Rooting Pear, Plum Rootstocks

growth-regulator treatments and a warm preplanting storage period promoted rooting of fall-collected hardwood cuttings

Hudson T. Hartmann and Carl J. Hansen

Taking hardwood cuttings in the fall—while the buds were in the rest period—treating them with indolebutyric acid, followed by immediate planting or holding at 60°F–65°F for several weeks before planting gave good rooting of several difficult-to-root tree fruit rootstocks.

In propagating nursery trees of some fruit species there is a trend toward the use of selected, vegetatively propagated rootstocks rather than seedlings because clonal rootstocks may have certain special characteristics, such as disease or insect resistance, freedom from virus, or dwarfing or invigorating influences on the tree.

For widespread use of such rootstocks, simple, inexpensive propagation methods—as the use of hardwood cuttings—are needed. However, hardwood cuttings of most fruit tree species are notoriously difficult to root.

The usual procedure of collecting the cutting material in late winter and planting the cuttings in early spring often results in failure. The bases of the cuttings are set 6″–8″ deep in the soil where temperatures in early spring — in Central California — are about 50°F–55°F — a level not conducive to rapid root formation. The buds above ground, under the influence of warm daytime spring temperatures, develop into leaves, transpiration soon desiccates the cutting and it dies before roots have a chance to form and absorb water. If root primordia can already be initiated at the base of the cuttings before planting they should quickly develop into roots and absorb water to compensate for the loss of water from the leaves, thus permitting survival of the cuttings.

Induction of adventitious root formation by holding cuttings for a period of time at temperatures high enough to stimulate root formation before planting is best done in the fall when the buds in most deciduous species are in the rest period. In late winter or early spring the buds have received their normal winter-chilling and are no longer in the rest period, and storage at temperatures high enough to stimulate root formation would be likely to cause undesirable development of the buds and leaves.

The Marianna 2624 plum—a vigorous seedling selection of the parent Marianna plum—is widely used in California as a rootstock for plums and apricots, due to its resistance to root-knot nematodes and oak root fungus. It is ordinarily propagated by hardwood cuttings, but with some difficulty, especially in the heavier soil types.

Marianna 2624 plum was the only variety used in the 1956–57 tests. In one test cuttings were taken November 16, treated with indolebutyric acid, then held in storage in damp peat moss at six different temperatures—80°, 70°, 60°, 50°, 40°, and 36°F. Visible roots appeared after three weeks at 80°F, four weeks at 70°F, and six weeks at 60°F. At the three lower temperatures no roots appeared even after 13 weeks.

Comparisons were also made between fall and spring collection and planting. Cuttings were taken October 2, November 13, and February 12. At each collection date one third of the cuttings were treated before planting with indolebutyric acid at 45 ppm—parts per million—for 24 hours, one third with IBA at 500 ppm for five seconds, and one third were untreated. In addition, relatively high temperature preplanting storage treatments were given to other groups of cuttings in both the fall and spring collections. At the October and February dates, cuttings were collected, then held in moist storage at 60°F in a mixture consisting

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Percent Survival of Hardwood Cuttings of Several Fruit Species
Cuttings prepared November 20, 1957. Counts made June 27, 1958, 150 cuttings per treatment

Species and variety	Time of planting and concentration of IBA in parts per million*										Diff. req. for significance at 1% level
	Nov. 21, 1957				Dec. 20, 1957 (after 4 weeks storage at 65°F)			Mar. 3, 1958 (after 4 wks. storage at 65°F followed by 10 wks. storage at 40°F)			
	0	45*	100*	200*	45	100	200	45	100	200	
Old Home Pear	.	..	0	1	..	34	46	..	9	16	13
Farmingdale Pear	.	..	0	0	..	0	0	..	0	0	..
Variolosa Pear	.	..	63	41	..	19	9	..	1	0	36
Brompton Plum	1	33	33	..	7	1	..	2	0	..	18
White Damson Plum	0	7	11	..	27	19	..	3	2	..	24
Santa Rosa Plum	5	22	19	..	43	32	..	16	19	..	21

* Base of cuttings soaked for 24 hours.

Effect of Time of Collection, Storage, and Auxin Treatments on Survival and Growth of Marianna 2624 Plum Hardwood Cuttings
Three replicates of 45 cuttings each per treatment, 1956–57

Date collected	Handling method	Treatment IBA	% survival	Av. tree height July 26, 1957
Oct. 2	Planted immediately	45 ppm*	56	83 cm
		500 ppm**	46	85
		Control	28	63
Oct. 2	Stored for 6 weeks at 60°F Planted Nov. 13	45 ppm*	53	73
		500 ppm**	50	71
		Control	23	70
Nov. 13	Planted immediately	45 ppm*	79	96
		500 ppm**	75	102
		Control	29	73
Nov. 15	Stored for 6 weeks at 60°F Moved to 36°F until planted Feb. 19	45 ppm*	95	100
Feb. 12	Planted immediately	45 ppm*	50	60
		500 ppm**	75	70
		Control	8	48
Feb. 12	Stored for 3½ weeks at 60°F Planted Mar. 8	45 ppm*	65	67
		500 ppm**	28	73
		Control	0	..
Feb. 12	Stored as shoots for 4 weeks at 32°F Planted Mar. 13	45 ppm*	69	60
		500 ppm**	54	63
		Control	2	40
Difference required for significance at 1% level			32	17

* Base of cuttings soaked for 24 hours in indolebutyric acid, 45 ppm.
** Base of cuttings dipped for 5 seconds in indolebutyric acid, 500 ppm.

Lemon Fruit Quality Studied

comparative tests made of several new strains frequently used to avoid some diseases prevalent in old line Eurekas

G. E. Goodall and W. P. Bitters

To avoid the lemon tree diseases of Dry Bark and Lemon Tree Collapse—so prevalent in the old line Eureka strains—new strains have come into use in Santa Barbara County within the past 10 years.

A study of the quality of the fruit produced by some of the newer strains included one old line Eureka—the Thornton—recognized to be of superior fruit quality. Two new Eureka nucellar types—the main types planted in recent years—and four Lisbon type strains—which appear to produce longer-lived trees than the Eureka nucellars but have not been evaluated in Santa Barbara County for their fruit quality—were the new strains tested.

The fruit for the tests came from a 1950 planting on land previously used for walnuts. The number of trees used varied from 14 to 20 for each selection.

Two test picks were kept separate from the orchard pick through storage. The picks were made on May 13 and July 18, 1957, and account for approximately one third of the season's fruit.

Each strain selection was washed and sample graded. The fruit was stored by color separation—maturity—for the normal time for each color. The longest were the dark-greens of the May 13 pick that were stored over five months. Two 10-fruit random samples were taken for laboratory determinations from each strain and color separation just before the fruit was packed.

A past serious infestation of red scale in the test orchard showed up on the fruit of both picks and contributed to the larger than normal elimination at grading. No significant difference in scale could be observed among the eight selections.

The fruit from the pick of July 18 showed about 2% of sunburn on each of the three Eureka type lots but none on the Lisbon type strains.

Decay in storage was not a serious factor. Small numbers of decayed fruit, blue green and alternaria rots, were observed in Thornton, Monroe-on-sweet-rootstock, Frost Nucellar Eureka, and Cook Nucellar Eureka.

The total yield for the two picks presented in the table shows the relationship between field box yields and cartons of first grade fruit.

The quality of the fruit of the Prior 14-18 and the Frost Nucellar Lisbon appeared to be about equal to the Eureka types, long used as the standard lemon for coastal areas. However, the poor bearing record of the Prior 14-18 in Santa Barbara County would eliminate that strain for new plantings. Of the Lisbon types tested, only the Frost Lisbon appears satisfactory from the fruit quality point of view.

The Monroe and Hales on sweet rootstock showed good packout records. But they were low in juice and acid and therefore inferior in over-all fruit quality. The Monroe on grapefruit root produced fruit that gave both a poor packout and low laboratory rating. This combination is a heavy yielder of total fruit but gives no more first grade fruit than other good selections.

Of the Eurekas tested, the old line Thornton excelled in fruit quality, but it is a weak, diseased tree. There was no difference in fruit quality between the two Eureka nucellars tested—Frost and Cook—indicating that both are good Eureka type selections.

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Citrus Field Research, Inc., T. B. Bishop Co., and Goleta Lemon Assn. cooperated in the studies reported in the above article.

The above progress report is based on Research Project No. 1134.

Sample Grading of Lemons

Weighted average of picks of May 13 and July 18, 1957, for eight strain-rootstock combinations from 8-year-old trees

Strain/Rootstock	Packout		Color	Av. size fruits per carton	Yield per tree	
	Fresh %	First grade %	Dk. & Lt. green %		Field boxes	First grade cartons
Old Line Eureka						
Thornton/Bishop Swt.	87	73	82	167	2.7	2.4
Nucellar Eurekas						
Frost/Bishop Swt.	84	64	92	162	2.3	1.8
Cook/Bishop Swt.	85	64	85	166	2.3	1.7
Old Line Lisbons						
Monroe 1-7/Bishop Swt.	84	71	83	167	2.5	2.1
Monroe 1-7/Stow Gpft.	70	53	77	175	3.6	2.3
Prior 14-18/Bishop Swt.	84	69	94	168	1.3	1.2
Hales #2/Bishop Swt.	89	72	81	167	1.7	1.6
Nucellar Lisbons						
Frost/Stow Gpft.	80	65	81	168	2.8	2.2

Laboratory Determinations of Lemon Fruit Quality

Weighted average of samples taken from storage of eight strain-rootstock combinations under test

Strain/Rootstock	Rind thickness Av. mm.	Juice % by volume	Citric acid Lbs./ton
Old line Eureka			
Thornton/Bishop Swt.	5.0	33.7	44.6
Nuclear Eurekas			
Frost/Bishop Swt.	5.0	32.4	45.4
Cook/Bishop Swt.	5.0	32.4	45.1
Old Line Lisbons			
Monroe 1-7/Bishop Swt.	5.6	28.6	40.2
Monroe 1-7/Stow Gpft.	5.4	29.9	42.5
Prior 14-18/Bishop Swt.	4.9	31.9	44.1
Hales #2/Bishop Swt.	5.6	29.1	39.6
Nucelllar Lisbon			
Frost/Stow Gpft.	5.1	31.4	44.3

ROOTSTOCKS

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of half vermiculite and half perlite for about 40 days for the fall collections and 24 days for the spring collections before planting.

Rooting of Marianna 2624 cuttings was considerably promoted by IBA applications. Such benefits were very pronounced with cuttings taken in the spring; in fact, practically no rooting was obtained otherwise. With IBA-treated cuttings there was no appreciable difference between those taken and planted in the fall or in the spring. Best rooting, by far, however, was obtained with cuttings taken in mid-November, stored for six weeks at 60°F, when roots became

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NITRIFICATION

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may become quite acid as the oxidation of ammonia progresses, and nitrification rate will decrease.

In two calcareous soils—Salinas clay and Imperial clay—nitrification of all three fertilizers proceeded rapidly at low levels of application. At higher levels part of the ammonia was converted to nitrite instead of being oxidized all the way to nitrate. The nitrification process takes place in two steps, each performed by a different group of bacteria. In the first step ammonia is converted to nitrite by *Nitrosomonas* and *Nitrosococcus*. In the second step nitrite is converted to nitrate by *Nitrobacter*. Free ammonia, present when soil pH is above 7, is toxic to *Nitrobacter*, so that nitrites may accumulate temporarily in alkaline soils at high ammonia concentrations. Nitrites are toxic to growing plants in relatively small amounts, but fortunately their toxicity is much less in alkaline soils than in an acid environment.

In the calcareous soils there were decreases in ammonia nitrogen not compensated by increases in nitrite and nitrate, indicating some loss of ammonia by volatilization.

These experiments indicate that although nitrification may be inhibited in localized zones due to high ammonia concentration, high pH, or other factors, nitrate production usually goes on at rapid rate. Slow nitrification in the field may occasionally be observed where biological activity in general is decreased by factors such as inadequate moisture or low temperature, but is not likely due to lack of a vigorous nitrifying population in the soil. For example, the maximum rate of nitrate production observed in the Salinas clay was 88 pounds nitrogen per acre per day.

pH Changes in Two Soils During Nitrification

Weeks: 0	1	2	3	4	0	1	2	3	4
Yolo loam					Hanford sandy loam				
100 pounds nitrogen (aqua)									
8.0	7.0	7.4	7.1	7.1	6.6	6.0	5.6	5.7	5.6
1,600 pounds nitrogen (aqua)									
9.9	8.5	7.8	6.7	5.8	9.8	9.1	9.1	9.1	9.1
100 pounds nitrogen (ammonium sulfate)									
7.4	6.9	6.8	6.8	6.8	6.1	5.7	5.3	5.5	5.8
1,600 pounds nitrogen (ammonium sulfate)									
7.1	6.4	6.0	6.0	5.4	5.9	5.9	5.5	5.2	4.9

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The above progress report is based on Research Project No. 1681.

ROOTSTOCKS

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barely visible, then moved to 36°F until planted on February 19.

In the 1957–58 studies, cuttings were made of Old Home, Farmingdale, and Variolosa pear, and of Brompton, White Damson, and Santa Rosa plum.

Old Home and Farmingdale are valuable pear root and body stocks due to their high resistance to fire blight—*Erwinia amylovora*. Variolosa is under test as a promising vigorous pear rootstock. White Damson and Brompton plums are being tested for use as peach rootstocks in wet areas in orchards. Limited experiments have indicated that Santa Rosa plum may have considerable resistance to oak root fungus so it is being tried as a rootstock mainly for Japanese plums.

Only fall-collected cuttings were included in the 1957–58 tests. Three replicate groups of 50 cuttings each were used for each treatment. One set of cuttings was planted in the nursery immediately after collecting on November 20. Most of the cuttings were treated by soaking their bases in a solution of indolebutyric acid for 24 hours at various concentrations. Untreated pear cuttings were not included because earlier studies showed complete failure to root unless IBA was used.

A second set of cuttings, also collected November 20, was treated with IBA then stored in slightly damp peat moss in orchard lug boxes at 65°F for four weeks to hasten initiation of root primordia. At the end of this time—December 20—when adventitious roots were barely visible on the cuttings they were removed and planted in the nursery.

A third set of cuttings was handled as the second except rather than planting in the nursery after the 65°F storage period, they were transferred to 40°F for 10 weeks until they were planted on March 3. The 40°F temperature prevented further root development and, at the same time, overcame the rest period of the buds.

The most suitable treatment varied with the variety. Old Home pear cuttings gave the best rooting when planted in the nursery just following the 65°F storage period. Variolosa pear showed best rooting when planted in the fall immediately after collecting. Farmingdale pear completely failed to root under any of the treatments. Brompton plum rooted best when planted in the fall just after collecting. White Damson and Santa Rosa plum both rooted best when given the 4-week 65°F storage period just before planting. Holding the cuttings at 40°F for 10 weeks following the 65°F storage period was detrimental with all the varieties used in the 1957–58 tests.

Root systems developed by August 7 on typical cuttings of the varieties used in the 1957–58 tests. *Left to right*—Brompton plum, White Damson plum, Santa Rosa plum, Old Home pear, and Variolosa pear.

Use of IBA was definitely beneficial in rooting plum cuttings in each of the three instances where untreated controls were included. The photograph on page 14 shows typical root systems which developed from the cuttings of the varieties used in the 1957–58 tests.

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TREE SHAKING

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Fruit removal was found to be affected primarily by four variables: *1*, the frequency of the shake; *2*, the stroke; *3*, the force required to remove the fruit divided by the weight of the fruit—F/W—and, *4*, by the number of limber fruit bearing hangers in any given tree.

The upper graph on page 3 shows the relationship of stroke and frequency with fruit removal. At low frequencies there is a large difference in the percent removed by use of the various strokes. However, at higher frequencies the difference is small. The relationship represents the average removal that could be expected, but any particular tree or group of trees might vary from this as a result in the effect of F/W and the number of limber fruit bearing hangers.

No attempt has been made to isolate the effect of F/W or the number of limber hangers. However, F/W, which is the number of g's—unit weight—acceleration required, is of importance because fruit removal by shaking is the result of accelerating the limb away from the fruit. With regard to the limb characteristics, it was found that the percent of fruit removed was less on trees having several limber hangers than on rigid type trees with few hangers.

Tree damage tests indicate that limb breakage increases with increasing stroke. However, minimum damage occurred within a frequency range of 700–900 cpm. The damage may be greater when using a higher or lower frequency. All combinations of frequencies and strokes are possibly acceptable to growers, although the long stroke with a low frequency causes the tree tops to whip which increases limb breakage particularly on old brittle trees.

A number of years observations are needed before final judgment on possible root damage caused by shaking can be made. However, visual observations made in these studies indicate that boom shakers may cause less tree damage than cable shakers.

Further studies are planned to evaluate the effect of the position of the clamp on the limb, and the F/W on fruit removal and power required.

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CYANAMID

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the treated area introduces a new source of weed infestation.

In moist, sandy loam soils, planting was started 8–10 days after treatment, but in heavier soils a waiting period of two weeks after irrigation or rainfall was found necessary.

The observations made at the test plots were verified in commercial field treatments.

The amount of cyanamid applied varies with the distance between beds and the width of band treated. A rate of 1,500 to 2,000 pounds per acre is required but the amount actually applied depends on the treated portion of the field. If two 6″ bands of cyanamid are applied to 36″ beds only one third of the soil is treated. Therefore, between 500 and 666 pounds applied meet the required rate of 1,500 to 2,000 pounds per acre.

Because cyanamid contains 21% nitrogen, the cost of the treatment—$25–$30 per acre for material—was divided equally between nitrogen fertilizer and weed control.

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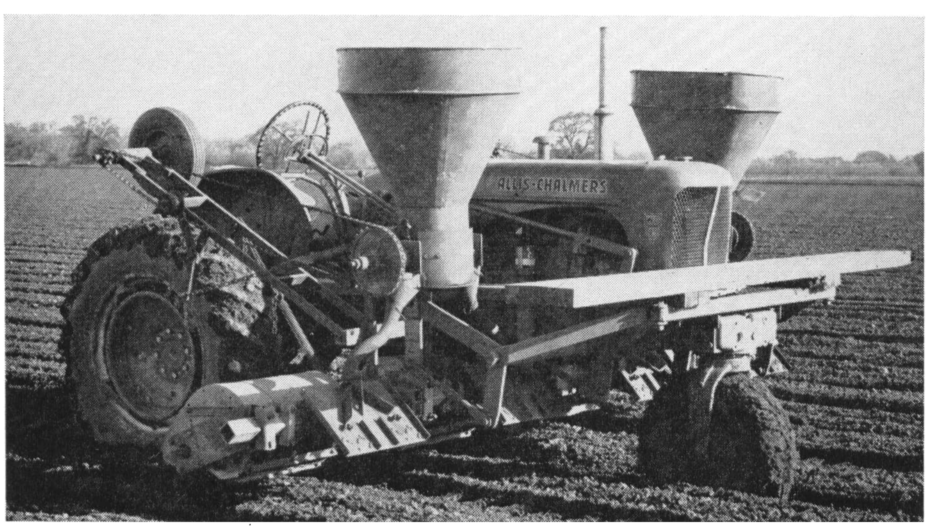
Calcium cyanamid applicator and mulcher units mounted on same tractor used in treatment for weed control.



CDEC

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Crop injury was rated in terms of stand reduction and stunting of growth. Stand reduction at the 18-day rating was based on the unthinned stand. The rating at maturity was based on the stand left after hand thinning. Normal field thinning eliminated any evidence of stand reduction caused by CDEC.

Crop Injury from Treatment with CDEC

Variety	Stand reduction		Stunting	
	18-day	Mature	18-day	Mature
Red leaf	None	None	None	None
Salad bowl	None	None	2%–5%	None
Butter lettuce	5%	None	5%	None
Romaine	None	None	2%–5%	None
Endive	None	None	None	None

Stunting consisted of a slight curling and twisting of the leaf margins. This symptom appeared on only the first leaves and later leaves were normal. At maturity no differences between the treated and the untreated plants were observed.

Complete weed control was not obtained with CDEC at rates up to 10 pounds per acre, but the results—although from only one test in one area—warrant further trials with the herbicide as a method of selective weed control for pre-emergence treatment of lettuce.

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H. F. Arle, Field Crops Research Branch, USDA, Phoenix, Arizona, and W. D. Pew, Arizona Agricultural Experiment Station, reported the experiments conducted in Arizona.

The Fujiwara Brothers, ranchers in the Chino area, cooperated in the experiment with CDEC.

The above progress report is based on Agricultural Extension Service Project No. 4188.