VARIATION AMONG PROGENIES OF PINUS STROBUS CLONES FROM SEVERAL NORTHEASTERN SEED ORCHARDS [1]

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Abstract. A progeny test growing east of Annapolis, Maryland from seed collected in 11 northeastern seed orchards is yielding valuable data for nurserymen and growers of ornamental and Christmas trees. These data are the result of five years' performance of over 90 open-polinated progenies of Pinus strobus including some commercial (control) seedlots from native stands. Although survival ranged between 50% and 100%, these differences were not statistically significant at the 0.05 level. Five-year heights of individual progenies ranged from 68% to 138% of the test mean (60 cm). The most rapidly growing progenies came from a seed orchard in Maryland, a North Carolina stand, and a bulked mix of orchard seed from Tennessee. These young trees are already demonstrating many of the characteristics sought by growers of ornamentals. Foliage color of different sources ranged from yellow to blue-green. Those sources most consistently exhibiting the blue-green needle color were from native stands in North Carolina and several clones from seed orchards in Maryland and Pennsylvania.

INTRODUCTION

Eastern white pine (Pinus strobus L.) is still one of the most widely planted tree species in the northeastern U.S.A. and southeastern Canada. Consequently, large amounts of seed must be collected. There are several advantages in obtaining seeds from selected clones planted in seed orchards. One advantage in addition to easier harvest is improved genetic quality of seeds which depends on the quality of the selected clones and the method of progeny testing. Crossing each clone with all other clones should result in the most reliable progeny evaluation. This is also the most difficult and expensive method. One commonly used method of information is to compare open-pollinated clonal progenies. In this case the paternal parent is unknown.

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This report is based on studies using such open-pollinated clonal progenies from several seed orchards in the northeast. Earlier nursery studies showed significant variations in growth rate and other characteristics (Genys and Hunt, 1981 and 1983). Significant variation among similar clonal progenies was also found in New Jersey (Kuser and Hobbs, 1984 and 1985). The present data are based on 5-year old trees, grown in Maryland's coastal plain.

The authors feel that this report may be more helpful in identifying poor clones than further selection of the superior sources. Identifying and removing inferior clones from the seed orchards may result in significant improvement of the genetic properties of the future plantations.

METHODS

Seed lots of P. strobus for this experiment were collected in 1978 from various open-pollinated clones in 11 seed orchards, including some samples from natural stands. These were subdivided for various studies. In April 1979, a large nursery experiment with over 90 different sources was started by the senior author in Maryland. The seedlings were measured and intensively studied during the two-year period (Genys and Hunt, 1981 and 1983).

In Spring 1981, two-year old trees were distributed for evaluation in Connecticut, Pennsylvania, Michigan, Vermont, New Hampshire, New Jersey, New York and Maryland. The Maryland experiment was established in April 1981 on land belonging to the Chesapeake Bay Foundation, known as Meredith Creek Outdoor Recreation Center, east of Annapolis, Maryland. This site is located on the Coastal Plain with a frost-free growing season of about 180 days and fertile, well-drained soils. This former farm field had been invaded by poison ivy (Rhus toxicodendron L.), tall weeds and local shrubs. Prior to planting, this vegetation was removed and the area was plowed. The study consists of four randomized blocks with each source represented by three tree row-plots in each block. Trees were spaced at 1.2 m within row-plots, and 2.4 in between the rows and between the row-plots.

Tree-heights and survival data were measured in February 1934 when the specimens were five years old from seed, grown three years in the field. Fall needle colors were scored in December 1984. Each tree's color was scored on a scale from 1 to 10. Using the sums (for three trees) as indices, a 14 or less indicated a yellowing tendency and 16 or more - a tendency toward blue-green.

Row-plot means for height and row-plot sums for color indices were used as items in the analysis of variance. Consequently, the analytic structure included a total of 359 degrees (df): 39 df for sources, 3 for blocks and 267 for interaction. Missing plot data were calculated. However, sources with more than one missing plot are not included in this report.

RESULTS

Survival

Survival of different sources of trees three years after planting ranged from 50% to 100% (Table 1). Most mortality occurred at random. Consequently, the survival rates were not different at the 0.05 level of significance. This suggests that survival rate need not be a primary factor in the selection of better sources for central Maryland. All sources, given suitable care may demonstrate satisfactory survival.

Heights

Five-year heights of individual progenies ranged from 68% to 138% of the test mean (x 60 cm). Since outplanting, the ranking of heights has changed. Progenies from each major seed orchards included some rapidly growing and some slow growing sources. For example, source #20 from Vermont grew nearly twice as large as Vermont source #41. New Hampshire's source #1 was 40% larger than New Hampshire's source #7. Maine source #33 was above average, but the poorest progeny (Maine source #10) grew to only 55% of the plantation mean. The New York source #10 grew 11% above average while two native sources were considerably below average. Twelve sources from the Pennsylvania group were above average, while seven were below. Tennessee's seed orchard mix was 36% above average compared to a below average native stand collection.

Majority of the progenies from the three seed orchards in Maryland had above-average heights, and some progenies were distinctly outstanding. For instance, the progeny #8 from the orchard designated "MD" was 21% above-average and the same #8 clone growing in the "SM" orchard was 38% above average. Populations from the BRIGHAM pine, PA-10, GP-01 and SS-01, were 25%, 22% and 2% above average, respectively. A progeny from the tallest P. strobus tree in Garrett County, Maryland (GP-12), a high elevation source, was 9% below average. Also, SM-13 from a selected tree which is a half-sib descendent of the BRIGHAM pine grew slower than expected.

December Foliage Color

Foliage color may be an important factor if the seedlings are intended for Christmas or other ornamental use, such as urban plantings or in parks. Color grades of different progenies ranged from yellow-green (grade 14) to blue-green (grade 23) (Table 1). The least significant difference (at 0.05 level) was 5; consequently, all sources with a score smaller than 15 had more or less yellow-green needles. Those graded 20 and above tended to be more blue-green.

The greatest numbers of trees with blue-green foliage were from the native stands of North Carolina. The native source from Tennessee was also blue-green. The color of progenies from most individual orchards was highly variable. For instance, the Maine orchard was represented by

Table 1.--Variation among various progenies of eastern white pine (Pinus strobus) grown from seed collected from open-pollinated ramets in various seed orchards in the Northeast. Some seed sources from native stands were also included as controls (C). Total growth represents two years growth in the Maryland State Nursery at Harmans and three years growth northeast of Annapolis near the Chesapeake Bay Bridge.

CODE:	(1)	(2)	(3)	(4)	(5)
Seed source	Height stock	3-yr. survival	5-yr. hgt. real	5-yr. hgt. comp.	color
	%M	%	cm	%M	grade
VERMONT ORCHARD					
Selected clones					
VT-15	95	100	62	105	16
VT-20	97	67	65	117	18
VT-31	95	75	50	83	17
VT-32	91	92	53	89	16
VT-41§	96	75	39	65	16
VT-61	94	67	50	83	17
VT-71	95	92	58	98	15
VT-91	97	92	55	92	15
NEW HAMPSHIRE ORCHARD					
Selected clones in New Hampshire					
NH-01	101	75	67	112	16
NH-02	32	83	51	87	16
NH-03	97	92	55	92	18
NH-04	96	67	51	86	16
NH-05	92	83	51	87	17
NH-06	98	92	58	97	17
NH-07	95	92	46	72	19
NH-08	99	75	56	95	15
MAINE ORCHARD					
Selected clones in Maine					
ME-10	80	92	32	55	14
ME-12	99	100	52	88	15
ME-22	106	75	52	88	15
ME-23	85	83	47	79	17
ME-28	97	61	52	89	18
ME-32	86	75	48	80	17
ME-33	93	92	62	104	14
NEW YORK ORCHARDS					
Selected clones; controls (C) from native stands					
NY-10	99	83	66	111	17
NY-11	98	100	51	87	17
NY-34C	73	75	52	88	16
NY-35C	74	67	46	77	17
PENNSYLVANIA ORCHARD					
Selected clones in Pennsylvania and elsewhere					
PA-01	121	75	76	128	16
PA-02	99	58	53	89	18
PA-03	113	58	56	94	19
PA-04	98	75	60	102	20
PA-05	102	67	61	103	17
PA-06	98	75	63	106	16
PA-07	116	75	77	129	17
PA-08	111	83	63	106	18
PA-09	107	89	51	87	18
PA-10§	110	67	74	125	14
PA-11	106	100	60	102	19
PA-12§	93	83	63	106	17
PA-13	111	75	60	101	18
PA-14	106	92	59	99	19
PA-15	95	58	55	92	16
PA-17	106	75	56	94	18
PA-18	106	92	62	104	18
PA-19	97	58	53	90	19
PA-20	95	67	64	109	18

CODE	(1)	(2)	(3)	(4)	(5)
OHIO PLANTATION					
Bulked seed lot (from planted trees)					
OH-01§	85	50	52	88	15
MARYLAND ORCHARDS					
Some clones selected in provenance tests					
MD-02§	109	92	72	114	20
MD-03§	108	67	63	107	16
MD-04	-	75	60	102	15
MD-08§	103	100	72	121	19
MD-11§	98	58	52	88	18
MD-15	-	75	66	111	17
MD-16§	104	83	58	97	19
MD-17§	111	75	73	123	20
MD-19§	109	92	62	104	17
MD-20	-	67	54	91	18
SM-02§	107	83	61	103	19
SM-03§	117	83	65	110	19
SM-06	-	75	45	76	16
SM-07	102	75	82	138	17
SM-08§	112	92	82	138	20
SM-09	-	100	67	113	18
SM-11	-	67	63	107	13
SM-13	-	75	40	68	16
SM-14§	100	92	57	96	18
SM-20§	102	100	55	92	17
SM-21	-	92	67	113	20
SM-85	-	83	62	104	15
GP-19§	-	92	64	108	18
GP-12	-	83	54	91	17
GP-21§	-	75	59	99	20
GP-21	100	58	52	84	16
GP-25	-	75	50	84	-
GP-51	-	67	67	113	19
GP-01	-	58	72	122	16
GP-21	-	75	56	95	18
SS-01	-	-	60	102	17
TENNESSEE ORCHARD ET AL.					
Bulked orchard seed; control (C) from native stand					
TN-01	114	92	81	136	19
TN-82C	102	58	58	97	23
NORTH CAROLINA NATIVE TREES (N)					
Populations from native stands					
NC-01N	106	50	56	94	15
NC-83N	-	83	67	112	20
NC-85N	108	100	82	138	23
NC-86N	98	67	59	99	22
NC-87N	106	92	58	97	23
NC-88N	107	50	72	122	20
LSD	19	ns	26	2	5
F (0.05)	11.5	1.2	2.9	2.9	3.1

§ = Clones selected in plantations of unknown or non-local origin.
(1) M = 17.2 cm
(4) M = 60.0 cm
(5) Grades:
< 15 = yellow-green, 15 - 19 = green,
> 19 = blue-green

green and yellow-green sources, whereas progenies from the Pennsylvania orchard included sources with yellow-green, green and blue-green leaves.

If selections were to include both characteristics of rapid growth and blue-green color, Maryland #8 (SM-08, MD-08) would be a good candidate. If average growth plus blue-green color is desired, TN-82 would be a possible choice. No populations with blue-green foliage were found among the sources from orchards in New York, Vermont, New Hampshire or Maine.

DISCUSSION

Height growth as evaluated in this study allows some unique comparisons. Clonal progenies from several state seed orchards may be compared with typically used commercial seed lots. Such rough comparisons allow the states an initial indication of the improvement they may expect from their seed orchard seed. Other possible comparisons include those of the same half-sib offsprings pollinated in other seed orchards (PA-10, GP-01, SS-01). Similar performances tend to reinforce estimates of maternal quality regardless of different pollen sources. Differing performances should alert states toward possible problems, i.e., inbreeding, lack of pollen, etc.

Rapid growth is not the sole characteristic of interest for the states. During the past decade both authors have come to appreciate that the fastest growing sources are not always the most valuable from the standpoint of urban and ornamental choice. Height growth and stem volume are rarely the traits most city residents seek for their lawn or door-yard. Homeowners often wish their trees would not grow so rapidly, and would not outgrow their allotted spaces.

Urbanites often seek diversity - different species, different cultivars, and different shapes. Crown form, leaf color and branching habits are as important as the growth rate. Ultimately, the value of a tree depends upon its prime use.

Survival rates are of major importance to urbanites. They expect trees to live surrounded by blacktop and concrete, flooded by road salts, choked by bicycle cables and attacked by lawnmowers. Our trees were not subjected to such trials. Therefore, our findings on survival are not applicable to urban conditions; more relevant are the data on heights and foliage color.

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