TIME OF FERTILIZER APPLICATION AFFECTS SIZE OF CONIFER SEEDLINGS

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Studies of fertilizer use in Ontario have indicated that time of fertilizer application may markedly affect both seedling quality, in particular nutrient content, and size. Further, a previous study (Armson 1960) of nutrient uptake in white spruce indicated that although the uptake rate for nitrogen, potassium, and phosphorus was maximum early in the growing season and decreased with time, the phosphorus uptake increased again in mid-August to September, while the other two did not. Another observation was that white spruce growth, as dry weight, increases almost linearly with time until freezeup; thus, the growing season is much longer than was formerly thought.

The present study was made at Swastika Nursery (approximate latitude 48° N.). Seedbeds of four species--red and white pine and black and white spruce--were used. During the first and second growing seasons a given amount of fertilizer was applied to the seedlings in one, two, three, or five applications between May and September. The object of this study was to determine what effects these treatments would have on seedling growth.

Soil management immediately prior to seedbed formation in the fall of 1959 consisted of the following applications: 300 pounds of 0-30-10 fertilizer, 350 pounds of triple superphosphate, and 200 pounds of urea formaldehyde. These fertilizers contained the following pounds per acre of major nutrients: nitrogen, 78; phosphorus, 110; and potassium, 25. The soil was a fine, sandy loam with a pH of approximately 4.5 to 5.0. This nursery had not previously grown a seedling crop; the previous cover was a natural jack pine stand.

During the 1960 (first) growing season 40 pounds of nitrogen per acre was applied as ammonium sulfate, 90 pounds of phosphorus per acre as triple superphosphate, and 28 pounds of potassium per acre as potassium sulfate. These rates are the total amounts that each treatment plot received during the season. The fertilizers were applied as a top dressing and watered-in. During the first year all seedlings were shaded by lath screens which passed approximately 50 percent of the total light.

At the beginning of the 1961 (second) growing season the seedlings were thinned to a density of approximately 35 per square foot and were unshaded. For red pine 100 pounds of nitrogen was applied per acre as ammonium sulfate and 90 pounds of phosphorus per acre as triple superphosphate. For the other three species the corresponding rates were (nitrogen) 60 pounds and (phosphorus) 90 pounds. No potassium was applied.

The size of each treatment plot was 2.44 square yards, and each treatment was replicated three times. Details of treatments are given in table 1. In October 1960, 30 seedlings of each species were sampled from one replication of each treatment plot, and mean seedling dry weights top/root ratios, and foliage concentrations of nitrogen, phosphorus, and potassium were determined.

In October 1961, 20 seedlings were selected at random from each plot for the three species--red pine, black spruce, and white spruce. Mean seedling dry weights and top/root ratios (weight basis) were measured.

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Results

Mean seedling dry weights, top/root ratios, and foliage concentrations (percent ovendry weight) of nitrogen, phosphorus, and potassium are given by species in tables 2-5. The data for 1960 are for samples from only one replication; those for 1961 are for all plots and were subjected to statistical analysis.

The 1960 results show that for red pine the early applications (A, B, and D) have produced the largest seedlings, and that of the late treatments only E has resulted in an increase in size compared with the control. Treatment E also resulted in a large top/root ratio. As expected late fertilizer treatments (E and F) have resulted in higher foliage nitrogen concentrations, but the concentrations of phosphorus and potassium were not increased. Results for white pine are somewhat similar to those for red pine. Early treatments A and D have resulted in the largest seedlings, and early plus late treatments B and C have resulted in intermediate size seedlings. Late fertilizer treatments increased the foliage nitrogen concentrations but had no effect on seedling size.

TABLE 1.--Fertilizer application dates for all species

Treatment plot	1960					1961				
A.....	--	June 28	July 21	--	--	--	June 18	July 14	--	--
B.....	June 7	do	do	Aug. 8	Sept. 1	May 25	do	do	Aug. 15	Sept. 7
C.....	--	do	do	--	do	--	do	do	--	do
D.....	June 7	do	do	--	--	May 25	do	do	--	--
E.....	--	--	--	Aug. 8	Sept. 1	--	--	--	Aug. 15	Sept. 7
F.....	--	--	--	--	do	--	--	--	--	do
Control...	--	--	--	--	--	--	--	--	--	--

TABLE 2.--Results, red pine

Treatment plot	1960					1961	
	Mean dry weight	Top/root ratio	Nitrogen	Phosphorus	Potassium	Mean dry weight	Top/root ratio
	Grams		*Percent*	*Percent*	*Percent*	*Grams*	
A.....	0.310	2.12	2.51	0.29	0.84	2.25	5.16
B.....	.299	1.91	2.58	.31	.77	2.45	5.27
C.....	.259	2.21	2.66	.29	.82	2.06	5.24
D.....	.299	2.20	2.41	.27	.63	2.69	5.28
E.....	.217	2.64	3.31	.30	.83	1.37	4.19
F.....	.177	2.26	3.46	.30	.80	.98	3.96
Control.....	.179	2.02	2.57	.27	.96	.87	3.68

TABLE 3.--Results, white pine

Treatment plot	1960[1]				
	Mean dry weight	Top/root ratio	Nitrogen	Phosphorus	Potassium
	Grams		*Percent*	*Percent*	*Percent*
A.....	0.205	1.52	2.59	0.29	0.80
B.....	.168	1.56	2.59	.31	.82
C.....	.182	1.57	2.84	.34	.90
D.....	.243	1.53	2.31	.34	.95
E.....	.151	1.83	3.40	.30	.91
F.....	.120	1.48	2.97	.34	.80
Control.....	.153	1.52	2.78	.26	.65

[1] 1961 results not sampled.

TABLE 4.--Results, black spruce

Treatment plot	1960					1961	
	Mean dry weight	Top/root ratio	Nitrogen	Phosphorus	Potassium	Mean dry weight	Top/root ratio
	Grams		*Percent*	*Percent*	*Percent*	*Grams*	
A.....	0.040	3.21	1.70	0.36	1.30	0.99	3.02
B.....	.061	3.71	2.28	.42	1.21	1.46	3.20
C.....	.051	3.29	2.42	.47	1.33	1.15	2.78
D.....	.053	3.26	2.03	.41	1.22	1.42	3.16
E.....	.039	3.76	2.79	.35	1.16	.40	2.37
F.....	.043	3.27	3.33	.38	1.27	.26	2.41
Control....	.016	2.55	2.47	.39	1.43	.17	2.11

TABLE 5.--Results, white spruce

Treatment plot	1960					1961	
	Mean dry weight	Top/root ratio	Nitrogen	Phosphorus	Potassium	Mean dry weight	Top/root ratio
	Grams		*Percent*	*Percent*	*Percent*	*Grams*	
A.....	0.063	3.37	2.28	0.36	0.88	1.22	3.07
B.....	.093	3.30	2.39	.34	.96	1.61	2.95
C.....	.092	2.87	2.54	.46	1.25	1.28	3.05
D.....	.076	2.67	1.75	.31	1.08	1.39	3.07
E.....	.049	1.78	2.81	.41	.95	.75	2.33
F.....	.063	2.48	3.04	.40	.89	.61	2.65
Control....	.036	2.03	2.10	.39	1.11	.35	1.66

The results for black spruce in 1960 show the largest seedling to be produced by the B treatment, but late applications (E and F) have resulted in considerable seedling growth response as compared with the control. Only nitrogen foliar concentrations were increased by late fertilizer applications. Treatments B and E resulted in the highest top/root ratios. The white spruce results show that the largest seedlings were produced by treatments B and C, and that late treatments E and F noticeably increased seedling size. As with the other species late fertilization increased the foliar nitrogen concentrations.

In 1961 the red pine mean dry weights were affected markedly by treatments. Treatments B and D produced the largest seedlings, and the single late application (F) did not result in an increase in seedling size compared with the control. The top/root ratios of the four largest seedlings do not differ markedly.

For black spruce (1961) treatments B and D resulted in the largest seedlings. Late treatment E resulted in a significantly larger seedling than the control. As with the red pine, the largest top/root ratios are associated with the largest seedlings. For the white spruce treatments B and D produced the largest seedlings, and late treatments E and F resulted in larger seedlings than the control. The largest top/root ratios are similar and associated with the largest seedlings.

Discussion

From the results it may be concluded that for all species those treatments which incorporated the earliest fertilizer application (Band D) resulted in the largest seedlings. A distinction between the pines and the spruces is indicated in terms of growth response to late fertilizer applications (E and F), the pines showing much less response than the spruces, especially white spruce. For example, although at the end of the second year treatment E had increased growth for red pine by 57percent, for white spruce treatments • and F have increased growth by 114 and 74 percent, respectively, over that of the control. For black spruce treatments E and F have increased growth by approximately 130 and 52 percent, respectively, over the control.

From data obtained by the end of the first growing season it can be concluded that late fertilizer applications resulted in increased foliage nitrogen concentrations in all species, but there was no corresponding increase in phosphorus and potassium concentrations. The lack of increased uptake of phophorus by white spruce, as indicated by foliage concentration, may be associated with the fact that phosphorus applied at the surface of the soil is not readily moved within the rooting volume of the soil.

During the late fall and early summer of each year the seedlings were inspected for evidence of low-temperature injury, particularly those on plots which received early or late fertilizer treatments. However, no signs of damage from these treatments were found, even though as many as 14 degrees of frost were recorded during the fall of 1961 at the nursery.

The results from this study indicate that the size and nutrient status, particularly nitrogen concentration, may be controlled by the nurseryman by varying the times during the growing season that a given amount of fertilizer is applied. Both white and black spruce seem more susceptible to manipulation of treatment than white and red pine.

Literature Cited

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