INTRASPECIFIC VARIATION AMONG TWENTY-FIVE POPULATIONS OF BLACK CHERRY, PRUNUS SEROTINA, STUDIED NEAR WASHINGTON, D.C. [1]

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ABSTRACT

Prunus serotina from 25 different seed sources, studied in Maryland, near Washington, D.C., varied in growth rate, survival, date of setting leaves and flowers, and branching habits. Six-year heights ranged from 3.6 (Wise County, Virginia) to 9.6 feet (Alachua County, Florida). Five-year survival varied from 44% or less (Florida and Georgia populations) to over 85% (five populations from the northern range). The earliness of setting leaves and flowers was inversely correlated with the elevation; also, the earliness of flower-set was positively correlated with the annual temperature of the provenance. A population from Monroe County in Tennessee had distinctly straighter stems and smaller branches than most other populations studied.

INTRODUCTION

Black cherry (Prunus serotina Ehrhart) is one of the species of genus Prunus (Family Rosaceae), that is an important forest tree. It grows to large sizes (up to 100 feet and more) and differs from domestic cherries by its small flowers arranged on cylindric glabrous racemes (Rehder, 1947). In contrast to many other cherries, P. serotina flowers develop in late spring ("serotina" = late appearing). The black, small cherries and nearly black bark are two characteristics associated with its common name - "black cherry." P. serotina is also known as "rum cherry" because its aromatic fruits are used to produce a drink, "cherry bounce." The most important product of black cherry is its hard, reddish brown, narrow-grained wood, that ranks among the most beautiful and most valuable woods for furniture, interior trim, tools and veneer. Desirable specimens of black cherry are in high demand and are sold for very high prices.

Black cherry is distributed over a large range in the southern sections of eastern Canada and in most of the eastern United States (Little, 1971). From the eastern sections of South Dakota, Nebraska, Kansas, Oklahoma and Texas, the range extends to all other eastern states, except the lower Mississippi Valley and southern Florida (Figure 1). This species is also found on the West Coast in Arizona, New Mexico, Mexico, Guatemala, and the Revilla Giged Island (McVaugh, 1951).

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Prunus serotina is a variable species. The taxonomists have recognized at least two geographic varieties in the eastern range - P.s. var. alabamensis (Mohr) Little (syn. to subsp. hirsuta (Ell) McVaugh) in portions of Georgia, Alabama and Florida, and the typical variety P.s. var serotina. The populations on the west coast have been classified as P.s. var rufula (Wont and Stand].) Little (Little, 1953). Rehder (1947) has identified a number of cultivars: P.s. "pendula" Dipp., P.s. "aspleniifolia" (kirchn.) Jaeg., and P.s. "phelloides" Schwerin. Trees in the southern range (Virginia to Alabama), with broader elliptic leaves were classified as P.s. montana (Small) Britt. A population of black cherries, that has been cultivated in Mexico and Peru since 1820, has been identified as P.s. salicifolia (Kunth) Koehne.

With the increasing interest in planting more black cherries for production of its valuable wood, new studies are needed to learn about its variation in growth rate, and other qualities that are important to foresters and consumers of cherry products. A small study of black cherry, based on seed sources from different locations in Maryland, was initiated in 1962 (Genys, 1963). One-year-old seedlings showed a significant variation in growth rate. In 1967, a comprehensive experiment with range-wide populations was undertaken by the West Virginia University. Valuable information on geographic variation in seed and seedling characteristics, top and root characteristics, and other observations has been reported by Cech and Kitzmiller (1968), Kitzmiller (1969), and Brown and Cech (1972).

MATERIALS AND METHODS

This experiment is a part of a study of black cherries that was initiated at the West Virginia University in 1966. Seed collection included 33 seed sources. Each population was represented by seeds collected from five mother trees growing at least 150 feet apart. Details on seed weights and studies in the nursery were described by Cech and Kitzmiller (1968). The planting stock was produced at the Parsons State Nursery, Parsons, West Virginia.

In mid-April 1969, 25 populations (Figure 1) of one-year–fld trees were supplied to the Natural Resources Institute in Maryland and planted in two locations. One plantation on a lowland near the Potomac River was damaged by floods caused by tropical storm Agnes. The second plantation, which is the subject of this report, was established on April 10th, 1969, on the Maryland University Tabacco Experimental Farm in Prince Georges County, about 10 miles east of Washington, D.C. The site is a typical rolling coastal plain, elevated about 100 feet above sea level; soil is a fertile Monmouth fine sandy loam; growing season about 175 days; annual rainfall about 45 inches; and an average annual temperature 52°F.

The experiment was laid out in 4 randomized blocks. Each block included 25 populations, each represented by row of 7 trees, spaced 4 feet apart within rows and 8 feet between rows. The intention is to grow only four trees per plot (after some of the seven trees die, or after the three surplus trees are removed). Each block includes one plot of tulip tree, Liriodendron tulipifera, that was planted for comparison.

Figure 1.--Natural distribution of black cherry, Prunus serotina, in its eastern range (Little, 1971). Dots identified by seed-lot numbers indicate the locations of seed sources of 25 populations of this species studied in Maryland. Seed lot FG-1 from Georgia included about an equal portion of seeds from northeastern Florida.

The initial height-measurements and survival-counts were made in the fall of 1969, when the trees were two years old from seed. The final measurements, which are the basis for this report, were made on May 17, 1974. This included measuring heights, scoring degree of advancement in setting leaves and flowers, and scoring of branching habits.

Statistical interpretation of the data, including correlation analysis and analysis of variance, were made on a "1108" computer at the University of Maryland, Computer Science Center.

RESULTS

The twenty-five populations of black cherry, studied near Washington, D.C., varied in growth rates, survival, setting of leaves and flowers, and branching habits (Table 1). Relationships between these traits and their relationship to the climatic and geographic features of their provenance are expressed by correlation coefficients in Table 2.

Table 1.--Data on origin, growth rate and other characters of black cherries from different seed sources studied in Prince George's County, Maryland.

Seed lot No.	Origin of seed source State and County	N. Latitude	W. Longitude	Elevation	Height at years from seed 2	Height at years from seed 6	Survival in Md. at years 1	Survival in Md. at years 5	Setting of (1)Leaves (2)Flowers May 17, '74 (1)	Setting of (1)Leaves (2)Flowers May 17, '74 (2)	Branching habits
		degree		feet	feet		percent		grade*		grade**
	NORTHERN POPULATIONS										
VT-1	Vermont, Chittenden	44.5	72.9	1000	1.6	4.6	94	82	15	4	16
NY-1	New York, Carland	42.8	76.2	1600	1.7	4.5	100	71	14	4	12
MI-1	Michigan, Kalamazoo	42.4	85.4	830	1.8	5.3	100	82	10	4	12
PA-1	Pennsylvania, Warren	41.8	79.3	1200	1.6	5.1	100	86	9	4	15
PA-2	" Potter	41.7	78.0	2000	1.9	5.7	100	86	13	4	9
PA-3	" McKean	41.8	78.8	1750	1.5	4.5	94	86	11	4	10
PA-4	" Centre	40.9	77.8	1400	1.6	4.0	100	79	5	4	15
	CENTRAL POPULATIONS										
OH-1	Ohio, Wayne	40.8	86.9	----	1.4	5.6	94	75	8	4	14
MD-2	Maryland, Garrett	39.7	79.3	2000	1.7	5.2	100	61	6	4	12
MD-3	" Anne Arundel	39.1	76.5	25	1.6	7.4	100	57	16	15	15
CR-1	West Virginia, Monongalia	39.7	80.0	2200	1.5	5.2	100	82	6	4	12
WV-1	" " "	39.7	80.0	2300	1.2	4.6	100	82	7	4	14
WV-2	" " Wood	39.0	81.5	500	1.0	4.4	94	82	8	4	13
WV-3	" " Tucker	39.1	79.7	2900	1.6	4.5	100	79	11	4	10
WV-4	" " Greenbrier	37.7	80.2	1750	1.4	4.7	100	89	9	4	16
WV-5	" " Wayne	38.0	82.3	650	1.2	4.7	100	82	9	4	14
IL-1	Illinois, Williamson	37.7	89.1	455	1.3	6.2	100	71	12	10	14
VI-1	Virginia, Russell	37.0	80.0	2000	1.3	5.1	100	64	12	4	17
VI-3	" Wise	37.0	82.6	4000	1.2	3.6	88	64	6	4	10
TE-1	Tennessee, Morgan & Scott	36.3	84.5	1900	1.6	4.5	88	64	10	4	13
TE-2	Tennessee, Monroe	35.3	84.3	3800	1.1	4.6	94	75	10	4	5
	SOUTHERN POPULATIONS										
AL-1	Alabama	32.7	85.5	750	1.3	6.2	100	86	14	15	15
GA-1	Georgia, Decatur	30.9	84.5	150	1.0	8.7	75	43	16	17	13
FL-3	Florida, Alachua	29.7	82.3	120	.9	9.6	56	36	15	15	9
FG-1	Florida-Georgia (combined)	(29.4)	(82.8)	----	1.1	8.0	44	39	13	18	10
Average					1.4	5.5	93	73	10.6	6.6	12.6
F-value					5.8	7.2	4.3	6.2	7.0	24.8	2.3
Least sign. Diff. (at 0.05 level)					.4	1.9	24	21	5	3	7

*Grades ranged from 4=no leaves or flowers present to 20=leaves and flowers fully developed.

**Grades of branchiness were as follows: 4=short branches, single straight stem, 12=medium-sized branches, single stem, and 20=heavy branches, more than one stem.

Table 2.--Relationships among different characters of black cherry, and their relationship to various geographic factors of provenance, expressed by correlation coefficients (r).

Code Numbers	Factors and Characters Y_2 / Characters Y_1	(17) Height in Md. 6 yrs. old	(19) Survival 5 yrs. Md.	(20) May 17th, '74 setting of Leaves Md.	(21) May 17th, '74 setting of Flowers Md.	(22) Branchiness 6 yrs.
		r				
(1)	Northern latitude	-.63**	.63**	-.20	-.67**	.12
(2)	Western longitude	.25	-.06	-.05	.33	-.09
(3)	Elevation	-.61**	.08	-.43*	-.54**	-.60**
(4)	Annual temperature	.37	-.05	-.04	.66**	.23
(5)	April-September temperature	.42	.01	.03	.66**	.37
(6)	Annual precipitation	.10	-.11	-.04	.33	-.56*
(7)	April-September precipitation	.11	.07	-.17	.24	-.45
(8)	Seed weight	-.26	.02	-.48*	-.14	.16
(9)	Seed diameter	-.23	.02	-.46	-.11	.18
(10)	Stem-length, 1 yr., W.Va.	.24	.09	.17	.44	-.04
(11)	Plant-weight, 1 yr., W.Va.	.57*	.26	.16	.72**	.15
(12)	Number buds, 1 yr., W.Va.	.65**	.26	.37	.92**	.20
(13)	Number crooks, 1 yr., W.Va.	.06	.00	-.24	.36	.15
(14)	Survival, 4 yrs., W.Va. (C.B.)	-.78	.73**	-.45	-.68**	.30
(15)	Survival, 4 yrs., N.Y.	-.54**	.63**	-.23	-.51*	.32
(16)	Height, 2 yrs., Md.	-.39	.46*	-.08	-.45*	.03
(17)	Height, 6 yrs., Md.		-.76**	.65**	.89**	-.03
(18)	Survival, 1 yr., Md.	-.68**	.78**	-.34	.66**	.32
(19)	Survival, 5 yrs., Md.	-.76**		.40	-.70**	.19
(20)	Setting of leaves, May 17th.'74	.65**	-.40		.65**	.03
(21)	Setting of flowers, May 17th,'74	.89**	-.70**	.65**		.01
(22)	Branchiness, 6 yrs., Md.	-.03	.19	.03	.01	

* Significant level of 5%
** Significant level of 1%

Growth Rate.--Heights were measured twice, at 2 years and at 6 years of age from seed. Two-year heights of different populations ranges from 0.9 to 1.9 feet. At this age, trees from the northern range were significantl taller than those from the south. The smallest seedlings were from Florida, Georgia, and Tennessee, The general trend of variation was in agreement with the first year heights at the nursery in West Virginia (Cech and Kitzmiller, 1968). In general, the variation of two-year heights was more a result of conditions enjoyed by the plants in West Virginia rather than the conditions of central Maryland, where the seedlings grew only one year.

Six-year heights of different populations ranged from 3.6 to 9.6 feet. Most rapidly growing strain was FL-3 from Alachua County in Florida, followed by populations GA-1 and FG-1 from Georgia, and from Florida-Georgia, respectively. Among the strains from the central range, the most rapidly growing population was MD-3 from Cape St. Claire in Anne Arundel County, Maryland; and among the northern populations the most outstanding was PA-2 from Potter County, Pennsylvania.

Six-year heights and the heights of two-year old seedlings, grown one year in West Virginia and one year in Maryland, showed no relationship (r=-.39). Apparently, a prediction of the potentials of growth rates on the basis of two-year old trees would have been misleading. Further analysis indicated that six-year heights in Maryland were inversely correlated to the latitude (r=-.63) and to the elevation (r=-.61). This suggests that populations from the lower elevations and from the south grew somewhat more rapidly than others. Six-year heights were also correlated with the total weight of tops and roots of one-year old seedlings, grown in a West Virginia's greenhouse (r= .57), and to the number of buds per seedling studied at the same time (r= .65). Apparently the seedlings grown under controlled environmental conditions in West Virginia showed more reliable relationship to the six-year heights in Maryland than the seedlings grown in the nursery.

The relationships between six-year height and such factors as the annual temperature, the April-September temperature, the annual precipitation, and the April-September precipitation were insignificant. Also, the six-year heights showed no significant correlation to the seed size (seed weight and seed diameter).

At six years of age, tulip trees had an average height of 8.7 feet. Apparently, their growth rate was about equal to the growth rates of the most rapidly growing populations of black cherry from Florida and Georgia.

Survival.--Survival of different populations of black cherry in Maryland showed a significant variation. A very high mortality of trees from Florida and Georgia occurred during the first year after planting. The one-year mortality of different populations ranged from 44 percent (FG-1, from Florida-Georgia) to no mortality (15 populations from more northern regions, including AL-1 from Alabama). Naturally, this early mortality was a determining factor on the results at five years after planting at which time the survival rates varied from 36 percent (FL-3 from Florida) to 86 percent or more (5 populations from more northern range, including AL-1 from Alabama).

Correlation analysis suggested that survival rates in Maryland were correlated with survival rates in West Virginia and New York (r= .73). Also, the survival rates were correlated with the northern latitude of the provenance (r= .63), and inversely correlated with 6-year heights (r=-.76).

Despite all data suggesting a poor survival of some southern populations, no final conclusion can be made, because the planting stock for this study was grown in West Virginia, known for its much colder climate than in Central Maryland. Many one-year old seedlings from Florida and Georgia had dead tops, "frost-burned" leaves, and appeared kind of weak, including some dead. Mortality of such seedlings in Maryland may have been a result of their poor development in West Virginia.

Tulip trees, planted within this black cherry experiment, included only one dead tree out of 28. This survival rage ranked higher than in any population of black cherry.

Earliness of Setting Leaves and Flowers.--On May 17th, 1974, about all southern populations of black cherry had well-developed leaves and flowers, while most other populations were still without flowers. Unexpectedly, very advanced development of leaves was observed among some populations from the northern range - Vermont and New York. At the same time, very advanced development of flowers was in populations from Central Maryland and Illinois. The earliness of setting leaves was inversely correlated to the elevation of the seed source (r=-.43), meaning that populations from the lower elevations set their leaves somewhat earlier than others. Also, the earliness of leaf-set was positively correlated with the six-year heights (r= .65).

Earliness of flower-set was correlated with the earliness of leaf-set (r= .65). In addition, flower-set was correlated with the annual and the April-September temperature of the provenance (r= .66). A very significant correlation was between the earliness of setting flowers and the number of buds per tree on one-year old trees, studied in West Virginia (r= .92).

Branching Habits.--The six-year old trees had enough space for open growth and for development of various branching habits. These varied from very long branches and multiple stems to short branches and single stems. Strong variations occurred among trees within the same population. The most desirable branching habit and stem form was observed in population TE-2 from Monroe County, Tennessee. The next two populations with single stems and relatively short branches were PA-2 from Potter County, Pennsylvania, and FL-3 from Florida.

The extensive branchiness was inversely correlated with the elevation (r=-.60) and the annual precipitation (r=-.45). This suggests that trees originating from lower elevations and from regions with less precipitation had somewhat smaller branches.

DISCUSSION

The results of this study extend the data on racial variation in black cherry and compliment some earlier information from studies in West Virginia. In many respects these data will be improved when further information will be received from other plantations established in the Northeast.

The present studies in Maryland proved beyond doubt, that black cherry is a variable species in many characteristics, such as growth rate, survival, branching habits, and earliness of setting leaves and flowers. Some of these traits, such as time of setting leaves and flowers are most likely a result of natural selection for the best adaptation to the local climate. Rapid early growth of the southern strains may have been a result of natural selection caused by competition from other rapidly growing species in the southern range.

If selection of the best seed source of black cherry would be based on this study alone, it would be difficult to point out such a population. There was no single population that combines all the desirable characteristics, such as rapid growth, good survival, straightness and desirable branching. For example, if stem straightness is of primary interest, TE-2 (from Monroe County in Tennessee) would be the choice; but this population showed only a moderate growth rate. If considerable branchiness can be tolerated, MD-3 (from Anne Arundel County in Maryland) deserves consideration for selection as one of the most rapidly growing populations from the central range.

This study failed to determine, if the early mortality of the southern strains was due to their intolerance of Maryland climate, or due to the weakness of seedlings that were brought from West Virginia. At this time, the rapidly growing populations from Florida and from the other most southern regions should be considered with a risk of having poor survival.

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