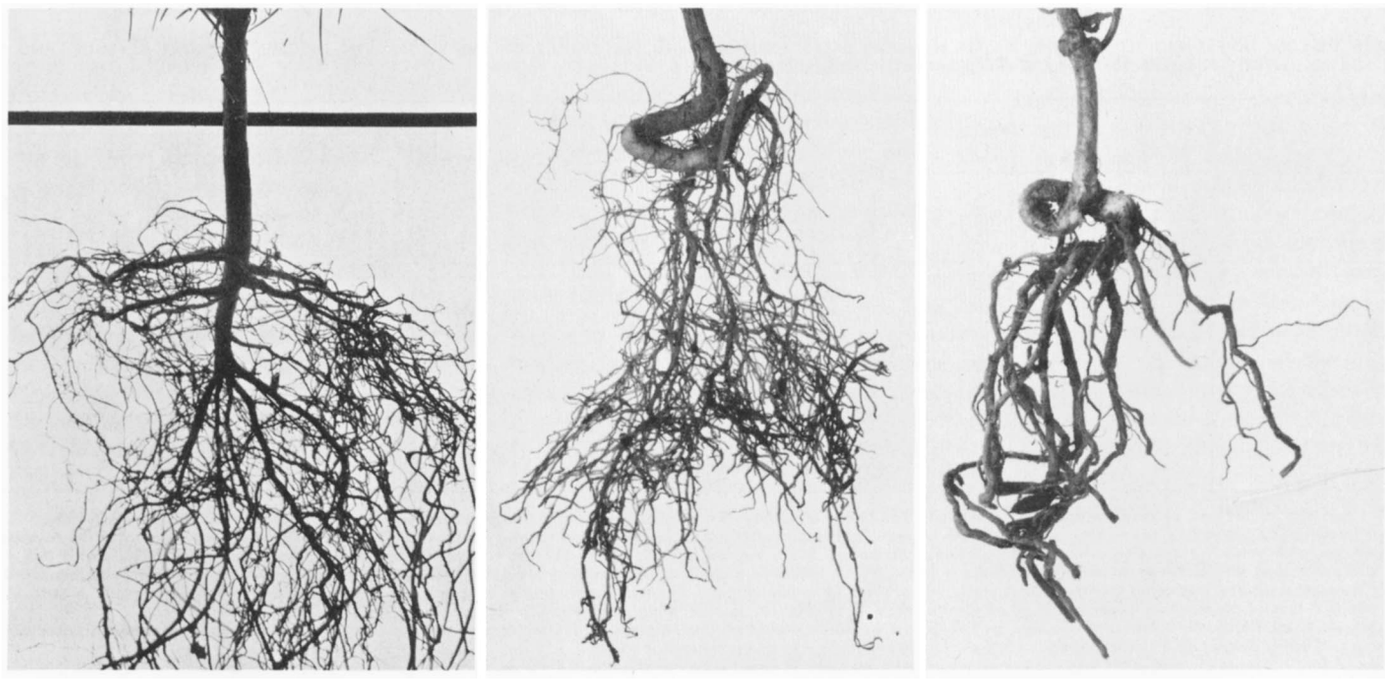
Effects of root pruning and transplanting in nursery liner

Root pruning and care during the first two nursery transplantings of four tree species significantly increased the percentage of plants with good root systems. The earlier the plants were moved from the seedflat into peat pots and then into gallon cans, the higher the percentage of plants with good root systems, and the larger they grew in caliper and height. Plants root-pruned during the early moves were larger than those not pruned. However, later root pruning resulted in smaller plants than those moved earlier, or than those moved at the same time but not root pruned.

DEATH, GROUND-LEVEL breaking of trunks, and poor growth of trees in the landscape can result from roots that are circled or kinked at the trunk near the soil surface (see photos). Although this problem is most commonly found in container-grown plants, it also occurs at times in field-grown trees. These particular root problems appeared to be caused by propagation practices at the liner stage.

Experiments reported here were conducted with the cooperation of the Oki Nursery, Sacramento, during 1966 to determine the influence of root pruning and different times of transplanting (from seedflats and liners into gallon cans) on root quality and plant performance. Species frequently found to have root defects in the landscape were used: *Eucalyptus sideroxylon* A. Cunn (red ironbark) *Pinus radiata* D. Don (Monterey pine), *Pistacia chinensis* Bunge (Chinese pistache), and *Quercus ilex* L. (holly oak). In one group of plants the seedlings and the liners were moved without the roots being pruned; in another the roots were pruned so that the seedlings could be placed in 2¼-inch peat pots without bending the main roots, and at the second move, the roots extending through the peat pots were removed before the plants were placed in gallon cans.

Roots of three species after growing in a gallon can 4 months. Left, Monterey pine root with good distribution free of kinking and circling. Center, liquidambar root with serious kink. Right, red ironbark root seriously kinked and circling. Both root conditions (center and right) occurred during transplanting from the seedflat to the liner pot.



time of production

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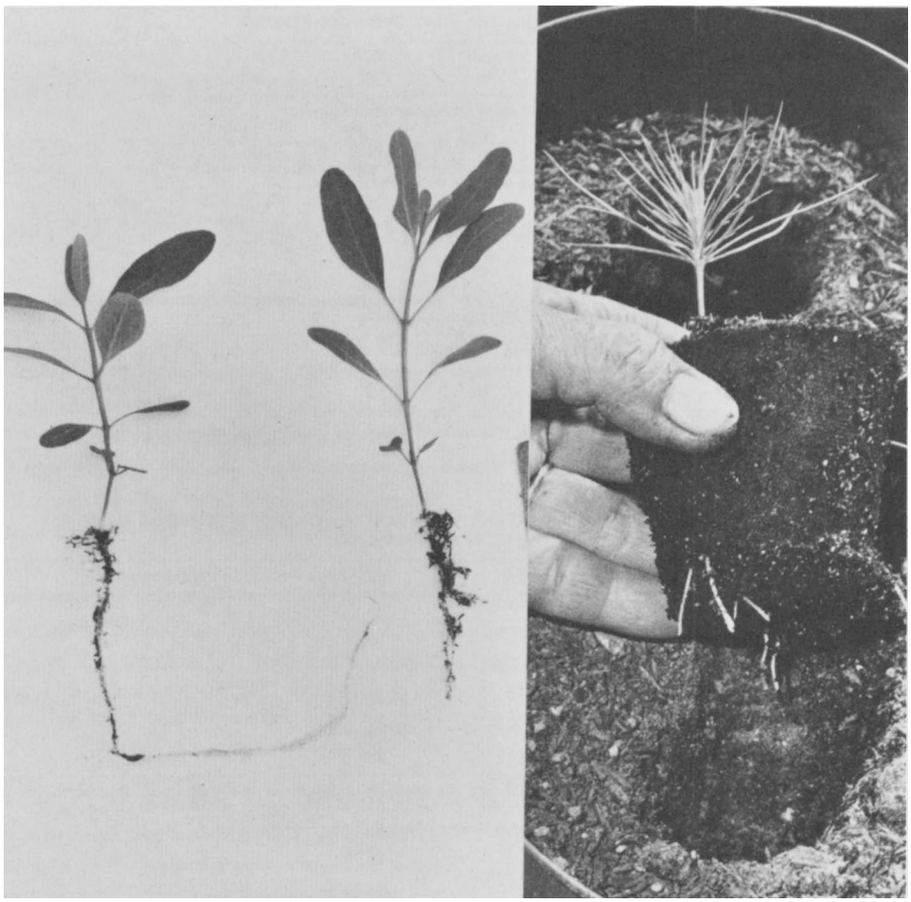

Left, ironbark seedlings from seedflat ready for transplanting into liner pot. (plant on right has been root-pruned). Right, Monterey pine before removal of projecting roots, in move to the gallon can.

Groups of seedlings were transplanted at different stages of development. The ironbark seedlings were first moved from the seedflat 35 days after seeding when the main roots had reached the bottom and had grown along the bottom for about 1 inch (about two weeks earlier than normal transplanting time). Two later moves were made, 11 and 31 days after the first. The other three species were moved from the seedflat only once, when their roots were 1 to 3 inches along the bottom (about five days earlier than normal transplanting time). Each of these groups of plants was moved into gallon cans at three different times, beginning when their roots came through the peat pots by about ½ inch. The first two moves for each species were earlier than usual nursery practice.

Transplanting

All the plants were grown in a glasshouse through the liner stage, then were moved to the field when they were transplanted to gallon cans. Roots penetrated the moist peat pots with little difficulty. At the end of the growing season, the plants were measured and their roots were washed clean and rated as to the amount of kinking and circling.

Root pruning and care in transplanting significantly increased the number of trees with good root systems (table 1). Root pruning during the two moves reduced the percentage of plants with seriously kinked roots, as well as those with roots both seriously kinked and circling. When roots were longer than the depth of the pot in which they were to be placed, kinked roots developed—as well as root circling in a high percentage of the plants (photo 2, right), particularly in the oak and pistache which are taprooted. When they were not pruned, roots that extended much more than an inch beyond the peat pot also caused kinked and circling root systems.

On the other hand, pruning did not affect the percentage of plants with roots which were circling only. In fact, regardless of the root-pruning treatment, none of the oak or pistache had root systems which were circling only. Of the few unpruned plants of these two species with good root systems, the taproots were probably broken off in transplanting so, in effect, those plants were root pruned.

Root pruning

Root pruning minimized circling, but there was a modest amount of kinking—particularly with pistache—even when the plants were root pruned. This indicates that even when roots are pruned, plants should be transplanted with care to minimize bending and kinking. Root pruning did not adversely affect the survival of the trees that were transplanted to gallon cans and placed out of doors (table 1).

Experiments were designed with ironbark, pine and pistache to separate the influence of root pruning during the transfer from the seedflat to the peat pot, from the influence of the root pruning during the move from the peat pot to the gallon can.

Root pruning at the first move (seedflat to peat pot) significantly increased the number of plants wth good root systems (table 2). Root-pruning ironbark during the move from the peat pot to the gallon can was as effective as pruning at the first move. Pruning during both of these transfers increased the percentage of ironbark with good roots from 42 to 84. With pine, the first move was the more critical, root pruning had little effect during the second move. Root pruning pistache at the first move to the peat pot increased the percentage of good root systems. In pistache, a root pruning during the move to the gallon can, seemed to be effective only if the roots had been pruned at the first move.

TABLE 1. EFFECTS OF ROOT PRUNING ON THE STRUCTURE OF THE ROOT SYSTEM AND PLANT SURVIVAL THROUGH THE FIRST GROWING SEASON

		Ironbark	Oak	Pine	Pistache
Number of trees per treatment†		416	180	288	128
		Percentage of trees with good root systems			
	Unpruned	40**	4**	48**	22**
	Pruned	86	91	94	80
		Percentage of trees with root defects			
Kinked	Unpruned	44**	30**	30**	32**
	Pruned	10	8	3	18
Kinked & Circling	Unpruned	14**	66**	20**	46**
	Pruned	2	1	1	2
Circling	Unpruned	1.7	0	2.3	0
	Pruned	1.9	0	2.4	0
		Percentage of survival in the field			
	Unpruned	96	98	99	90
	Pruned	96	97	98	96

† Trees for the root evaluations were those in gallon cans examined at the end of the growing season. Survival was determined then also.
** Results for unpruned and pruned significantly different at the 0.01 level.

TABLE 2. INFLUENCE OF ROOT PRUNING AT TRANSPLANTING ON THE PERCENTAGE OF TREES WITH GOOD ROOT SYSTEMS

Root-pruning treatments		Trees with good root systems		
Seedflat to peat pot (*first move*)	Peat pot to gallon can (*second move*)	Ironbark 16†	Pine 16	Pistache 8
			Percent	
Unpruned	Unpruned	42[a]*	61[a]	31[a]
Unpruned	Pruned	72[b]	72[a]	19[a]
Pruned	Unpruned	72[b]	98[b]	53[b]
Pruned	Pruned	84[c]	94[b]	72[c]

* For each species, values with different letters are significantly different at the 0.05 level of probability or higher according to Duncan's multiple-range test.
† Number of plants inspected for each of the 4 replicates of each of the four treatments.

Transplanting time

The percentage of plants with good root systems decreased the longer the seedlings stayed in the seedflat or the liner—particularly if not pruned. No matter how early the plants were moved into peat pots and into gallon cans, unless the seedlings were root-pruned and moved carefully, a high percentage of plants would have defective root systems. Of the plants not root-pruned, only the earliest move of ironbark resulted in more than half of the plants (82%) with good root systems. Any combination of later moves into peat pots and into gallon cans, reduced the percentage of plants with good root systems to less than 30%. The second move in each case was earlier than usual nursery practice.

In both the pine and ironbark which were not pruned, the percentage of plants with good root systems was higher for the third move to the gallon than for the second. At the first move to gallon cans, the roots coming through the side of the liners were short and bent very little. At the second move, the roots were longer and were bent and kinked when placed in the gallon can. At the third move, the roots were long and intertwined in the soil mix under the peat pots. Many roots were broken off when the plants were lifted from the flats. This served as a root pruning and resulted in fewer plants with kinked roots.

The thicker taproots of oak and pistache were not easily broken during the later transplantings. At the third move to gallon cans, good plants of those not root-pruned were less than 10%.

Root pruning was effective in ensuring plants with good root systems at almost all times of transplanting, particularly after transplanting from liners into gallon cans. Only at the third move of ironbark from the seedflat, was the percentage of plants with good root systems significantly reduced. Root-pruning of plants from the seedflat shortened the roots to the depth of the liner but did not shorten the spreading laterals. Many of these laterals were kinked during the third transplanting into the liner. On the other hand, when the liner was moved to the gallon, all roots projecting through the peat pot were removed. In general, the earlier the plants were moved into peat pots and into gallon cans, the more they grew in trunk caliper and height.

Root pruning ironbark at either the first or second move to the gallon cans (of plants that had been root-pruned at the first move to the peat pots) resulted in plants of larger caliper, 85% more trunk area, and 30% more height than root pruning at the second or third moves into gallon cans (of those moved into peat pots at the third move).

As with ironbark, root pruning of oak, pine and pistache resulted in slightly (although not significantly) larger caliper plants than those not root pruned—particularly at the earliest move into the gallon can. Root-pruning oak at the third move reduced plant caliper and height compared with earlier moves, or compared with unpruned plants at the same third move.

Severe kinking

The severe kinking and circling which occurred, particularly on plants not root-pruned, did not affect the survival or growth of the plants. Root circling would not be expected to reduce growth or survival of these plants during the first season in the nursery. Since most of these plants were staked or grown close together, a plant unable to stand alone because of a kinked trunk root would not be noticed unless untied from the stake. The fact that kinking and circling of roots usually does not affect survival or growth of plants in the nursery, does not mean that these defects may not lead to problems later in the landscape.

Even though only peat pots were used in the study, it can be stated with reasonable certainty that regardless of the kind of liner container, pruning the roots of seedlings in transplanting from the seedflat and into the gallon can is essential to production of roots relatively free of kinking and circling. Root problems can develop later in nursery production if trees are left too long in a container and are not root pruned when transplanted. However, if initial care is not taken, no reasonable amount of effort later can correct root defects caused in these early stages.

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