

New Roots on Pine Seedlings

greenhouse tests with ponderosa pine seedlings indicate time of transplanting affects rooting ability of seedling

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Many cut-over forests in the California pine region are producing at much less than full capacity because of the practice of relying upon natural restocking by seed from the remaining trees. Some of these areas contain too few trees, some support trees of less desirable species, and some have been occupied by brush. If left as they are, many of these areas will require fifty to a hundred years before full production is achieved.

Tree planting—which would promptly restock the cut-over lands—has not been more extensively employed partly because of the considerable costs involved but primarily because of the high rate of mortality among the planted trees.

Although some of the planting failures can be attributed to rodents, livestock, competing vegetation, and the long summer drought, there are many instances where the seedlings are neither eaten nor trampled but nevertheless die before soil moisture becomes limiting. As an earlier study indicated, this failure is at least partly related to the physiological condition of the seedling when planted. Some seedlings develop new roots; others, apparently morphologically similar, do not, which—in effect—is the same as planting dead seedlings.

In the present study, changes in the physiological condition of the seedling—as determined by new root production—are being followed throughout each month of the year.

During the first week of each month, two-year-old ponderosa pine seedlings—1-1 stock—are dug out of the ground at the U. S. Forest Service nursery at McCloud, packed in wet vermiculite, and shipped to Berkeley. They are then root pruned to approximately 6" and—in groups of 10 each—are planted in eight sand-filled five-gallon crocks. Perlite—sponge rock—has recently been substituted for the sand because perlite-filled crocks are easier to handle and because no appreciable difference in root growth between the two media has been indicated.

Two crocks are then placed in each of four constant temperature water baths at 50F, 59F, 68F, and 77F. Twice each day the seedlings are watered with Hoagland's nutrient solution. Drainage is accomplished through a suction tube inserted through the rooting medium to the



Ponderosa pine seedlings lifted 30 days after transplanting to sand culture in greenhouse. Left—November lifted seedling representative of the 70%–80% that formed new roots. Center—November lifted seedling representing the 20%–30% that did not form new roots. Right—April lifted seedling representative of the 100% that did form new roots.

bottom of each crock. Thirty days later the crocks are removed from the baths, turned on their sides, and the seedlings gently washed out with the sand. New root development and growth are then measured and recorded.

So far, in the 1955 study, observations have been made on stock transplanted from the nursery in October and in November. However, a comparison of root regeneration between fall lifted stock and spring lifted stock can be made—with seedlings in the 77F water bath, for instance—by using data collected in April 1953.

In the 1953 experiment, 1-1 ponderosa pine seedlings were dug from the same nursery at McCloud and planted in five-gallon sand-filled crocks. At that time,

the root temperature was held constant by a 2"-thick blanket of fiber glass insulation around the crock and by the constant temperature of the nutrient solution used in watering. The temperature in the root zone fluctuated a little more than in the 1955 experiment but presumably not enough to be of any concern.

Some objection might be raised to the 6" pruning procedure used. However, since the roots of all the seedlings were pruned to the same length and since new root development was not restricted to the lower portion of the original root system, the severe pruning was considered unimportant in these studies.

Findings

As shown in the accompanying table, new root growth on fall transplanted seedlings was much poorer than on spring transplanted seedlings. Of the stock transplanted in October, 40%–50% failed to produce any roots at all during the following month. The November transplants fared considerably better, with only 20%–30% failing to produce new roots during the first month. On the other hand, April transplanted stock all produced roots within the first month after transplanting.

Of the transplants that developed new

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Root Growth of Seedlings Lifted in October, November, and April One Month After Being Transplanted to Sand Culture in Greenhouse

	Trans-planted October		Trans-planted November		Trans-planted April	
	Crock I	Crock II	Crock I	Crock II	Crock I	Crock II
% seedlings with roots . . .	50	40	70	80	100	100
Of seedlings with roots:						
Av. no. roots over 2"	0.6	0.0	0.3	0.4	2.5	2.3
Av. no. roots 1"–2"	0.6	0.8	1.8	0.8	3.5	2.8
Av. no. roots .5"–1"	1.2	2.3	0.8	1.6	2.6	2.6

SODIUM-CALCIUM

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solutions and decreasing those of calcium was to greatly reduce the fresh and dry weights of the root systems.

In drained soil cultures of three-gallon capacity the effect of adding increasing concentrations of sodium nitrate to Hoagland's nutrient solution was studied to determine whether any changes occurred in the calcium content of the dry matter of the roots when calcium was always abundantly supplied. At the two highest sodium concentrations, the calcium content of the roots of rough lemon seedlings showed a decrease. An increase in sodium nitrate in the nutrient solution was accompanied by an increased calcium content in Cleopatra mandarin roots.

The table on page 13 shows the consistently high calcium content of the roots of the sour orange—Spanish—seedlings in the various sodium nitrate cultures.

Results of the tests confirm previous preliminary findings on the calcium content of the roots of various citrus rootstocks collected from trees in the rootstock variety plots. In the plots of these orchard trees, there were no appreciable sodium concentrations and the results in the table indicate the tendency to maintain a more or less stable calcium and magnesium content in the roots of citrus seedlings when sodium is increased and the supply of calcium is maintained by the nutrient solution and initially increased by base exchange.

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APPLE APHID

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There were three heavy peaks of movement—in late July, late August, and early September. The sudden drop in September was due to the action of parasites which killed a high percentage of aphids during this time. In the treated plots, the downward movements can be used as a measure of the control obtained following the foliage applications. As shown by the almost negligible number of aphids trapped on the bands, 12008, 3911, and Diazinon were very effective. Good control—though less outstanding—was also obtained with 1303. In contrast to its effect on upward movements, the weakest of the phosphate compounds was 17147, the reason for which is not clear. Ryania—as compared with the check—again showed a reduction in aphid movement but was far less effective

than the systemic and nonsystemic phosphate compounds.

As a check on the method of analyzing results by the use of sticky bands, colony counts and core aphid counts were made on each plot at harvest. The colony counts were made by recording the number of active colonies on four limbs in each tree and were expressed as the average number of aphid colonies per limb. The core aphid count was made by selecting 100 apples at random from each plot, cutting them in half from calyx to stem, and recording the number of infested cores. The materials used, dosages, times of application, and harvest counts are summarized in the table below.

Summary of 1955 Woolly Apple Aphid Plots, Watsonville, California

Material	Dosage per 100 gals.	Dates of application	Harvest counts	
			Av. no. aphid colonies per limb	% core aphid
Ryania	6 lbs. 100% wettable	Apr. 19 May 26 June 23 July 27	2.7	7.0
Am. Cy. 12008	1 qt. 48% emulsion	Apr. 19 May 26 June 23 July 27	0.1	0.0
Stauffer 1303	1 pt. 50% emulsion	Apr. 19 May 26 June 23 July 27	0.5	1.0
Bayer 17147	1 lb. 50% wettable	Apr. 19 May 26 June 23 July 27	1.2	2.0
Diazinon	1 qt. 25% emulsion	Apr. 19 May 26 June 23 July 27	0.3	0.0
Check	No spray	9.6	16.0

The harvest counts correlated closely with the band counts. Excellent control was obtained with 12008, 3911, and Diazinon. Less effective—but still providing commercial control—were 17147 and 1303. Ryania was the least effective of the materials used.

At harvest—because the number of colonies present in the check trees indicated that a higher percentage of core aphid should have been present—a check was made and 50% of the apples were found to have an open calyx, which was less than had been recorded in previous seasons. Although many apples in the unsprayed plot had active aphid colonies on the stem and calyx end, the aphids were nevertheless unable to penetrate to the core. The variation in core aphid infestations from season to season is no doubt connected not only with the severity of aphid infestations in the tree but also with the factors which cause open and closed calyx ends in the fruit.

Most of the chemicals used in the Watsonville plots are still in the experi-

mental stage. In the case of the systemic compounds—which were so effective in reducing the aphid movements—it may be possible, in further tests, to lengthen the intervals between treatments.

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PINE

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roots within the first month, October and November seedlings produced an average of less than three new roots over 1/2" long per seedling, whereas the April transplants averaged more than eight new roots over 1/2" long per seedling—a highly significant difference statistically.

Close examination of the seedlings that produced roots and of those that did not failed to reveal any external morphological differences. Apparently, therefore, some physiological condition exists which is associated with the ability of seedlings to produce new roots.

If these findings are substantiated by later and more comprehensive observations, a basic change taking place during the winter which increases the ability of the seedling to produce roots will be indicated.

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WALNUT APHID

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results can be obtained only where they are thoroughly applied with adequate equipment under favorable weather conditions.

In areas where the resistant walnut aphid is known to occur, an aphicide other than parathion, malathion, or TEPP must be used.

Insecticides used in the walnut aphid control program are poisonous and care must be exercised in handling and applying them, especially with parathion, TEPP, and Systox. Precautions—as given on the insecticide manufacturer's container—should be followed carefully.

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