# Hardwood Cuttings as a Nursery Practice: *Prunus*, Developmental Aspects

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**Hardwood cuttings are made of 1-year-old, dormant, leafless cuttings of deciduous plant species. For clones with a capacity to initiate adventitious roots easily, the procedure is simple, economical, and readily adapted to commercial applications. The development, introduction, and commercial success of a new nursery product, such as a clonal rootstock, is a long-term project which does not end in the research plot, but continues until the product is accepted by both the propagation nursery and the production industry. This paper describes a case history of one such product and ongoing stages in its development.**

**Rooting Parameters.** Biological and horticultural parameters for rooting, nursery handling, and site establishment are the following: (1) genetic potential, (2) propagation source selection and management, (3) cutting selection and treatment, and (4) environmental management and survival.

**Prunus Rootstocks.** The stone fruit (*Prunus*) and nut industries and nurseries of California prefer seedlings as rootstocks. 'Nemaguard' is the most often used rootstock for commercial peach orchards. Nevertheless, clonal rootstocks are being introduced for specific uses. 'Marianna 2624' plum is a major success story in rootstock development and is a model system in California for clonal rootstock propagation. The original 'Marianna' rootstock originated as a seedling of myrobalan (*P. cerasifera*) plum in Texas, believed to be from a cross with *P. munsoniana*. Trees of this hybrid were in the collection at the Dept. of Pomology, U.C., Davis. Leonard Day (1953) planted seeds from the hybrid and tested a range of seedlings for ease of propagation and as clonal rootstocks for stone fruits. Two clones were selected as 'Marianna 2623' and 'Marianna 2624'. The latter showed some tolerance to *Armillaria* (oak root fungus) and was introduced to California nurseries where propagation began in the 1950s. Early experiments (Hartmann and Hansen, 1958) with hormones and methods of handling showed a useful procedure to make cuttings in the fall (mid-November in California), treat with IBA , preferably quick dip in 50% alcohol, and store in moist peat moss at 60F for 6 weeks. Root initiation started, but shoots did not grow because of their dormancy. Shifting to 36F overcame the rest in buds and, when planted in the nursery row in the spring, the previously formed roots emerged promptly. Burchell (1996) describes the general procedure that is now widely used in California nurseries.

## ROOTSTOCK BREEDING AT U.C, DAVIS

Rootstock breeding and selection programs continued to test nematode resistance genes in peach germplasm (Sharp et.al., 1969) utilizing controlled-greenhouse screens. Ultimately, breeding lines and individuals resulted which were immune to the two major species of root knot nematode (*Meloidogyne incognita* and *M. javanica*) in California (Hansen, et al., 1956). One of these known as Pch Sel. 1-8-2, although itself immune, was heterozygous, segregated genes as seedlings, and could only be utilized as a clone. A second line of research was hybridization between peach and almond which included its use as a rootstock (Kester and Hansen, 1966), inheritance of root initiation (Kester and Sartori, 1966) and transmission of nematode resistance (Kester et al., 1970 ). Peach rooted easily while almond was very difficult and the hybrids showed a range from easy to difficult. Testing individuals from seedling populations of hybrids produced selections that combined nematode immunity, high vigor, ease of rooting, and what was thought to be some *tolerance to Phytophthora* (Kester and Asay, 1986). Hansen and Hartmann (1968) published a procedure for clonal propagation of peach (Pch sel. 1-8-2) and PA hybrid 2-16-8-63 clones which included fall collection of firm basal hardwood cuttings, and treatment with a relatively high concentration of IBA (quick dip; 50% alcohol) in conjunction with a fungicide [Captan and talc, 1 : 1, (v/v)]. Cuttings were immediately planted in the nursery row and left overwinter to grow out in the spring. Pch Sel. 1-8-2 was not introduced because it showed low initial survival in the orchard.

**Hansen Hybrids.** Eventually two hybrid rootstocks 'Hansen 2168' and 'Hansen 536' were released (Kester and Asay, 1986). Only 'Hansen 536' was attempted by nurseries and the initial reaction with the direct sticking procedure described (Method No. 1) was unfavorable and nurseries reported that rooting percentages were low. In the late 1980s, the Plant Research Laboratory (Driver, pers. comm.) in cooperation with The Burchell Nursery, Inc. found 'Hansen 536' to be well adapted to tissue-culture propagation and subsequent transfer to the field (Method No. 2). Relatively large numbers of almond trees propagated to 'Hansen 536' under the trademark name TrueClone™ began to be distributed by Burchell Nursery with some commercial success. The argument was made that 'Hansen 536' had lost rooting potential due to reduction in juvenility whereas micropropagated material enhanced rooting potential.

Two problems arose with the tissue-culture procedure, however. First, root systems produced were unique, being slender, spindly, and elongated, possibly due to juvenile influence. Although not seeming to create an establishment problem, they were not always viewed favorably as nursery plants. Secondly, the procedure was expensive. Procedures were then initiated utilizing the nursery-grown tissue-cultured plants as sources of cuttings that were grown by direct nursery rooting with some modification of timing and handling of source material (Method No. 3.). Eventually Burchell Nursery returned to the direct method.

Three other commercial nurseries were able to adapt the direct method of rooting to commercial production although all reported that the percentage was less than desired (averaged about 50%) and production was erratic both in the nursery row and in different years. In addition, some trees in specific lots sometimes failed to survive transplanting, particularly if stored or if planting was delayed. 'Hansen' has a short chilling requirement and (as stated by one nurseryman), has a short "window" for nursery handling (digging and transplanting).

**New Rootstock Selection.** In 1993, test plot information from a range of rootstocks indicated potential superiority of another experimental peach × almond hybrid with different parents as "Hansen 536" but from the same program. Cutting material was provided to three commercial nurseries and to Foundation Plant Materials Service, U.C., Davis (FPMS) to be planted in the same nursery rows as 'Hansen 536' a range of rooting percentages (27% to 61%) resulted for the experimental hybrid and a comparable range of 33% to 65% for 'Hansen 536'. Rooted cuttings of both rootstocks were budded to 'Nonpareil' almond and produced under standard production procedures of the three participating nurseries. Trees were dug, handled according to individual practice, and delivered to Department of Pomology, U.C., Davis. Trees of the two rootstocks were alternately planted in close planted rows at the Nickels Research Farm, Arbuckle, CA, each nursery source being kept separate from the others.

Tree survival counts made in mid summer showed differences both between rootstocks and among nurseries indicating genotype × environment (management) interactions. Trees produced by one nursery showed essentially complete survival (97% vs. 100% survival of the two rootstocks). Trees produced by Nursery 2 had been delivered in a timely fashion to U.C., Davis and were heeled in at a sawdust holding bin under a shelter, but in the open. Because of extensive rain in February, planting was delayed until after trees had leafed out. Only 4% of the trees on 'Hansen 536' survived, but 49% of the experimental hybrid had survived and grew well. Trees from Nursery 3 had been in cold storage where they remained until planting. Examination of the root systems in storage showed rotting and deterioration on essentially all roots of 'Hansen 536'; in contrast roots of the experimental hybrid were healthy with little or no rotting. Planting took place in March, of which 90% of the experimental hybrid survived whereas only 16 percent of trees on 'Hansen 536' survivied. All surviving trees on both rootstocks were growing well at the end of the year.

## DISCUSSION

Rooting response and adaptation to nursery propagation may result from interactions among parameters listed in the early part of this paper. Genetic factors determine if a particular clone is easy-to-root as with 'Marianna 2624' . 'Hansen 536',which falls into an intermediate rooting category, may be vulnerable to other rooting and survival parameters. Short chilling of 'Hansen 536' narrows the dormancy window and may make this clone more susceptible to adverse storage and handling conditions. Changing to a higher chilling genotype may overcome some of the handling problems, but not improve rooting. Hormone treatments, timing of collection, type of cutting material, and source of cutting material need to be investigated. Protecting the exposed cutting from drying out in the fall and winter in the nursery row may help to increase survival (Burchell 1996). Thinner cutting material of plum produced higher rooting percentages than thicker material. However, unless the cuttings were well protected they were less capable of surviving in the nursery row. Thicker cuttings survived better under field conditions (Howard, 1994).

Selection and handling of stock material for hardwood cuttings of intermediate rooting clones as 'Hansen 536' have brought into question the possibility of loss of rooting potential occurring during the initial distribution of the clone and during subsequent maintenance. Tissue-culture propagation, although expensive, was apparently effective initially in developing a supply of nursery plants to establish a market and possibly restoring some rooting potential which was beneficial in the next propagation generation when used in combination with other modifications of stock plant handling and timing. In the longer term, micropropagated plants did not result in significantly improved production, and the commercial nurseries involved returned to conventional propagation procedures, which had problems of inadequate and somewhat erratic rooting. Key biological questions concerning the importance of juvenility status of source plants and other procedural parameters could not be answered because of trade secret aspects of the operation.

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