	
Red oak											
Dom.		65	55	59	60	61	49	41	31	54	
Int.		71	68	73	58	62	69	55	40	65	57
Supp.		85	82	85	80	85	50	—	80	75	
Hickory											
Dom.		—	—	—	—	—	—	10	—	10	
Int.		50	—	80	—	10	10	—	10	40	43
Supp.		62	69	15	40	30	20	5	—	46	
Witch hazel											
Dom.		73	41	22	20	14	19	60	8	26	26
(Understory)											
Mean treatment[4]		71	54	48	44	43	40	37	25		

[1] Duplicate blocks per treatment.

[2] Society of American Foresters. 1958. Forestry terminology: A glossary of technical terms used in Forestry. Dom.—Dominant: Int.—Intermediate: Supp.—Suppressed.

[3] and [4] Any two means having a common line are *not* significantly different (5 percent level). Duncan, D. B. 1955. Multiple range and mulitple F tests (4).

height.-Height response among the eight grid treatments varied inversely with the amount of fenuron applied per spot (at each of the four corners of the square) and its spatial distribution. The height response common to a given number of grams per spot was found to be significantly correlated with both the 6 by 6 and 12 by 12 foot spacings (fig. 3). A comparison in height between the two spacings (based upon 4 duplicate plots per spacing) indicated that a better height response was obtained with pellets applied to the soil at a 6 by 6 foot interval. Under the vegetative competition levels of this test, a mean height advantage of 2.4 inches in favor of the 6 by 6 foot spacing was obtained after the third growing season. Thus, for grid applications of pelleted fenuron herbicide, the height response resulting from the indirect effects of hardwood defoliation were correlated with reasonable precision from two independent variables, rate and spacing. The percent of total variation in seedling height accounted for by nine independent variables was assessed initially by multiple correlation techniques. Simple correlation coefficients derived from these data were used as a preliminary guide to the relationships among the independent variables tested. Analyses of variance methods were then used to determine the significance of independent variables, and the separation of individual treatment means was subjected to Duncan's New Multiple Range Test (3).

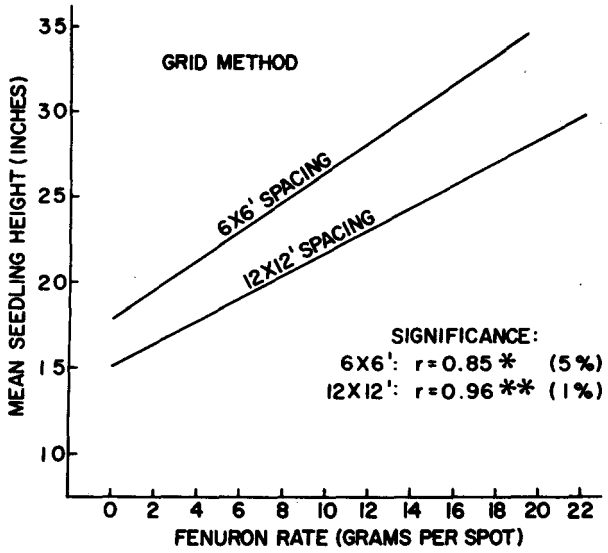

Figure 3.—Mean seedling heights in relation to fenuron rate and spacing for grid method of application (after three growing seasons).

Data obtained in these exploratory trials, and under the ecological stand conditions at time of testing, show that soil-applied fenuron pellets are effective in the establishment and early release of underplanted two-year-old Japanese larch seedlings from six species of competing low-grade hardwoods.

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Appendix

Some useful weights, measures, and doseages for fenuron (Dybar)

1 lb. Dybar	=¼ lb. fenuron =8000 pellets (Dybar) =453 gms. (Dybar) =61 heaped teaspoonsful =80 level teaspoonsful
1 heaped teaspoonful	=7.3 gms. (Dybar) =130 pellets
1 level teaspoonful	=5.6 gms. (Dybar) =100 pellets
1 gm. Dybar	=18 pellets

For grid applications:

Lbs./acre[1]	Spacing (feet)	Spots (number)	Spot (grams)
45	3 by 3	4840	4.2
45	6 by 6	1210	16.8
15	3 by 3	4840	1.4
15	6 by 6	1210	5.6

[1] Bulk weight (25 percent active ingredient).