Summary of Black Cherry Improvement at the Hardwood Tree Improvement and Regeneration Center (HTIRC)

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Background

Black cherry (*Prunus serotina*) is found in southeastern Canada and throughout the eastern US. It is the only native species of the genus *Prunus* that is of high commercial value for timber and sawlog production. Black cherry wood is one of the most valued woods in North America for cabinets, furniture, fine veneer, and architectural woodwork. Hardwood lumber mills are constantly seeking high-quality sources of this species, because stands of large, straight-stemmed, black cherry trees are becoming increasingly difficult to find. Attack by several species of insects causes gum defects in black cherry, resulting in reduced timber quality, especially for veneer (Rexrode and Baumgras 1984). Gum spots (gummosis) in the wood are often associated with the feeding and activity of the lesser peachtree borer (*Synanthedon pictipes* Grote and Robinson) [Lepidoptera]. Damage to the parenchyma cells causes a discoloration and production of lysigenous gum canals or gum spots. Gum spot defects drastically reduce the yield of marketable lumber and veneer from otherwise excellent logs. Logs rejected for veneer stock because of gum spots may be reduced in value by as much as 60 to 70 percent.

In 1966, the USDA Forest Service began a tree improvement program based on plus-tree selection of black cherry primarily from the Allegheny National Forest (ANF), the most important timber production area for the species. Mature plus-trees in even aged stands were selected in areas where black cherry was dominant. The goal of the program was to provide local, genetically improved planting stock for reforestation on the National Forest. For each plus-tree, three comparison trees of similar age were evaluated. Traits selected for were: merchantable volume, apical dominance, absence of black knot (caused by the fungus *Apiosporina morbosa*), gummosis, ice damage, and quality timber form. Detailed records for each select tree have been maintained by the ANF and the USDA-FS Region 9 Geneticist, providing the opportunity to re-evaluate and collect these trees. The breeding value of these selections remains to be fully investigated.

In March, 2005, HTIRC staff re-visited 36 of these trees to evaluate them and collect scion wood for our breeding research at the HTIRC. At the time of collection we re-measured DBH, recorded incidence of black knot and gummosis, and noted the general health of each tree. The trees were 64 years-old, on average, when they were selected in the 1960s, with an annual average DBH growth rate of 0.31 in/yr. Today they average 102 years-old, with an annual DBH growth rate of 0.20 in/yr. Eighty-six percent (31/36 trees) remained black knot free in the 38 years since selection (Table 1).

Table 1. Summary of growth and quality of select black cherry from the Allegheny and Monongahela National Forests.

			Orig. select traits[A]			Ann. DBH growth (in/yr)[B]		Black knot		Gummosis	
Tree	Age	DBH (in)	Ap. dom.	Ht.	Vol.	Initial	last 40 yrs	Initial	last 40 yrs	Initial	last 40 yrs
B-7	137	24.7	5%	11%	9%	0.19	0.15	0	0	0	0
B-10	96	26.9	31%	7%	100%	0.31	0.24	0	0	0	0
B-13	174	36.3	6%	5%	26%	0.21	0.21	0	0	0	0
B-16	77	23.0	9%	4%	27%	0.36	0.23	0	0	0	+
B-19	92	22.3	27%	8%	40%	0.26	0.21	0	+	0	+
B-24	104	33.4	115%	0%	32%	0.32	0.33	0	0	0	0
B-30	101	21.3	35%	11%	23%	0.23	0.17	0	+	0	0
B-31	104	30.7	22%	1%	22%	0.27	0.33	0	0	0	0
M-1	110	23.7	41%	-2%	17%	0.24	0.17	0	0	0	0
M-2	88	28.9	38%	1%	85%	0.45	0.18	0	+	0	0
M-7	111	36.4	-27%	18%	112%	0.33	0.33	0	0	0	0
M-9	91	26.2	82%	6%	140%	0.39	0.15	0	+	0	0
M-13	98	33.6	16%	29%	187%	0.45	0.17	-	-	-	-
M-16	125	25.3	-3%	16%	35%	0.24	0.11	0	0	0	0
M-17	93	25.2	81%	-2%	21%	0.34	0.18	0	0	0	0
M-20	85	27.5	36%	11%	93%	0.44	0.18	0	0	0	0
M-23	87	27.7	69%	8%	26%	0.31	0.33	0	0	0	0
NE-8	105	23.8	38%	8%	7%	0.28	0.14	0	0	0	0
R-12	137	30.7	37%	6%	32%	0.24	0.18	0	0	0	0
R-21	102	22.3	127%	13%	45%	0.24	0.17	0	0	0	0
R-23	97	30.1	15%	9%	42%	0.34	0.27	0	0	0	0
R-24	78	18.6	13%	9%	60%	0.31	0.15	0	0	0	0
R-27	83	18.3	42%	0%	0%	0.27	0.15	0	0	0	0
R-36	104	21.3	42%	13%	96%	0.26	0.09	0	0	0	0
S-5	85	19.6	62%	9%	0%	0.27	0.18	0	0	0	0
S-7	88	23.6	48%	9%	40%	0.33	0.19	0	+	0	0
S-11	90	25.8	41%	6%	20%	0.35	0.19	0	0	0	0
S-12	87	31.0	53%	4%	31%	0.42	0.28	0	0	0	0
S-17	94	22.5	36%	2%	12%	0.27	0.20	0	0	0	0
S-18	115	22.7	37%	9%	23%	0.23	0.13	0	0	0	0
TV-1	139	35.8	23%	15%	43%	0.26	0.25	0	0	0	0
TV-2	113	25.8	-4%	6%	34%	0.30	0.10	0	0	0	+
TV-3	102	23.4	90%	0%	-7%	0.25	0.19	0	0	0	0
AVG	**102**	**26.37**	**40%**	**7%**	**46%**	**0.31**	**0.20**	**0**	**0.16**	**0**	**0.10**
SD	20	5.08	33%	6%	43%	0.07	0.07	0	0.37	0	0.30

[A] Improvement of each select tree in comparison to the average of 3 companion trees for: apical dominance (Ap. dom.), total height (Ht.), and merchantable volume (vol.).

[B] Average annual diameter growth calculated by dividing DBH by age at the time of selection (initial) and from that time to the present (*c.a.*last 40 yrs).

The 1982 Klondike #685 Evaluation Planting

In the fall of 2005, we measured a 23-year-old planting (essentially a progeny test) containing open-pollinated seedlings from ramets of some of the ANF selections and seedlings from local, non-select parents planted as controls. The three-acre planting site, Klondike #685, was a clear-cut in the ANF (McKean Co., PA) that had failed to naturally regenerate.

Select and control seedlings were planted in full alternating rows at ~3m × 3m. Adjacent select and control rows were paired and analyzed as blocks (10 rows = 5 blocks) by ANOVA. Initially, the site was intensively maintained. At present, the site is fully stocked with the surviving planted black cherry and naturally regenerated pin cherry, red maple, and yellow birch. Because of the competition, the silvicultural class of each tree was determined, and only dominant and codominant trees were analyzed. Volume was calculated by Doyle's log rule with log lengths to the first fork. We rated the trees for apical dominance, straightness, self-pruning, and clarity of the bole. The seedlings from selected parents were significantly larger than the comparison seedlings in height, diameter, and volume. The incidence of black knot was not significantly different between sources.

The ANF Superior Trees and the HTIRC Breeding Program

Black cherry improvement began at the HTIRC in 2001, when 100 seedlings derived from a grafted seed orchard of selected PA black cherry (Penn Nursery c/o Mr. Alex Day) were obtained and planted at Martell. These trees exhibit a wide range of phenotypes and began setting seed in 2006, their fifth full growing season. These parents will be evaluated as clonal selections and in progeny tests.

In 2004, seed was collected for a limited range provenance test to examine the phenotypic diversity, quality, and adaptability of black cherry from five sources: IDNR commercial stock (seed sources from northern and southern Indiana), run-of-the-mill fence row trees at Purdue (north central Indiana); plus trees in a natural forest in southern Indiana (Harrison Crawford State Forest); plus trees selected at the Vallonia Nursery growing in an improved seed orchard; and seed collected from the ANF, primarily the Kane Experiment Station, Kane, PA. The seed was sown at the Vallonia nursery, and 1-0 trees planted in 2006 at 3 sites. A minimum of 100 seedlings per provenance were planted in a RCBD at each site. The plantings will be used to evaluate the adaptedness of the ANF sources, to determine how widely adapted southern and northern Indiana sources are, to evaluate phenotypic range of black cherry growing in Indiana in terms of growth and form, and to provide material for selection in the future.

In 2005, scions from the ANF superior trees were collected and grafted onto seedling rootstocks at Purdue. Grafted trees were planted in: (1) a clone bank with other first generation selections; (2) a seed orchard comprised of only PA selections; and (3) mixed seed orchards comprised of PA, IN, and selections from other states.

As of July 2006 there were 101 black cherry (*Prunus serotina*) accessions in the HTIRC black cherry improvement germplasm, not including the trees from the Penn Nursery. Nearly all the accessions are grafted ramets of select trees from the following areas:

60% (n=60) from the Allegheny Plateau in Pennsylvania
24% (n=24) from Indiana
13% (n =13) from Michigan
2% from West Virginia and Vermont (n=2 for each state).

Each clonal accession was grafted onto a seedling rootstock, and three ramets were randomly placed into a clone bank. Evaluation of the trees in the clone banks will provide initial data regarding their growth rate, timber qualities, and phenology. The clone bank also serves as a repository, a source of propagation material to establish breeding/seed orchards, and a source of scion wood or cuttings for further clonal testing. As the clone banks produce seed, they will be progeny tested. Controlled pollinations among clones will be performed to investigate their specific combining ability.

HTIRC has propagated four black cherry seed orchards. The Edinburgh, IN orchard, in cooperation with Danzer Forestland, is comprised of grafted selections from PA; the orchards at Martell contain either grafted selections from PA (orchard 2) or IN (orchard 3). The fourth orchard, located just west of the Purdue campus at the FNR farm, contains grafted accessions from Indiana and Michigan. All will be evaluated for straightness, growth rate and freedom from disease, used as sources of scion wood, seed for progeny testing, and as locations for controlled crosses.

Clonal production of black cherry

Clonal reproduction of commercially important hardwood tree species is necessary, in a tree improvement program, in order to provide improved planting stock for use in progeny testing and for production forestry. In vitro and vegetative propagation methods will be required to produce clones of elite black cherry genotypes or genetically improved genotypes. Genetic modification of hardwood tree species to produce trees with herbicide tolerance, disease and pest resistance, improved wood quality, and reproductive manipulations for commercial plantations is also a major aspect of a tree improvement program. Development of an effective gene transfer and efficient in vitro regeneration system for black cherry, that can be easily adapted for many genotypes, will be required to produce genetically improved black cherry trees.

Rooted cutting results from 9-year-old black cherry trees appear promising (Pijut and Espinosa, 2005). Forty-two percent rooting was achieved overall for softwood cuttings collected mid-June and treated with K-IBA or IBA. The greatest rooting success (54 percent) was with 12 mM K-IBA. Fifty percent rooting was achieved with 15 or 74 mM IBA. The number of roots per cutting increased with increasing concentration of K-IBA. Rooted cuttings survived (80 to 100%) overwintering in a controlled cold-storage environment. This protocol is being utilized to establish rooted cuttings from elite selections of mature black cherry trees. Establishment of in vitro shoot cultures for three genotypes of black cherry, and regeneration of adventitious shoots with rooting from in vitro leaf explants, has been successful (Espinosa et al. 2006). The maximum mean number of shoots regenerated per explant (5.05 ± 1.14) was obtained with 2.27 µM TDZ plus 0.54 µM NAA. The highest percent shoot regeneration (38.3) and mean number of shoots (4.13 ± 0.97) was obtained with 6.81 µM TDZ plus 1.07 µM NAA. The highest rooting (27%) of adventitious shoots and number of roots per shoot (2.3 ± 0.2) was obtained with 2.5 µM IBA when shoots were maintained for 7 days in the dark on rooting medium before transfer to a 16-hour photoperiod. The highest rooting (70%) of nodal explant-derived stock cultures and number of roots per shoot (2.7 ± 0.9) was also obtained with 2.5 µM IBA, but when shoots were maintained for 4 days in the dark before transfer to a 16- hour photoperiod. In total, 86% of the plantlets survived acclimatization to the greenhouse and 100 percent survival after overwintering in cold-storage. In vitro shoot cultures from elite, mature black cherry selections have been

established and will be used to further optimize this regeneration system for genetic modification and rooting studies. The development of transgenic elite black cherry trees with resistance to pests or engineered for reproductive sterility will potentially have great economic benefits to landowners, lumber mills, and the forest products industry. Genetic gain in black cherry genotypes through this research will complement traditional tree improvement efforts.

References

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