THE EFFECTS OF VARIOUS INTENSITIES OF LIGHT ON THE GROWTH OF FOUR SOURCES OF BLACK CHERRY

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INTRODUCTION

The value of black cherry (Prunus serotina Ehrh.) as a desirable component of the Allegheny Plateau hardwood forest has been well established (Hough, 1960). Although it reproduces well naturally both from sprout growth and seed, artificial regeneration techniques must be developed if genetically improved trees are to be introduced. Black cherry is classified as an intolerant species (Baker 1950, Fowells 1965, Spurr and Barnes 1973) but seedlings show some degree of tolerance during the first few years after germination (Fowells 1973). Tryon has observed that seedling black cherry may survive under the overstory 5 years or more. Tryon and Carvell (1958) noted that black cherry in northern West Virginia makes up a significant part of the understory vegetation.

Early survival and growth is important for the development of artificial regeneration techniques. If a strain of an intolerant species could be identified that will survive and grow well in shade, it would give the silviculturist more latitude in developing artificial regeneration techniques.

Artificial shade provided by some type of shade frame has been used as one method of studying tolerance and the effect of various light intensities on seedling survival and growth. Conditions in this type of study differ mainly from natural forest conditions in that root competition has been eliminated. Shirley (1945) utilized various cloth materials and lath to vary the shade intensity from 11 to 98% of full sunlight. He noted that at least 20% light is necessary for satisfactory growth of red, white, and jack pine and white spruce. Logan (1965, 1973), in Canada, used large shade frames covered with lath and fiberglass screen to compare growth in full sunlight with that under light intensities of 13, 25, and 45% of full sunlight with several species. He concluded that for the intensities tested, 45% of full sunlight was the best for the several hardwood species studied. Seed was apparently from local seed sources.

The fact that there is considerable geographic variation in most species is well documented. This is true of black cherry (Brown and Cech 1972, Cech and Kitzmiller 1968, Farmer and Barnett 1972, Genys 1963, Genys and Cech 1975, Pitcher and Dorn, 1972, Wright and Lemmion 1972). With the considerable geographic variation and the wide range of black cherry it is conceivable that there might be differences in tolerance attributable to source which could be utilized for improving artificial

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regeneration techniques. It is also of interest to determine at what specific level of shade black cherry seedlings perform best, The experiment reported here is our attempt to answer these two questions.

Procedure.--Five levels of light (5, 10, 20, 50 and 100%) were selected for testing using Saran shade cloth woven to the appropriate densities. The cloth for each treatment was fastened tightly over an 8-foot square angle iron frame at a height of 5 feet and draped over the sides of the frame to the ground. Preliminary tests indicated that unacceptable levels of heating occurred, especially in the high density shade. Therefore the shades were shortened so that the bottom of the cloth was approximately 6 inches from the ground to allow wind movement and cooling. While some air temperature increase was apparent under these conditions, it was neither consistent nor was it considered to be excessive (a variation of 5-8 ° F among treatments was found, the control being greatest in one case, but intermediate among treatments in all others). Actual light readings taken at 5 points under each shade cloth and averaged over treatments were 4.8%, 7,4%, 31%, and 53%.

The five treatments were randomized in five replications on a portion of the West Virginia University Horticulture Farm near Morgantown, West Virginia. The soil is a heavy clay loam with fair drainage.

One-year-old greenhouse grown seedlings from four widely separate seed sources (Alabama, Illinois, West Virginia and New Hampshire) were planted in May 1973. First-year measurements were made in July and November 1973, reflecting early and seasonal height growth. Second-year height and diameter measurements were made in November 1974,

Data were analyzed using the analysis of variance program of the SAS system developed by Barr and Goodnight as implemented by the West Virginia University Computer Center.

Results.--All three height and the 1974 diameter measurements (Table 1 and 2) were significant at the .01 level for treatment and source. Percent survival, (Table 1 and 2) although it differed somewhat among treatment and source, was not statistically significant at the ,01 level. Height in November 1973 is presented by treatment and source (Table 3). At the end of one year there was no genotype - environment interaction apparent. Height in 1974 is presented by treatment and source (Table 4, figure 1). Although there is some genotype - environment interaction, this is barely significant at the 10% level.

Discussion.--Since black cherry is a relatively intolerant species, one would expect little growth under dense shade, improving as light increases. This, in fact, is what occurred. Our results differ from those of Logan who noted that 45% of full sunlight was optimum for white ash, beech, silver maple, white birch, yellow birch, and sugar maple. Of these species, only white birch is intolerant and yellow birch and white ash are moderately tolerant. The others are tolerant species. The best growth of black cherry is in full sunlight.

Table 1.--Average height, diameter at root collar and survival, by treatment.

% Light	Height (cm) 7-73	11-73	11-74	Diameter (cm) 11-74	Survival % 11-74
4.8	5.4	6.5	15.1	.22	67.7
7.4	5.7	6.5	17.0	.23	65.2
31.0	9.8	14.2	48.8	.49	77.9
53.0	13.3	21.3	77.1	.83	76.5
100	15.5	35.8	118.7	1.42	67.8

Table 2.--Average height, diameter at root collar and survival, by source.

Source	7-73	11-73	11-74	Diameter (cm) 11-74	Survival % 11-74
Ala.	13.6	24.7	67.5	.68	77.6
Ill.	10.5	17.2	63.8	.81	58.3
N. H.	7.6	12.3	42.2	.53	68.4
W. Va.	7.2	11.0	51.5	.63	75.5

Table 3.--Height (1973) by treatment and source.

Source	Treatment % Light 4.8	7.4	31.0	53.0	100
Ala.	9.2	9.8	22.9	36.4	64.2
Ill.	8.4	8.1	21.8	35.1	44.7
N. H.	6.0	6.4	10.8	16.3	35.6
W. Va.	5.7	5.8	7.9	13.7	32.0

FIGURE 1 AVERAGE HEIGHT BY SOURCE – 1975

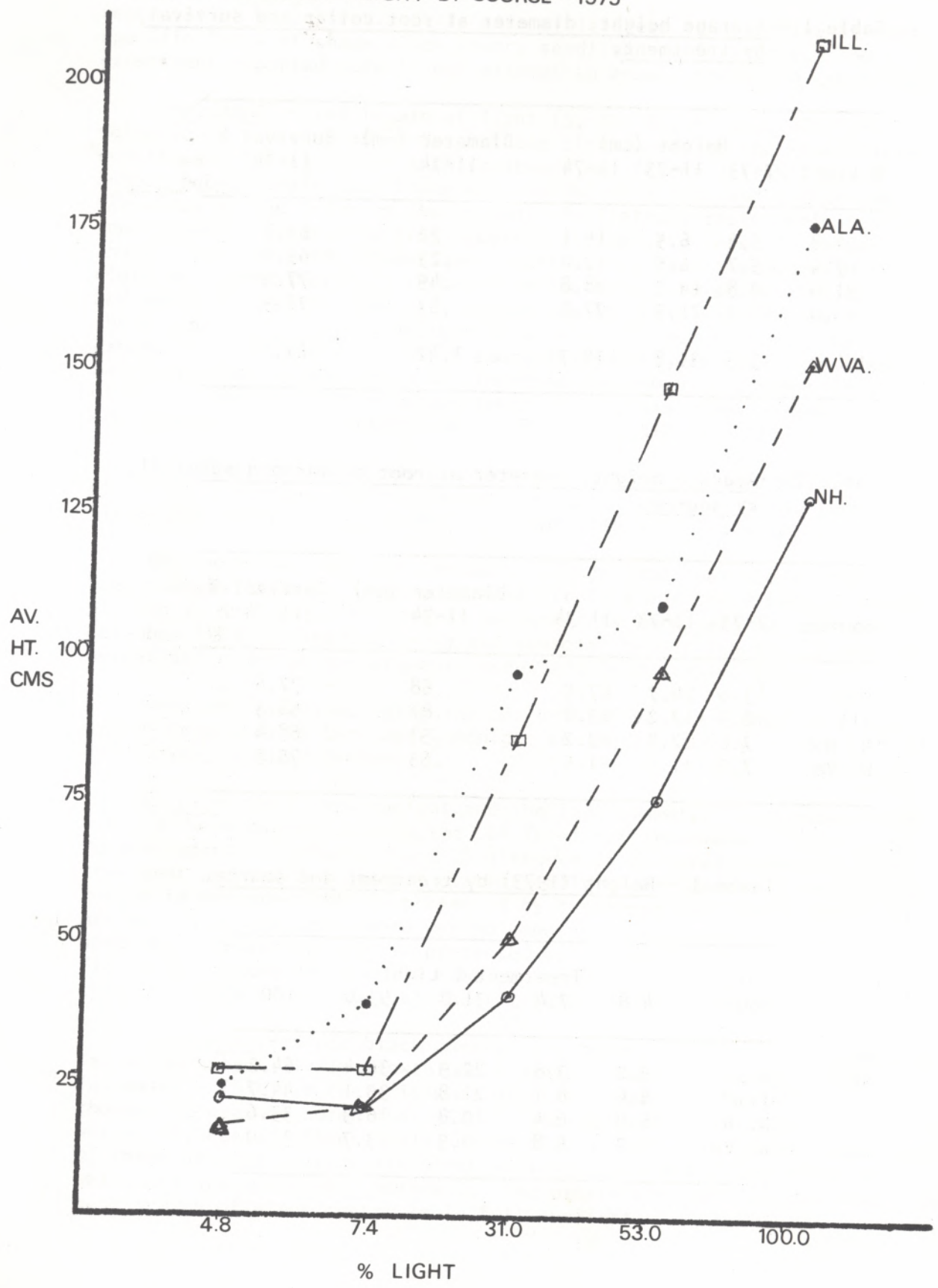

Table 4.--Height (1974) by treatment and source.

Source	Treatment & Light 4.8	7.4	31.0	53.0	100
Ala.	22.8	36.7	96.4	108.12	175.2
Ill.	26.3	25.6	84.2	146.8	206.2
N. H.	21.3	19.6	39.4	73.5	126.3
W. Va.	16.4	19.7	49.3	96.9	151.0

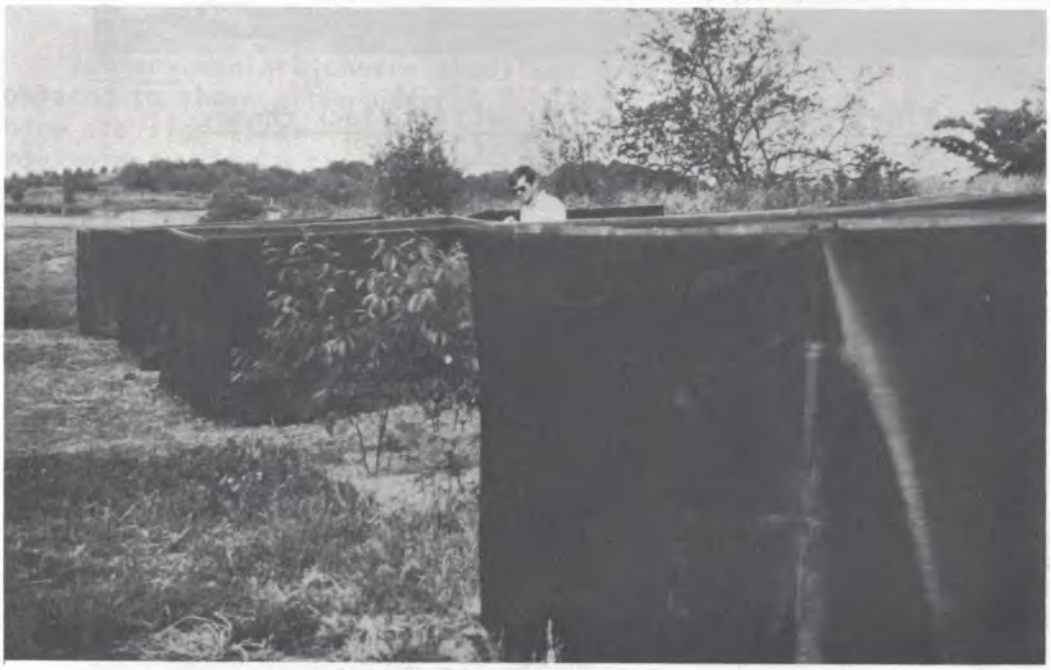

Figure 2.--Replication 1. Right to Left, shades giving: 7.4, 100, 53.0, 4.8, and 31.0 percent of full sunlight.

Figure 3.--Plot d, replication 3. Growth of black cherry seedlings under full sunlight.

Figure 4.--Plot C, replication 3. Growth of black cherry seedlings under 31.0 percent of full sunlight.

The seed sources were arbitrarily selected so as to sample the extremes of the range, and there are significant differences due to source, At three years of age the Illinois source is the tallest and has the greatest diameter. The Alabama source, is next, followed by the local West Virginia source and the New Hampshire source, These results are similar to those from a Maryland planting reported by Genys and Cech (1975) at 5 years from transplanting (6 years from seed) where the same Illinois and Alabama sources were the tallest followed by the West Virginia source, While the most northerly source in the Maryland study was from Vermont, it was the slowest growing as was the New Hampshire source in this study.

There is only a suggestion of genotype - environment interaction, this being evident at the lower light levels and, while it is only significant at the 10% level, bears some mention, This is probably one of those non-interpretable situations that can be added to those presented by Wright (1973), Apparently there is insufficient genotype - environment interaction to make tolerance a useful characteristic in developing artificial regeneration techniques.

Summary.--Black cherry seedlings grow best under full sunlight as compared to those grown under 4.8, 7.4, 31.0, and 53.0% of full sunlight. There are significant source differences, the local source (W. Va.) growing more slowly than the most western (111.) or the most southern (Ala.). The most northerly source (N.H.) grew the slowest. There is some suggestion of genotype - environment interaction which is not interpretable.

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