SELECTION EFFICACY IN YOUNG BLACK CHERRY PROGENY TESTS[1/]

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Abstract.-- Opportunities for juvenile selection in *Prunus serotina* Ehrh. progeny tests were examined among 35 open-pollination families and 12 comparison populations at three sites. There was large variation in height among genotypes at ages 1, 2, 3, and 5. During these years the ranking of some families shifted greatly at some sites. Also differential adaptation to two sites was observed, one having dense competing woody species and the other only low herbaceous vegetation. Other families, both fast and slow growing, were ranked similarly at the two sites. At age 5, 12 of 47 genotypes are among the tallest 15% at two locations, but only two of these have remained in the top 15% at both locations in all years. Eight of the 12 tallest genotypes changed greatly in rank among years, sites, or both. Age-age correlations of genotypes improved with age, but site-site correlations weakened. Mild juvenile selection against slow-growing families appears to be feasible, and will be more effective if it is site-specific. Substantial genotype x environment interactions indicate that adaptation to sites is an important consideration in strategies for designing and deploying improved varieties of black cherry.

Additional Keywords: juvenile selection, age-age correlations, site-site correlations, *Prunus serotina.*

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INTRODUCTION

Selection of black cherry plus trees under forest conditions is complicated by variable site conditions, ages, species composition, and spacing. Initial evaluations of open-pollination families from plus trees have been viewed (perhaps prematurely) as leading to little or no genetic gain in juvenile growth (Pitcher 1982). Yet there is ample genetic variation among black cherry provenances (Carter et al. 1983) and families (Stanton et al. 1983). So progeny tests could offer opportunities to select for fast juvenile growth and other desirable traits.

Large genotype x environment interactions found in these studies in young plantations might interfere with the effectiveness of selection. Therefore, a series of measurements taken at three locations and four ages were analyzed to examine the efficacy of juvenile selection in black cherry.

MATERIALS AND METHODS

Detailed descriptions of plant materials and plantation establishment are available elsewhere (Stanton 1984). Only the most germane facts are presented here.

Forty-seven genotypes were included, all grown in containers from seed after open-pollination. There were 21 families from 16 clones in a seed orchard, 14 families from plus trees, and 12 populations representing stands in which all but one of the 14 plus trees had been selected.

Plantations were established in June 1981 at three locations on the Allegheny National Forest. All were at similar elevations on similar soils, and had supported stands of northern hardwoods including black cherry before being clearcut several years before planting. At Blue Jay and Cozy Corner the topography is nearly flat, while at Reagan Run the slopes are 5 to 10 percent facing east and south. All sites had deer exclosures, but these did not prevent browsing of most seedlings especially in the first two years at Reagan Run and Cozy Corner; only at Blue Jay was there no browsing. But the most obvious difference at Blue Jay was that logging slash and stumps had been removed, the site was plowed and disked, and weeds were effectively controlled by an herbicide and mowing. In contrast there was dense woody and herbaceous vegetation competing with the cherry seedlings at the other two sites.

The planting design consisted of three-tree row plots in two randomized complete blocks, each with four split-plots. Nitrogen fertilizer was applied during the first two years to split-plots at four rates within the recommended range for maximum height growth (Auchmoody 1982); phosphate fertilizer was added at an optimum level. First year survival exceeded 90% at each location, but fell to 80% at Cozy Corner and 75% at Reagan Run after the second growing season.

Measurements of height were taken at ages 1, 2, 3, and 5, except at Reagan Run at age 5 because mortality was greater there and competing vegetation had become more variable in density and distribution. Mean heights of genotypes were calculated from sub-plot means, and ranked within locations and years. A split-plot analysis of variance using the general linear model procedure (SAS) was employed to determine the significance of genotype, nitrogen treatment, block, and interaction effects at each location. Consistency of performance by genotypes over locations and years was compared using Spearman rank correlations. F-values and correlation coefficients were judged significant at the 5 percent level.

DISCUSSION OF RESULTS

Different site conditions at Blue Jay versus Cozy Corner or Reagan Run provide an opportunity to compare growth rates of a sample of black cherry genotypes under contrasting silvicultural options. Cozy Corner and Reagan Fund had severe competition typical of clearcuts whereas at Blue Jay there was only low herbaceous vegetation, controlled by herbicide applications and mowing. Such thorough control of competition would be unusual under current management practices, but could be appropriate in seedling seed orchards in which selection would occur.

Genotypic variation in height was large at all sites during the first five years (Figure 1). In every analysis of variance, effects of genotypes were significant (Table 1). Likewise levels of nitrogen fertilizer influenced height, in most cases indicated by a significant nitrogen x block effect rather than a main effect of nitrogen. Genotype x nitrogen interactions were always small, however, and were barely significant in only one case. All of this bodes well for selection possibilities.

Complications arise when genotypic means are compared over different sites and years, Rank correlations of heights at Blue Jay versus Cozy Corner became increasingly weaker from 1981 to 1985, and were insignificant after 1982 (Table 2). Correlations within sites were moderately strong, ranging from 0.37 to 0.79 among age comparisons spanning two to five years (Table 2). Stanton et al. (1983) found correlations of 0.76 to 0.77 for family heights at age five versus age ten within three sites in Pennsylvania and West Virginia.

Upon closer inspection of the taller families (Table 3), presumably those of greatest interest, one finds that some rankings changed greatly with age (e.g., Nos. 4, 6, 16) and even more so between sites (e.g., Nos. 20, 38, 39, 54). Even families derived from two ramets of the same clone in a seed orchard showed striking differences (Nos. 38, 39). Nineteen of 47 genotypes were ranked higher at Cozy Corner than at Blue Jay in 1985. In fact, the absolute heights of 11 genotypes were greater at Cozy Corner where the plantation mean height was lower, illustrating considerable genotype x environment interaction. Furthermore, it appears that growth rates may still be changing differentially at the two sites (Table 3, Figure 2). It is also interesting to note that the tallest genotypes include seed orchard and plus tree families as well as comparison stand populations.

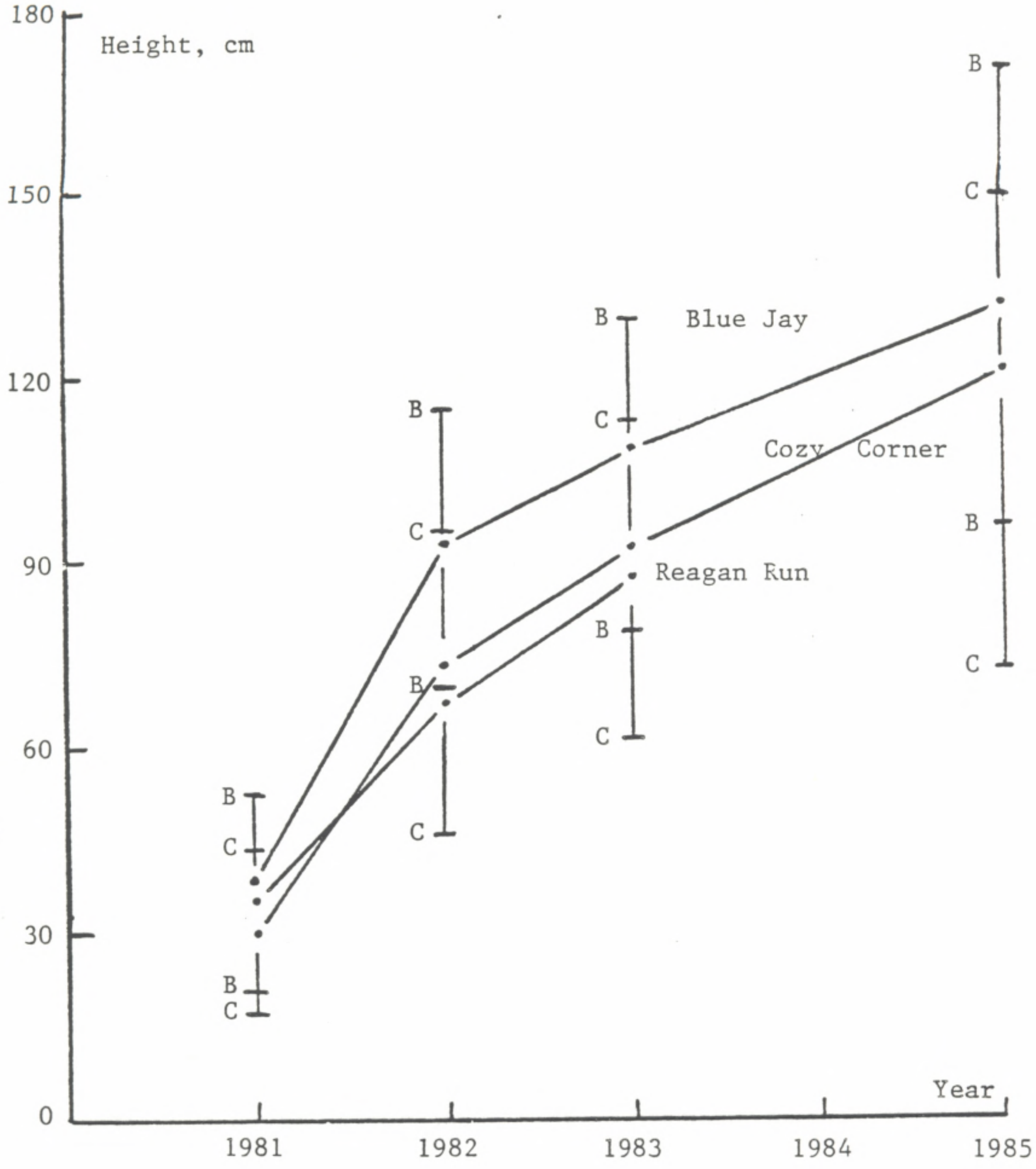

Figure 1. Mean heights at three sites, 1981-85, and ranges of genotypic means at Blue Jay (B) and Cozy Corner (C).

Table 1. F-ratios of genotype heights at three locations in three years.

Location	Year 1982	 1983	 1985
Blue Jay	2.64*	2.18*	2.85*
Cozy Corner	2.05*	1.63*	1.67*
Reagan Run	2.42*	1.71*	-

*Significant at the 0.05 level.
Block effects were not significant.
Nitrogen x block effects were significant except in one case, where nitrogen was significant.
Genotype x nitrogen effects were not significant except in one case.

Table 2. Rank correlations of genotypes comparing performance over locations and ages (Spearman coefficients).

Locations	Age 1	 2	 3	 5
Blue Jay vs. Cozy Corner	0.49*	0.29*	0.24	0.18
Cozy Corner vs. Reagan Run	--	--	0.15	--
Blue Jay vs. Reagan Run	--	--	0.07	--
	Ages 1-3	 1-5	 2-5	 3-5
Blue Jay	0.78*	0.53*	0.66*	0.79*
Cozy Corner	0.58*	0.37*	0.65*	0.75*

*Significant at the 0.05 level.

Table 3. Rankings of tallest 15 percent of genotypes at Blue Jay (B) and Cozy Corner (C) during 1981-1985.

Tallest genotypes in 1985		Type[1]	Height in 1985 cm		Rank at Blue Jay				Rank at Cozy Corner			
B	C		B	C	81	82	83	85	81	82	83	85
4		FS	150	104	7	23	10	6	2	10	29	42
	6	FS	146	142	27	17	17	8	30	17	12	5
	16	FS	133	142	6	3	3	22	8	22	17	4
19	19	PT	151	142	1	2	2	5	1	1	2	6
20		FS	156	131	9	15	8	3	34	33	40	12
21	21	PT	170	150	3	1	1	1	6	4	4	1
	35	SO	145	140	8	4	6	10	16	8	10	7
	38[2]	SO	126	149	39	42	38	34	29	5	6	3
39[2]		SO	149	115	24	22	16	7	26	30	26	34
51		SO	158	127	14	6	4	2	39	13	11	17
52		SO	155	129	16	9	5	4	13	7	9	14
	54	SO	126	150	23	36	33	33	3	11	3	2

[1] Seed origins indicated by:
SO = seed orchard
PT = plus tree
FS = forest stand

[2] These two families came from grafted ramets of the same clone, R 8.

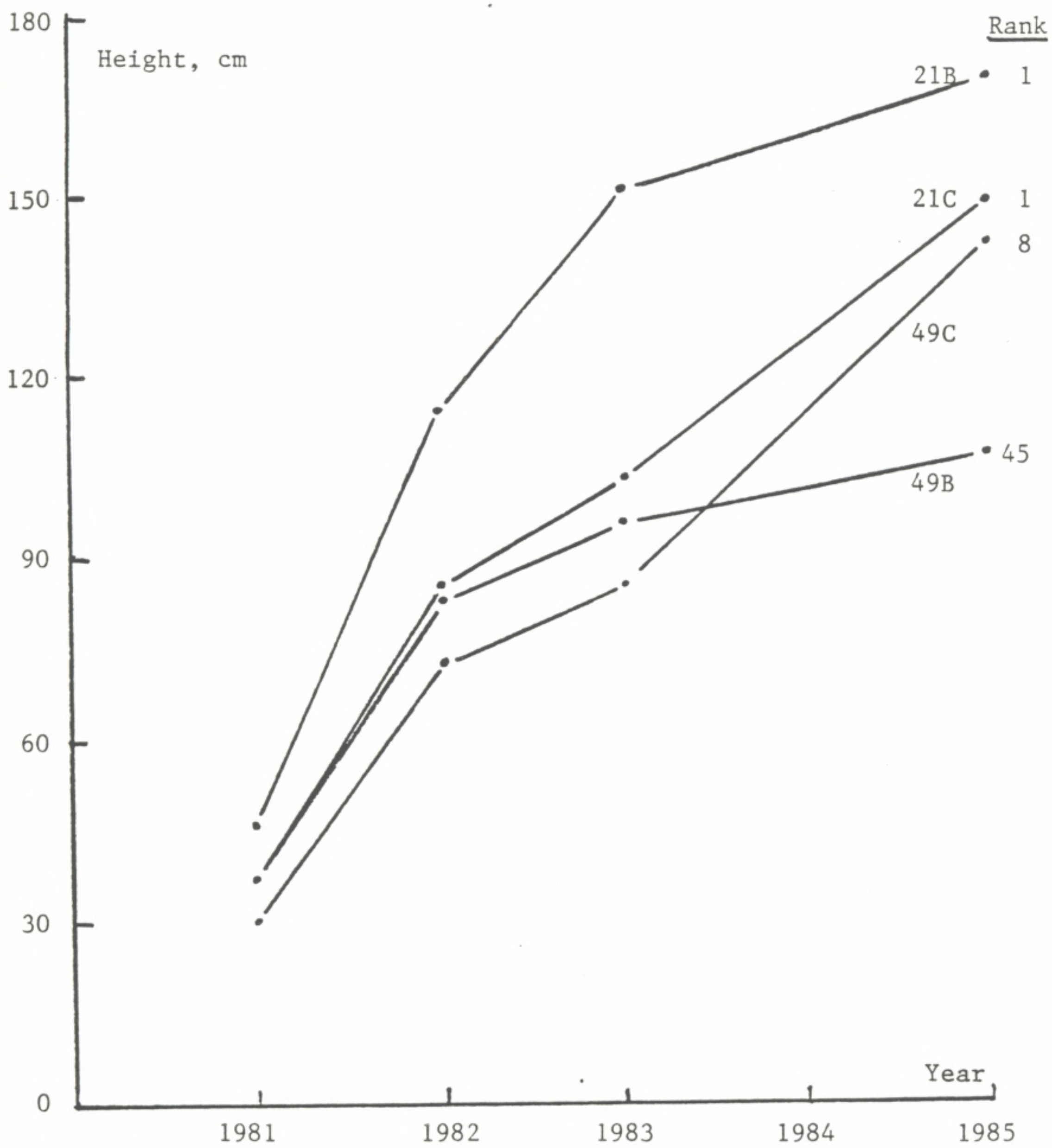

Figure 2. Differential responses in height of two families (21 and 49) to site conditions at Blue Jay (B) and Cozy Corner (C).

Despite these causes of uncertainty in juvenile selection, there are some encouraging findings. Two genotypes in particular have *performed* well at two sites (Table 3, Nos. 19 and 21). Four others at age 5 were in the top 15 percent at one site and in the top 30 percent at the other (Nos. 6, 20, 35, 52). Four of these six genotypes were the offspring of plus trees or seed orchard clones, indicating that some narrowing of genetic variability in families has not been detrimental to stability of performance. Accordingly moderate juvenile selection can be effective, thus permitting thinning of progeny tests or seedling seed orchards as crown closure occurs without removing the most promising trees.

The age at which selection will result in the greatest genetic gain per year cannot be determined until progeny tests are closer to rotation age. Additional data will be required on family means, heritabilities, and phenotypic variation during the juvenile selection period and at rotation age. In loblolly pine selection at age 8 was found to be the biological optimum to maximize gain per year, even though juvenile-mature family correlations increased subsequently above 0.71. (N.C. State University - Industry Cooperative Tree Improvement Program 1986).

CONCLUSION

Existing data give some insight into two practical matters that require attention in the meantime, before optimum age for selection can be determined. These are the thinning requirements in progeny tests and types of sites on which improved varieties may be deployed.

Thinning in black cherry progeny tests should take into account the substantial changes in family ranking that have occurred, and that are likely to continue. Accordingly, thinning should be delayed until it is clearly necessary. Then most thinning should occur within plots, and all or most families should be retained until age-age correlations become stronger. In this experiment the stand genotypes could be culled more severely than the families derived from selected trees.

An important question for selection strategy is whether a single, broadly adapted variety can be created, or whether separate varieties are needed for sites to which they are differentially adapted. Some black cherry genotypes appear to be more broadly adapted than others, so varieties having broad or narrow site adaptability appear to be biologically feasible. It would be useful to classify families according to this characteristic, whether or not it is practical to develop more than one improved variety under current conditions.

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