The second point that you brought up — could this particular planter take plugs? Yes, we can plant the plugs that come out of the Styroblocks. We had a very nice 5-inch column of cuttings on a peatlite mix; they went through the planter very well. It could not be used for planting grafted plants because we had that heavy root ball on it; they would just fall over as the heavy wheel went around. We had another planter that we used for grafted material which would insure that the understocks went well into the soil.

HUGH STEAVENSON: Larry, you were referring to Rhode Island Nursery. It is just a beautiful example of the old and tried ways. If you are traveling East and want to see an example of really the standard in *Taxus* and other production, you want to stop and see Rhode Island Nursery. East of the Rockies, to grow *Taxus* we refer to Rhode Island Nursery for the standard of excellence in that type of production. One of the things that they do is to plow manure under as heavy an application as they can plow under. Then they get a lush green finish on their *Taxus* when some of their neighbors, who don't use manure on their *Taxus*, are producing plants somewhat on the yellow side. It is something to see, and if you are out there, have Larry show you what Rhode Island Nursery is doing.

IRRIGATION REQUIREMENTS OF TRANSPLANTED CONTAINER-GROWN PLANTS

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Container-grown plants often fail to establish in the landscape because of desiccation. Transplanted container plants can suffer from lack of water since they usually have a large top (leaf surface) compared to the volume of the rootball in the container. In the nursery, they are irrigated frequently to keep up with evaporative demand. When transplanted, the rootball provides almost all the water for transpiration until roots have grown into the surrounding soil. Because of the limited amount of available water in the rootball, the plant requires frequent irrigation until it is established and can exploit the surrounding soil for water. Infrequent irrigation after transplanting can therefore result in moisture stress.

Moisture Relations in Transplanted Rootballs. After planting, water supply to the top is limited not only by a relatively small amount of water in the rootball but water may be further limited by water loss from the rootball to the soil surrounding the rootball (Figure 1). Soil at the bottom of the container is saturated (all pores filled with water), and the moisture content decreases with height. When the rootball is removed from the container and planted in the landscape, however, the soil surrounding the rootball can withdraw moisture from the rootball as the surrounding soil drains to field capacity or if the surrounding soil is drier than the rootball. Water will be transferred between the rootball and soil as long as moisture films are continuous.

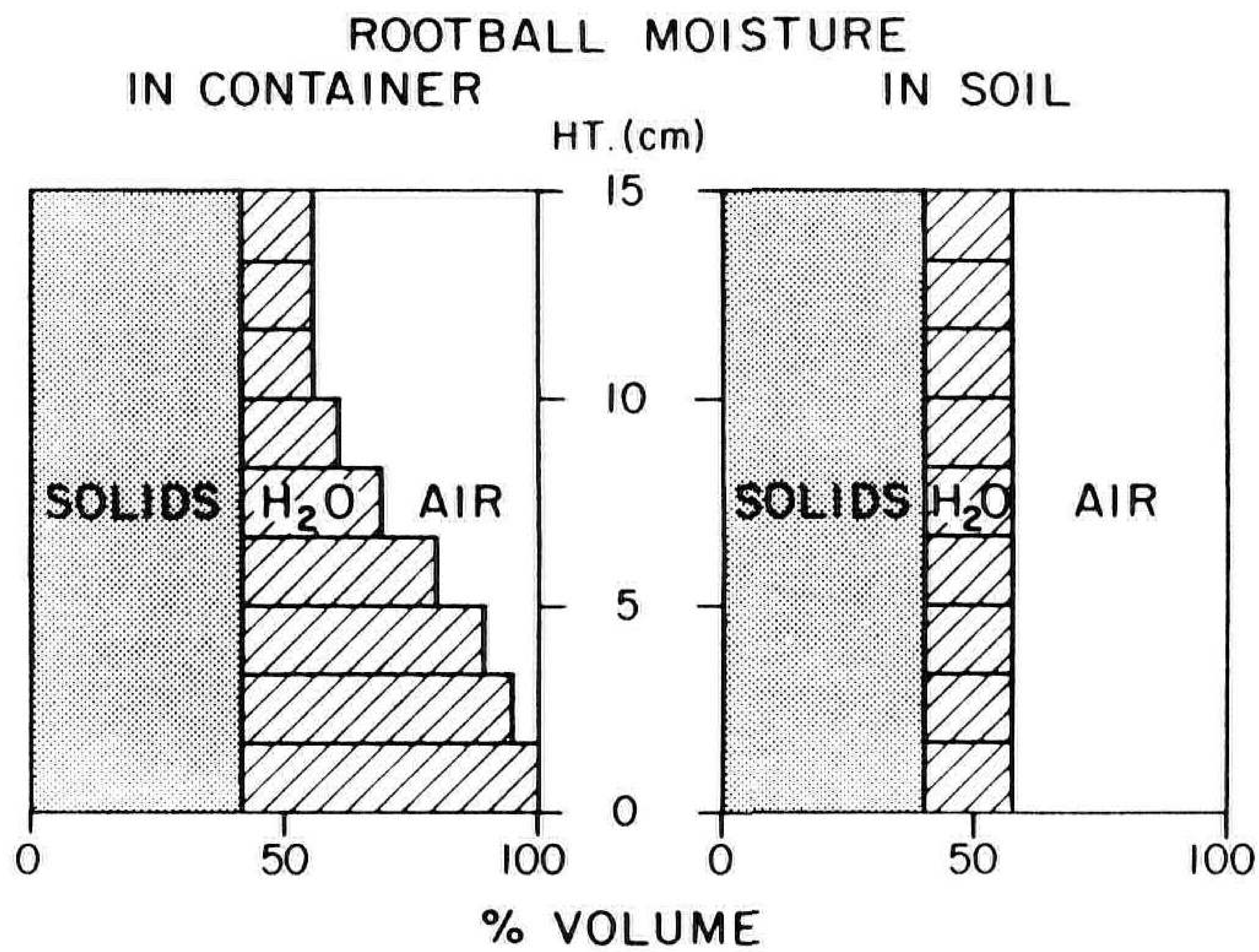

Figure 1. The soil moisture content profile of a container mix following irrigation of a rootball in a container and a rootball transplanted into the soil. When a rootball is placed in the soil, water drains from the rootball into the soil and may even be withdrawn below the field capacity of the rootball by the surrounding soil. Adapted from Spomer (3).

Because less water is retained in a planted rootball, a transplanted plant can dry out in a shorter time than when in the container (2,4). Costello and Paul (2) reported that 24 hours after irrigation, a loss of 85% of the water in transplanted one gallon rootballs compared to a 38% loss in containers. Thus, plants in containers that are irrigated every 2 to 3 days in the nursery would need to be irrigated every 1 to 2 days when planted in the landscape. Daily irrigation of many landscape soils, however, results, in the soil remaining too wet, creating a poor environment for root growth and function. If frequent irrigation of the rootball could be done without wetting the soil surrounding the rootball at each irrigation, the soil adjacent to the rootball would be more favorable for root growth and function (1).

In this report two field experiments are discussed which investigate the effects of irrigation on plant establishment. The first experiment was carried out in the summer of 1978 and the second experiment in the summer of 1979. Shrubs grown in U.C. mix (⅓ coarse sand, ⅓ redwood sawdust) in one-gallon containers were used. In the first experiment the objective was to evaluate the benefits of frequent irrigations confined to the rootball compared to frequent and infrequent irrigations to the basin.

1978 Experiment. Comparing root and top growth of *Escallonia rubra* given frequent or infrequent irrigations.

In July, 1978, 15 one-gallon *Escallonia rubra* (Ruiz & Pav.) plants were planted at each of two locations: one with a sandy loam soil and one with a clay loam soil. Thirty-inch diameter basins were built around each plant and filled with 30 liters (8 gallons) of water. A collar of plastic garden edging was placed at the top of the rootball and pushed into the soil at the soil/rootball interface on five of the plants. The collars were filled with 1.8 liters (0.5 gallon) of water every 2 days (Figure 2). Five plants were watered every 2 days by filling the basin with 30 liters of water, and 5 basins were filled every 4 days. For 3 weeks following planting, wilting, necrosis due to desiccation (burning) and plant survival were recorded.

Results. There was no visual difference between the response of the plants in the sandy loam from those in the clay loam, so the data from both locations were combined. All of the plants irrigated in the collar and all of the plants watered every 4 days wilted between each watering. After 30 days, 20% of the collar treatments and 30% of the 4-day basin plants had died, with those surviving showing severe leaf damage. One half of the basin plants receiving 30 liters of water every 2 days wilted between waterings the first week and showed slight foliar damage.

After the first three weeks of the experiment the number of days between irrigations was increased as indicated in Table 1.

For 3½ months after planting, trunk growth and root growth were measured. The trunk growth was not significantly affected by location, although root growth was significantly better in the clay loam soil. The percent increase in trunk crossectional area was significantly greater in those plants irrigated by basin every 2 days (Figure 3), but not between irrigat-

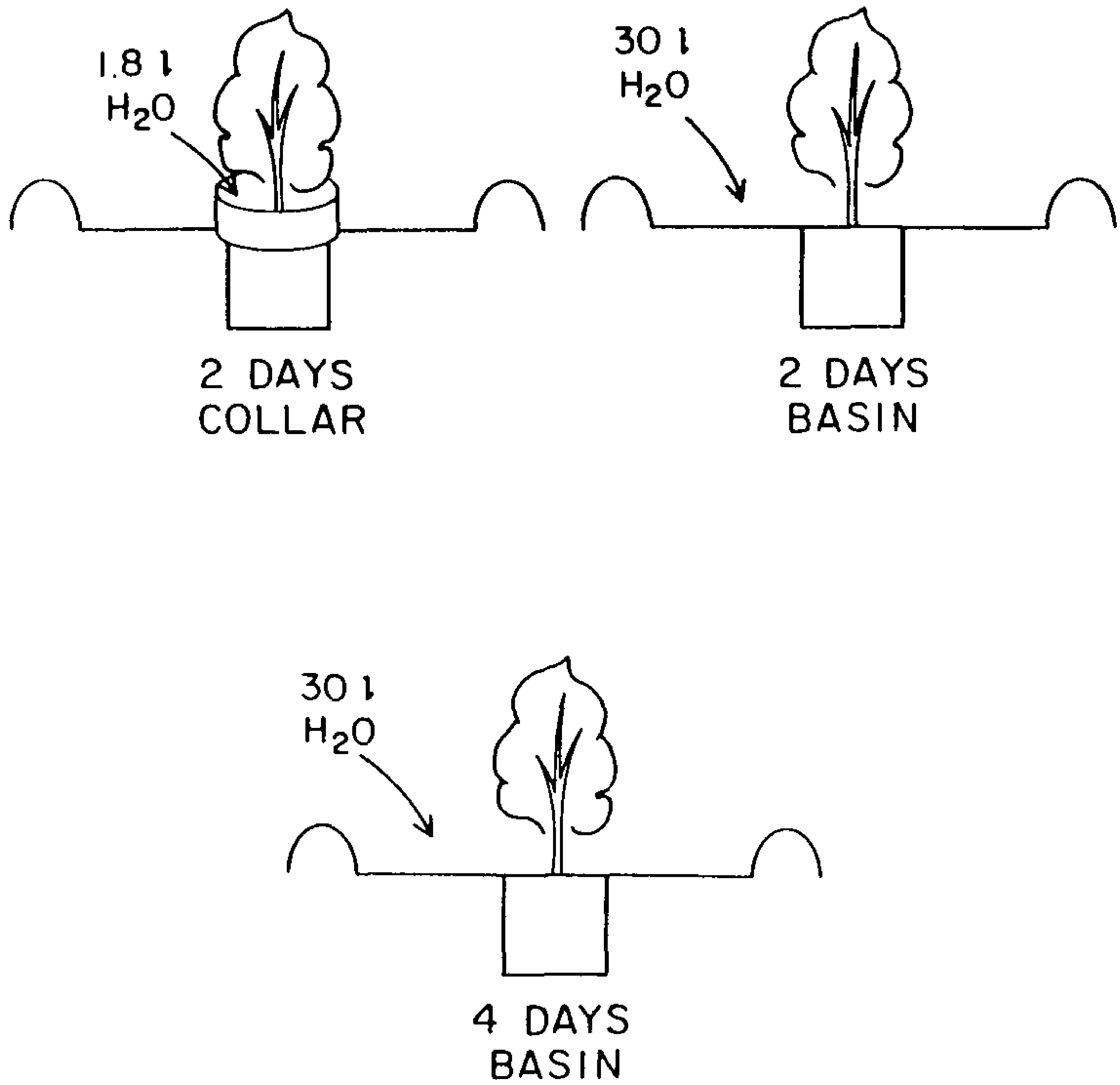

Figure 2. Treatments for the 1978 experiment. One-gallon *Escallonia rubra* plants were transplanted into the field soil and irrigated by filling the basin with 30 liters of water or by filling the collar at the top of the rootball with 1.8 liters of water.

Table 1. Water Schedule for the 1978 Experiment.

	TREATMENTS		
Date	COLLAR	2 DAYS/BASIN	4 DAYS/BASIN
July 20-Aug. 16 (3½ weeks)	2 DAYS/ 1.8 Liters of Water	2 DAYS/ 30 Liters of Water	4 DAYS/ 30 Liters of Water
Aug. 17	30 Liters of Water	30 Liters of Water	30 Liters of Water
Aug. 21-Sept. 5 (2 Weeks)	4 DAYS/ 1.8 Liters	4 DAYS/ 30 Liters	8 DAYS/ 30 Liters
Sept. 6	30 Liters of Water	30 Liters	30 Liters
Sept. 7-Oct. 28 (7 Weeks)	8 DAYS/ 1.8 Liters and 16 DAYS/ 30 Liters	8 DAYS/ 30 Liters	16 DAYS/ 30 Liters

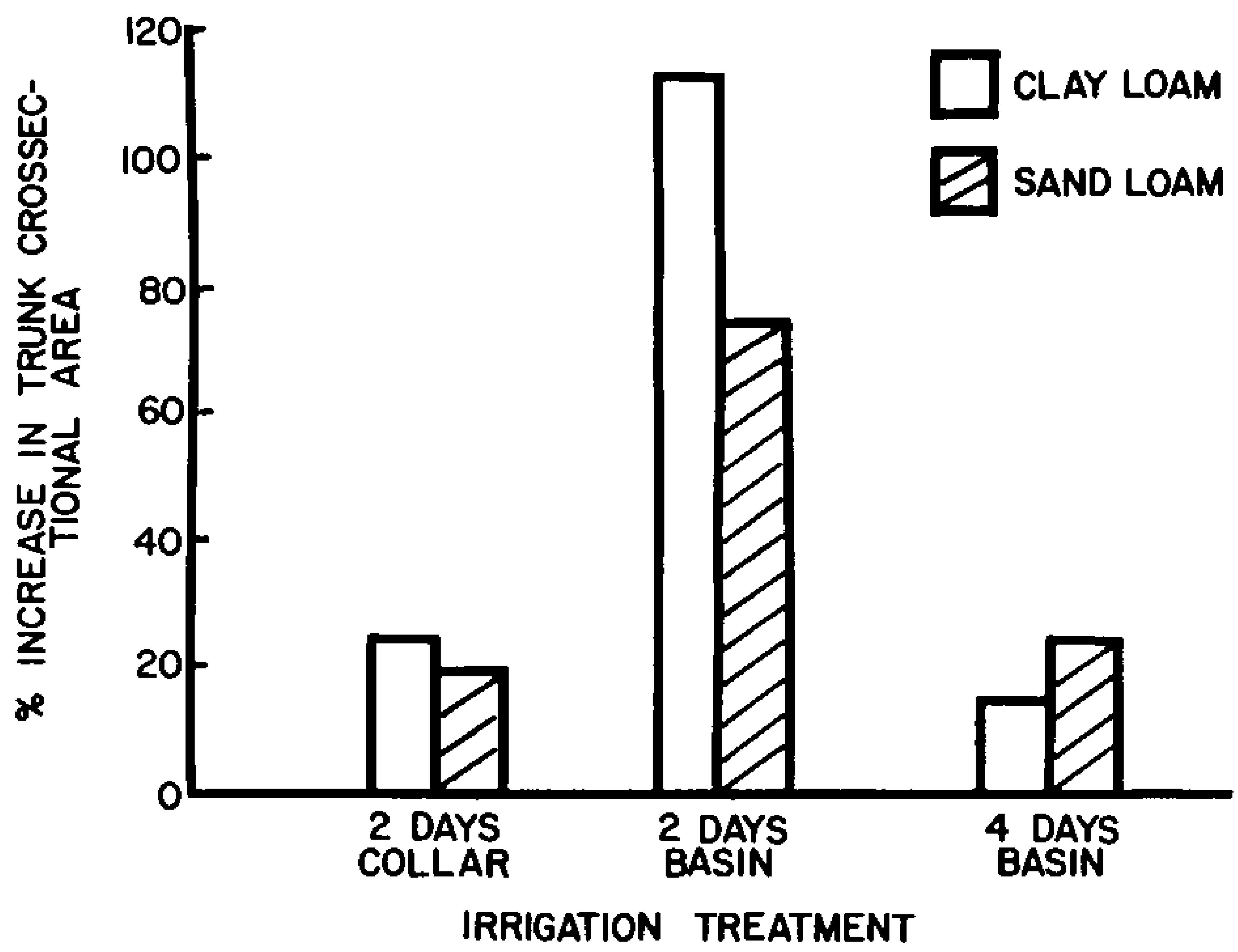

Figure 3. Percent increase in trunk crossectional area of *Escallonia rubra* in response to irrigation treatment in a clay loam soil and a sand loam soil.

ing the collar every 2 days and the basin every 4 days. The same relationship held true for the total number of roots.

The results indicate that water applied only to the rootball every 2 days was not sufficient to keep up with transpirational demand. When the basin was filled every 2 days, the soil remained above field capacity and wet enough to supply water to the rootball. If the surrounding soil was not rewet more often than every four days, even though it was at or near field capacity, the soil could not supply water fast enough to the rootball to prevent wilting and leaf injury.

1979 Experiment. Evaluating treatments to prevent or reduce the transfer of water from the rootball to the surrounding soil.

One way to reduce the loss of water from the rootball would be to break continuity of moisture films between the rootball and soil. A material with coarse pores placed between the rootball and field soil could act as a barrier to water movement due to its low conductivity of water. Preliminary experiments showed that using sand and pea gravel sleeves between the transplanted rootball and the field soil significantly reduced water movement out of the rootball during the first 48 hours following irrigation.

The 1979 experiment was designed to evaluate the effect of a sand sleeve and frequency of irrigation on root growth of *Laurus nobilis* plants. Sand was chosen as the backfill material (sleeve) because it would be a better medium for root growth than gravel and should be effective in reducing water movement out of the rootball.

In June, 1979, 72 one-gallon *Laurus nobilis* L. plants were planted: 24 with the rootball in contact with the soil and 48 surrounded by a 2 inch sleeve of sand (Figure 4). Half of those in sand were watered by filling the 30-inch basin with 20 liters of water and half by filling a collar at the top of the rootball (as described in experiment 1) with 2 liters of water. All plants were irrigated either every 3, 5, or 10 days to determine the effect of slight, moderate, and severe water stress on root growth. To monitor soil moisture changes, tensiometers were installed with the sensing tip near the middle of the rootball. Tensiometers were also placed in the field soil 2 inches from the rootball, or 2 inches from the sleeve. The moisture release curve (tension vs. moisture content) was determined for the container mix and using the tension values as a function of time, the volumetric moisture content of the container medium was estimated.

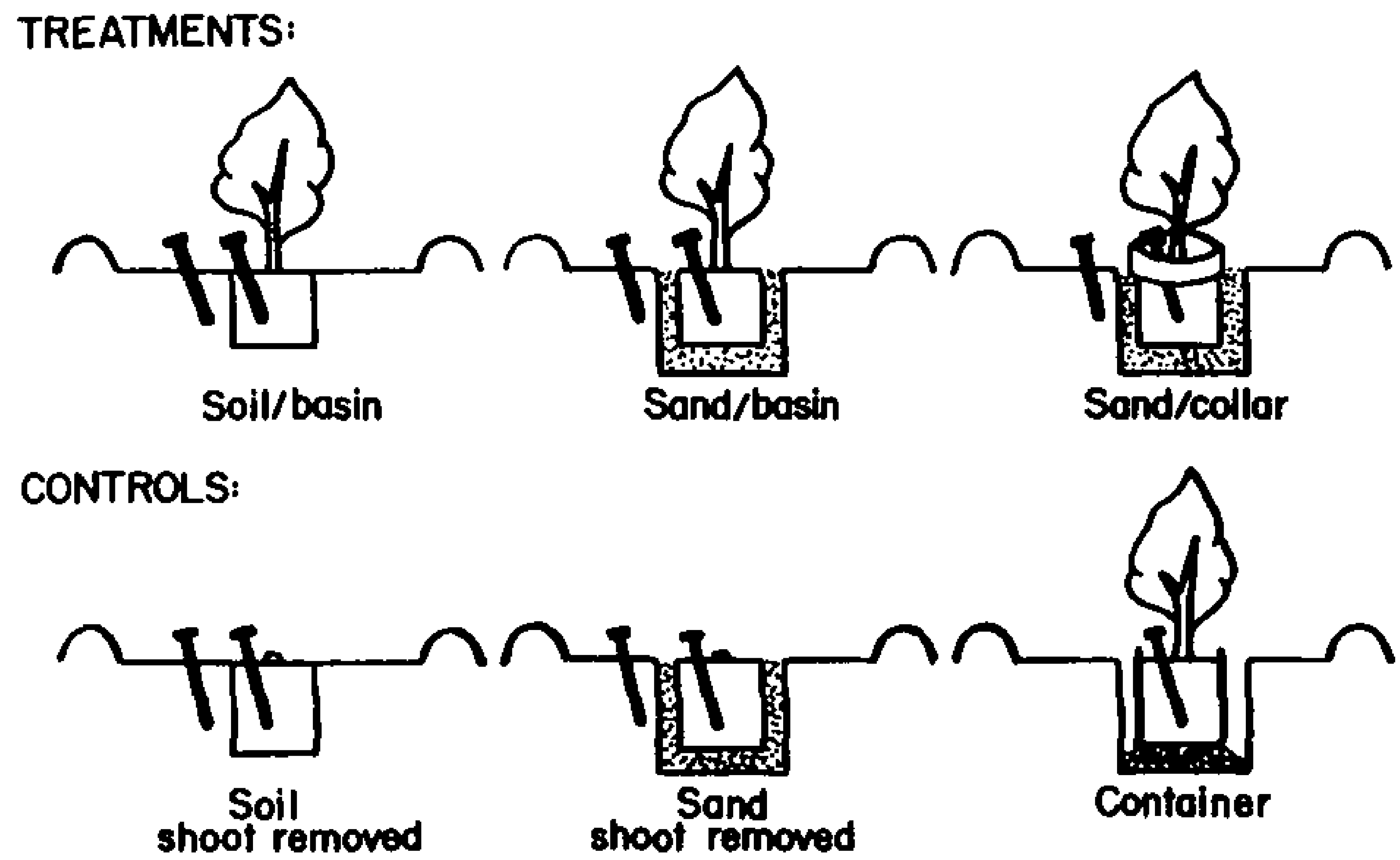

Figure 4. Treatments and controls used in the 1979 experiment. The treatments were irrigated every 3, 5, or 10 days with 8 replications in each treatment. Tensiometer placement in the rootball and surrounding soil is shown.

Three controls were used to help analyze the soil moisture changes in the transplanted rootballs. The transplanted rootballs lost water through drainage into the surrounding field soil and evapotranspiration. To eliminate transpiration losses, the tops of two control plants were removed. One rootball was planted in contact with the field soil (soil/shoot removed) and one in a sand sleeve (sand/shoot removed) with tensiometers installed in the rootball and adjacent field soil. Finally, moisture losses due to evapotranspiration were estimated by putting a tensiometer in the rootball of a third plant left in the container. The container was placed into a hole in the ground to keep the rootball at temperatures similar to the transplanted rootballs. About 2 inches of pea gravel were placed in the bottom of the hole so that neither the bottom of the can nor the drainage holes were in contact with the soil.

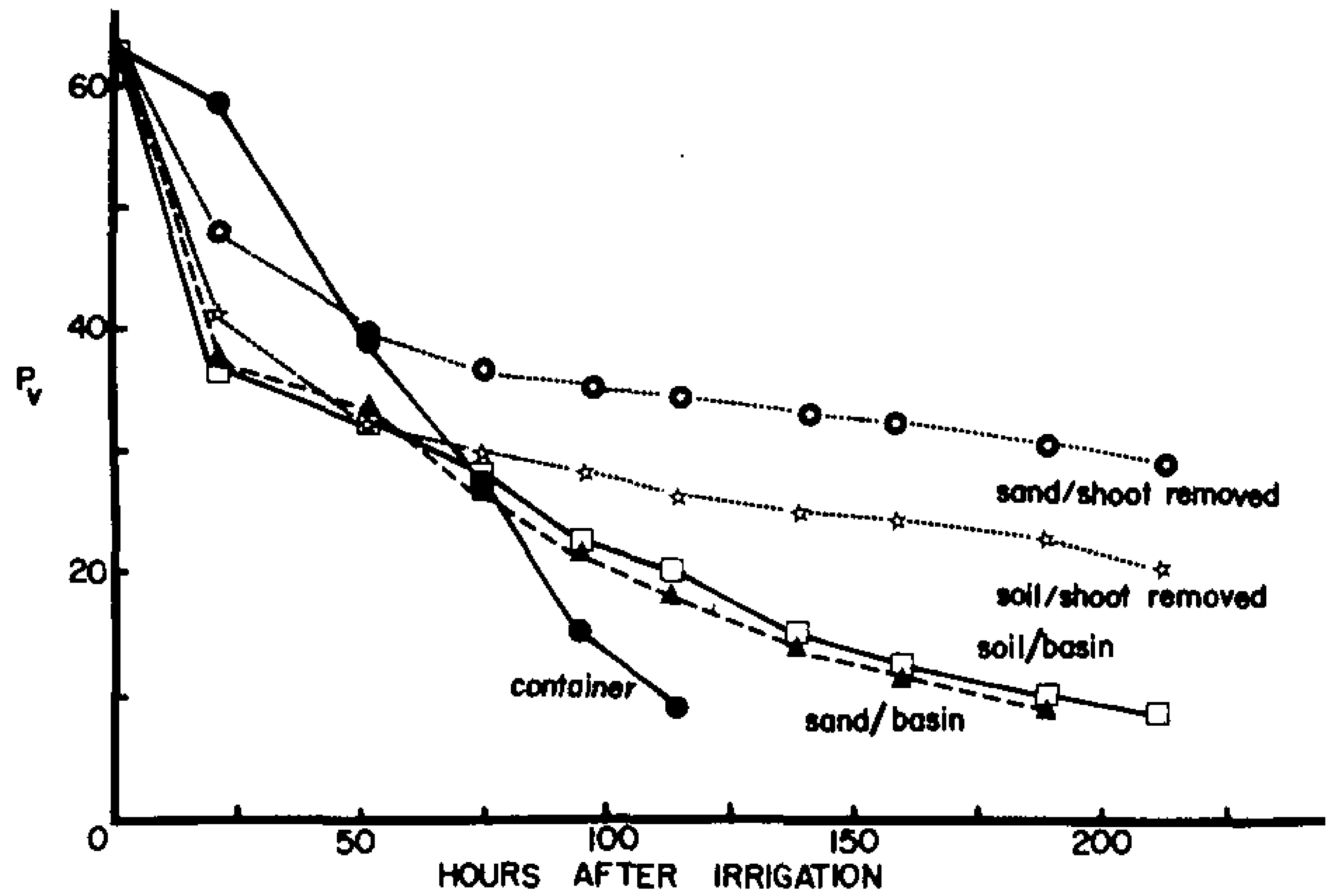

Figure 5. Percent volume of the rootball occupied by water as a function of time after one irrigation cycle for transplants watered every 10 days.

Results. The moisture content of decapacitated rootballs remained higher when surrounded by sand than when in contact with the soil even 212 hours after irrigation (Figure 5). This confirmed the previous finding that moisture transfer between the rootball and the soil could be reduced if a coarse-textured material is placed between the rootball and the soil. However, there seems to be no advantage in using this treatment with an intact plant since there was little difference between the moisture content in the rootball surrounded by sand or soil. No explanation is apparent.

The rootball in the container maintained a higher moisture level than any of the transplanted rootballs for the first 54 hours after irrigation because no moisture was lost to the surrounding soil. After 54 hours, moisture levels fell below those of the transplanted rootballs. The moisture in the rootball in the container was depleted to the wilting point 119 hours after irrigation, while in the transplanted rootballs the moisture content stayed above the wilting point for 188 hours in the sand/basin treatment and 212 hours in the soil/basin treatment. This suggests that water moved from the field soil into the transplanted rootballs. Costello (1) also found that water moved from the surrounding soil into the rootball, although the transpirational demand for water soon exceeded the rate at which the soil could supply moisture to the rootball. The *Laurus nobilis* plants used in this experiment had a relatively smaller leaf area to rootball ratio compared to the leaf area of the *Liquidambar* plants used by Costello (1). Because of the lower water use per rootball, apparently the field soil could supply enough water to the rootball to keep the plants from wilting between irrigations in the present experiment. However, if the plants had a large leaf area and water use per container was high, it is probable that the field soil could not supply water to the rootball fast enough to prevent wilting.

Five weeks after planting, the plants were dug, and the number of emerged roots, root length, and root dry weight were measured.

Root growth was best in the 5-day irrigation treatments and the 3-day sand/collar treatment (Table 2). The poorest growth was from the 10-day sand/basin and sand/collar treatments. The 3-day soil/basin and sand/basin and the 10-day soil/basin treatments were intermediate in the amount of root growth.

Table 2. Growth of roots emerging from 1 gallon plants of *Laurus nobilis* rootballs within 5 weeks after planting.

TREATMENT	TOTAL ROOT Length (cm)	NUMBER OF ROOTS	ROOT DRY WT (mg)
IRRIGATION FREQUENCY			
3 DAYS			
Soil/Basin	118.1[ab*]	58.2[ab]	11.5[ab]
Sand/Basin	159.9[ab]	70.6[ab]	15.7[ab]
Sand/Collar	203.2[b]	94.6[ab]	25.1[ab]
5 DAYS			
Soil/Basin	187.4[b]	93.9[b]	29.2[b]
Sand/Basin	279.9[b]	110.9[ab]	29.1[ab]
Sand/Collar	250.5[b]	102.2[ab]	29.4[ab]
10 DAYS			
Soil/Basin	110.0[ab]	46.5[ab]	17.7[ab]
Sand/Basin	64.6[a]	39.7[a]	7.3[a]
Sand/Collar	53.3[ab]	46.6[ab]	6.3[ab]

* Mean separation, within columns, based on Duncan's Multiple Range Test (59%) of Log transformed Data.

From this and other experiments connected with this study, it appears that a lack of soil aeration in the 3-day basin treatments and insufficient water supply in the 10-day treatments could be the reason for the poorer root growth. However, when only the rootball was rewet in the 3-day sand/collar treatment, adequate water for plant use was provided, yet the soil surrounding the rootball remained well aerated and was a favorable environment for root growth. This suggests that irrigations confined to the rootball could aid plant establishment under conditions in which the surrounding field soil remains too wet for good root growth between irrigations.

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Ed. Note: Dr. Tsai Ying Cheng, Oregon Graduate Center, Beaverton, Oregon, discussed her work on mass clonal propagation of fruit and shade trees.

A SIMPLIFIED ENTRY INTO TISSUE CULTURE PRODUCTION OF RHODODENDRONS

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Some growers are asking if tissue culture is a tool they should try. There is no single answer but with a few guidelines and a modest investment answers are soon evident. In the past two years Briggs Nursery has ventured into rhododendron tissue culture production. This effort is backed up by 10 years of interest and research support. A number of cultivars are now beginning to come out of test tubes and into pots in significant quantities. At this stage of production we feel it appropriate to share some of our beginning experiences including a brief review of starting rhododendrons in tissue culture and some of the systems that have worked for us.

Growers looking for information on how to get started can find help through many sources (5). Among these are agricultural extension agents, colleges, experiment stations, libraries, tissue culture and horticultural organizations, companies that sell tissue culture supplies, and from nurseries engaged in plant tissue culture. Courses in plant tissue culture are available at the W. Alton Jones Cell Science Center in Lake Placid, New York and many universities in the United States. The basic re-