MIST PROPAGATION OF BLACK CHERRY CUTTINGS: SOME EARLY RESULTS AND PROSPECTS FOR USE IN FORESTRY

ROBERT E. FARMER, JR., AND GERALDINE C. HALL[1]
Division of Forestry, Fisheries, and Wildlife Development
Tennessee Valley Authority
Norris, Tennessee

Vegetative propagation of black cherry (*Prunus serotina* Ehrhart) is essential to currently expanding breeding programs designed to produce forest tree stock with genetic potential for superior growth rate, form, and pest resistance. At present, grafting is being used successfully to establish breeding arboretums of phenotypically superior selections from natural populations, the first step in breeding. It would be more desirable, however, to use rooted cuttings in this work in order to circumvent possible stock-scion problems. In this high-value species, genetically improved clonal stock might also be produced commercially via cuttings. Thus, methods of rooting cuttings are of considerable potential value. Mist propagation techniques have been developed for named varieties and clonal rootstocks of horticulturally useful cherries (2, 3, 4). However, we found no report of black cherry rooting in the literature, although Cech[2] has rooted cuttings taken from stump sprouts of mature trees. In this paper we will report rooting of black cherry as influenced by juvenility, chemical rooting stimulators, and collection time.

METHODS AND RESULTS

1968 Tests

Initial trials were designed to develop suitable media and chemical rooting treatments. In the first, completed in May, July, and August 1968, indolebutyric acid (IBA) treatments outlined in Table 1 were used. Physiologically juvenile cuttings came from small, field-grown, two to three-year-old seedlings, and mature cuttings from two- to three-year-old grafted stock. At least ten genotypes were represented in samples. Six-inch-long apical cuttings were taken after shoots were at least partially lignified. Leaves were pruned to one-half their original area before cuttings were treated and planted in a greenhouse misting bench. We used a commercially available device with which misting cycles are regulated by evaporation rate. The rooting medium was sand: peat (1:1). The design was a split plot with eight, five-cutting replicates of the eight sub-plot rooting treatments. Cutting sources were assigned to main plots.

At three weeks, rooting of juvenile material in Treatments 3, 4, 7, and 8 was about 50 percent for the May trial (Table 1). Cuttings in control and quick dip treatments rooted poorly or not at all. Average July rooting was considerably

[1]Authors are, respectively, Plant Physiologist and Botanist They are indebted to Sara Potts and Ruth Moore for statistical analyses and to Melanie Davis for technical aid.

[2]Personal communication with F. C Cech, Department of Forestry, West Virginia University, Morgantown.

Table 1. Percent rooting of juvenile and matuie black cherry cuttings from three collections as related to IBA treatment.

Treatment	May Juvenile	May Mature	July Juvenile	July Mature	August Juvenile	August Mature
1. Control	0	0	0	0	0	0
2. Control + Folpet[1]	0	0	0	0	0	0
3. Basal ends dipped talc-IBA (0.8%) mix	47	22	25	12	13	0
4. Treatment 3 + Folpet	52	30	16	19	6	3
5. Basal ends dipped in 2000 ppm IBA, 5 secs.	10	0	0	0	0	0
6. Treatment 5 + Folpet	10	0	0	0	0	0
7. Basal ends soaked in 50 ppm IBA, 25 hours	47	7	22	12	16	3
8. Treatment 7 + Folpet	47	26	56	9	3	0

[1]Thirty minutes immersion in a mixture of 1 tablespoon Folpet (50 percent WP) in one gallon of water

lower than in May but had the same pattern of treatment effects noted in the spring. August rooting was negligible. Folpet[3], which is reported to act synergistically with IBA in rooting other species (1), had no significant effect in this test.

In another May trial with juvenile cuttings, sand and sand:peat (1:1) were found to be equally good media; rooting in both was about 50 percent after IBA treatment.

1969 Tests

Observation of about 50 percent rooting in 1968 suggested that there might be considerable tree-to-tree variation in rooting potential. This variation was studied in 1969, using the IBA-talc treatment to promote rooting in a sand:peat (3:1) medium. Potted three-year-old seedling and grafted (physiologically mature) stock was brought into the greenhouse in March and forced to break dormancy. The five-to-seven-foot tall plants were growing in 8-gallon plastic pots. Twenty-one juvenile plants and all mature grafts (representing nine clones) were pruned back drastically to promote growth of latent buds. Fourteen juvenile plants were left unpruned. The several tests were conducted using material from these plants. In spring, cuttings were rooted in a greenhouse mist bed as in 1968. Summer trials were in an outdoor bed for which a timer supplied ten seconds of mist every three minutes during daylight hours. In both beds the rooting medium was maintained at a temperature of at least 70° F by thermostatically controlled heating cables.

Test No. 1. Trials with cuttings from juvenile, pruned trees were conducted in April, June, and late July. Each had from two to four replicates of four-cutting entries from each tree in a completely randomized design. Controls were used in enough trials to demonstrate that no rooting is obtained with-

[3]N-(trichloromethylthio) phthalimide.

out IBA treatment. The rooting period was four weeks, after which time cuttings were washed out of the medium; the number of roots and the length of the longest root on each cutting were recorded.

Results are summarized in Table 2. April data are based on three trials started between April 7 and 28. Average rooting for individual trees varied significantly (0.05 level) from 0 to 100 percent; mean for the population was 66 percent. Rooted cuttings from most of the trees had abundant roots (10+), which were vigorously growing when trials were evaluated. Tree-to-tree variation in number of roots per cutting was statistically significant. Root length for trees also varied considerably, but differences were statistically non-significant due to wide within-tree variation.

Table 2. Rooting of juvenile black cherry cuttings as influenced by propagation date and tree.

Propagation Date	Rooting Percent		Roots per Cutting		Length of Longest Root, mm	
	Mean	Range[1]	Mean	Range[1]	Mean	Range[1]
April	66	0-100	15	1-23	43	20-70
June	52	0-100	9	1-18	23	6-35
July	17	0-100	11	7-20	27	10-42

[1]Range of tree means.

The June data are based on a single two-replicate trial in the outdoor mist bed. New shoots which had developed since April were the source of cuttings. Approximately one-third of the trees rooted as well as in April; the remainder exhibited an average decline in rooting of 29 percent. This decline was accompanied by a reduction in number and length of roots. With a few exceptions, ranking of individual trees with respect to rooting was approximately the same in April and June. A further reduction in rooting was exhibited in the July test, which was similar in design to that of June. Only four trees had rooting percent over 50, and most did not root at all.

Some basal necrosis was noted in many of the cuttings. This occasionally restricted root initiation to a portion of the stem immediately below the surface of the rooting medium.

Test No. 2. The second test was designed to compare rooting ability of apical cuttings from the following three sources:

(1) Physiologically mature scionwood grafted to juvenile stock and pruned back. All mature trees were field-selections being used in the TVA breeding program.
(2) Three-year-old pruned trees.
(3) Two-year-old unpruned trees.

On April 14, cuttings were treated with IBA (0.8 percent) in talc and planted in sand:peat in the indoor misting bed. The design was a randomized block with two four-cutting replicates of individual trees.

Results after a four-week rooting period are summarized in Table 3. Rooting percent of cuttings from pruned three-year-old trees was significantly (0.05 level) greater than that for cuttings from the other two sources. Cuttings from mature wood and two-year unpruned trees did not differ significantly in rooting. Root number and length were variable from tree to tree but did not differ significantly among cutting sources. Basal necrosis was again a problem with some cuttings developing roots only very near the soil surface.

Table 3. Rooting of black cherry cuttings as influenced by source of cutting material.

Source of Cuttings	Number of Trees Tested	Rooting Percent		Roots Per Cutting		Length of Longest Root	
		Mean	Range[1]	Mean	Range[1]	Mean	Range[1]
Grafted mature trees, pruned	9	19	0-50	13	1-21	32	15-45
Two-year-old trees, unpruned	14	9	0-63	10	1-21	21	6-60
Three-year-old trees, pruned	21	69	0-100	15	2-22	44	30-70

[1]Range of tree means

Test No. 3. Since basal necrosis reduced rooting surface of some cuttings in nearly all 1969 experiments, some preliminary trials were made to develop methods of reducing it. In the first, cuttings were soaked in a slurry of the fungicides, Folpet and Captan[4], then planted after an IBA treatment in untreated and Pan-O-Drench[5]-treated media. Neither Folpet, Captan, nor Pan-O-Drench significantly reduced basal necrosis which commonly affected 20 to 30 percent of the cuttings. Rooting percent was not increased by these substances.

In a second trial, Captan was mixed with the IBA-talc rooting compound (0.8 and 1.6 percent) at levels of 10 and 20 percent. While rooting percent was slightly higher and necrosis less at 0.8 percent than at 1.6 percent IBA, these differences were not statistically significant. Captan had no effect upon either rooting percentage or necrosis. However, the data suggested that high levels of IBA in talc may have some phytocidal effect.

Five juvenile and six mature trees were represented in these trials. While juvenile material rooted better (85 percent) than equivalent quality mature cuttings (59 percent), it is notable that as high as 91 percent rooting was obtained with cuttings from one mature tree.

Tests with Field-Collected Cuttings. In 1969, several tests with cuttings from field-grown trees were failures, in contrast

[4]N-/(trichloromethyl) thio/-4-cyclohexene-1-2-dicarboximide
[5]Cyno (methylmercui) guanidine

to results noted above. In two of these trials, apical cuttings collected from three and four-year-old mature-wood grafts and seedlings were treated with IBA and planted in both outdoor and indoor mist beds. Rooting at four weeks was less than 5 percent, and severe basal necrosis was noted in some replicates. Following these tests, some four-year-old seedlings (7 to 10 feet high) were moderately pruned in May and resulting shoots were propagated. These also generally failed to root in both mist beds after IBA treatment.

Handling Rooted Cuttings:

In both 1968 and 1969, rooted cuttings were planted in clay pots filled with a loam potting soil. They were placed under intermittent mist for one week, then removed to a greenhouse bench. Survival of well-rooted cuttings in pots was over 90 percent.

Most cuttings rooted in the spring renewed shoot growth under long greenhouse photoperiods and were well-established plants by August. Some cuttings rooted later in the season did not respond to greenhouse conditions, but could be induced to renew growth by gibberellic acid (GA_3) treatments. GA_3 effects were formally tested in late August. Established cuttings which had set apical buds were paired according to clone and size. One member of each pair was sprayed once daily for three successive days with an aqueous solution of GA_3 (100 ppm) ; the other member of each pair was untreated. At 10 days after treatment, GA_3-treated plants in 25 out of 29 pairs renewed apical growth. No control plants renewed growth. Statistical analysis of these results using the nonparametric "sign test" indicated that the GA_3 effect was significant at the 0.01 level of probability. GA_3-stimulated apical growth was initially rapid (8 mm per day) and shoots were typically spindly. As the new shoots lignified they partly lost this appearance. During rapid growth the new shoots were especially susceptible to moisture stress, some exhibiting permanent damage under conditions which had no visible effect on older leaves.

In late May and mid-June, rooted cuttings from 17 juvenile and 8 mature clones were transplanted from pots into a nursery bed. One to eight ramets from each clone were planted at 1- by 1-foot spacing in a completely randomized design. The beds were irrigated bi-weekly during the summer and clean cultivated. Survival and height data taken on October 1, are summarized in Table 4. Juvenile cuttings exhibited greater survival and growth than mature ones, and there was statisti-

Table 4. Survival and height of rooted cuttings from pots transplanted into nursery beds.

	Survival Percentage		Height, cm	
	Mean	Clone Range	Mean	Clone Range
Juvenile clones	85	50-100	80	54-117
Mature clones	62	0-100	38	6- 67

cally significant variation among clones within physiological age categories.

DISCUSSION AND CONCLUSIONS

Results from these studies indicate that both juvenile (three-year-old) and grafted mature black cherry can be rooted via mist propagation. The most influential factors related to rooting success were IBA treatment, tree-to-tree variation in rooting potential, season of propagation and the origin of shoots from which cuttings were taken. Wide variation in rooting percentage was associated with all four of these variables.

Effective IBA treatments were similar to those now fairly standard for plants which root with difficulty. Some research attention should be given to the possibility of localized phytotoxicity associated with the IBA-talc treatment. The basal-soak method of treatment with dilute solutions may be more suitable if these effects exist.

Shoots resulting from pruning of potted greenhouse-grown stock exhibited the best rooting, with juvenile trees propagating generally better than grafted mature stock. Moderately pruned field-grown plants produced cuttings which rooted poorly, and field-grown, three-year-old unpruned trees were not successfully propagated. Pruning of potted stock appears to have resulted in reversion to juvenile rooting capability, although this reversion was not demonstrated with moderately pruned field plants. The basis of this differences in response is unknown, and a formal comparison will be necessary to further substantiate it.

Other than treatment and material conditions, the mist propagation procedures used are standard. Both outdoor and indoor beds equipped with bottom heat and different mist control systems were suitable. Sand and sand-peat media commonly used with other species were effective.

Considerable variation in rooting success with juvenile trees was associated with genotype and season of propagation. While spring and early summer trials resulted in much better overall rooting than later tests, it is notable that the tree-to-tree range in rooting percent was 0 to 100, even in April. Since trees were all handled similarly, it is likely that this variation is fundamentally related to genetic differences among trees. Seasonal environmental differences existed and may have caused some reduction in rooting, but most of the decrease is probably due to seasonal changes in the physiological condition of cuttings. Once cuttings were rooted, survival was good regardless of season. In late season, shoot growth could be renewed by spraying rooted cuttings with GA_3.

Survival and growth of rooted juvenile cuttings was good under nursery conditions. The stem form of these plants is similar to that of seedlings. Mature cuttings in the planted sample were on the average one-half as tall as juvenile plants. This difference may be at least partly due to the generally smaller root systems of the sample of mature cuttings which we planted. Further comparative observations will be necessary before conclusions on relative growth can be made.

While more research will be necessary to perfect the above system of black cherry propagation, success to date suggests that the method could be commercially feasible if genetically superior clones were used. This genetically valuable material would warrant propagation costs higher than for seedling production which is commonly used in forestry. Schreiner (5, 6) has long advocated the direct use of genetically improved clonal lines with high-value forest tree species. Given this goal, some breeding efforts could be aimed at developing suitable clones for such direct use. One system might consist of selecting trees with especially good juvenile performance (3-4 years) from progeny tests, screening them for rooting potential, and subsequently evaluating large numbers of good rooters in long-term clonal tests. Due to generally lower rooting capability, direct use of material from mature field-selections does not presently appear as potentially useful as the above system. However, rooting success with most mature wood tested indicates that the procedure may be suitable for seed orchard establishment.

SUMMARY

Softwood stem cuttings of black cherry were rooted under intermittent mist. Indolebutyric acid stimulated rooting of material propagated in spring and early summer; late season propagation was unsuccessful. Successfully rooted cuttings all came from juvenile and mature (grafts) plants which were grown in pots and pruned to promote formation of adventitious shoots. Wide tree-to-tree variation in rooting percent (0 to 100) was observed. Basal necrosis of cuttings reduced rooting in some trials. Gibberellic acid was used to promote renewed shoot growth after rooting. Rooted cuttings were established in nursery beds. The propagation technique is discussed in relation to breeding and production of genetically improved black cherry.

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MODERATOR FLEMER: Thank you very much, Bob, for a most interesting paper. We have time for just a few questions.

JIM WELLS: I was interested in this basal necrosis; have you any idea what causes it?

ROBERT FARMER: I'm not sure if there is a pathogen involved and, if there is, whether it is primary or secondary. Possibly it is an IBA herbicidal effect; if it is, the pathogens would be secondary.

JIM WELLS: Do you think it could be a lack of oxygen effect?

ROBERT FARMER: This is possible; I noticed that in plain sand we didn't get too much necrosis.

JIM WELLS: Many years ago Hitchcock advocated putting cuttings in on an angle so that the leaves were nearly lying on the medium. This may be a way of preventing rapid respiration losses because the leaves are close to the medium and you may have lower respiration. This necrosis is a problem I have all the time and I also think light intensity is involved— but you were outdoors weren't you?

ROBERT FARMER: Yes, but we noticed our worse basal necrosis on the indoor beds in late spring and early summer, just before we had to move out of the greenhouse.

ANDY LEISER: Do you know the specific chemical quality of your sand and your irrigation water? Was your sand a quartz sand, or did it have calcium carbonate in it?

ROBERT FARMER: Our sand does have some calcium in it.

ANDY LEISER: We did some work on the chemical constitution of the rooting medium and found that the basal necrosis in five species of woody plants was essentially eliminated when we added calcium to the rooting mix. In media that were acid and low in calcium all five species exhibited extensive necrosis.

MODERATOR FLEMER: We move from a search for rapidly growing forest trees to a consideration of the propagation of extremely dwarf and contorted witches' brooms. Our first speaker is Sid Waxman, who is going to discuss with us the variability in rooting and survival of cuttings from white pine witches' broom seedlings.