members of this group have asked me about it. We find no problem at all. As soon as the seed is ripe, we pick it and clean it and immediately sow it in boxes. We sow it right away. Along about February or March, when the weather turns warm it germinates — no problem at all. So it must be in the southern states you are not getting sufficient cold stratification or your seeds have some other problem. I am not sure what it is, but apparently you have a problem in your area that is not typical here in the north.

VOICE: What temperature do you use for Mahonia seed stratification?

BRUCE BRIGGS: We take our outdoor winter temperature. We do clean the seed, take off the pulp, and immediately store it in shallow boxes. We put them outside — freezing is OK — through the winter, and by February the seedlings really come up. There is no problem at all under our conditions.

Friday Morning, September 5, 1975

DIRECT CANNING OF ROOTED CUTTINGS INTO ONE GALLON CONTAINERS

BARRY A. EISENBERG

California Polytechnic State University

San Luis Obispo, California 93401

Abstract. *Buxus japonica. Raphiolepis indica* 'Rosea'. *Trachelospermum jasminoides. Viburnum tinus* and *Weigela florida* were used to determine if rooted cuttings could be directly potted into one-gallon containers. Direct potting of rooted cuttings offers a grower a production operation that could reduce labor and materials costs. Direct potting of rooted cuttings was successful with four of the five species used in this study and demonstrated that a grower may be able to achieve an equal or better quality one-gallon container plant by direct potting. The condition of the root system at time of transplanting, the soil mix and conditions used to reduce dessication are the primary concerns a grower will need to evaluate for his specific growing conditions. The type of root system, either fibrous, stiffly branched or wirey, appears to be a root characteristic that lends itself to determining if a plant can be directly potted.

Much of the work involving direct canning of rooted cuttings has been done with deciduous plants. Worth (11) reported that direct canning of *Spiraea* and *Syringa* cuttings saves the labor equivalent to 8 or 10 persons.

Hill (5) observed that some *Salix*, *Prunus*, and *Pittosporum* species initiated growth earlier when canned directly in one-gallon containers than when placed in ground beds. In addition, he noted that direct canned cuttings had twice the growth of ground bed cuttings, which he attributed to less root disturbance during the growing period.

Vermeulen (10) reported the importance of a well aerated soil with high moisture-holding capacity for direct canning. In addition, Vermeulen (9) noted that increasing labor and materials costs are causing nurserymen to find ways of cutting expenses and offered the concept of direct canning of rooted cuttings into one-gallon containers as a practical solution to this problem.

Numerous persons have stated the disadvantages of direct canning of rooted cuttings. Anderson (1) noted that a grower can control environmental factors better in a liner pot than in a one-gallon container; pots need less checking for chlorotic conditions; and the Jiffy-Pot is easier to pot because the roots are confined to a specific area which reduces root damage. Blyth (2) agrees that direct canning of rooted cuttings may not be a beneficial practice. He stated that direct canned cuttings slowed the hardening-off process after transplanting when compared to plants grown in Jiffy-Pots.

The purpose of this study was to evaluate root characteristics of direct canning rooted cuttings vs those grown in liner pots prior to canning in one-gallon containers.

MATERIALS AND METHODS

The experiments involving direct planting of rooted cuttings into one-gallon containers was carried out at the Ornamental Horticulture Unit, California Polytechnic State University, San Luis Obispo. Two structures were used; a 50% shade house and a mist propagation house. The shade house was used to harden-off the cuttings after they had rooted in the mist house. After the rooted cuttings were planted in one-gallon containers, they had a 2 week period in the lath-house to reduce transportation so that dessication would not occur.

Thirty rooted cuttings of each of the following, *Buxus japonica* - Japanese boxwood; *Raphiolepis indica* 'Rosea' - India Hawthorn; *Trachelospermum jasminoides* - star jasmine; *Viburnum tinus* - Laurustinus; and *Weigela florida* - Rose weigela were rooted and ready to transplant May 25, 1974. Fifteen plants of each species were potted into one-gallon containers on May 25, 1974 and were placed in the 50% shade house for 2 weeks. The 15 remaining plants were placed in 3'' clay pots, left in the mist house out of mist for 1 week then moved to the shade house. The liner pots were then placed into one-gallon containers on July 11, 1974. The one-gallon containers were placed in full direct sun for the remainder of the growing period. On September 18, 1974, 5 plants from each treatment were evaluated.

The rooting medium consisted of 9 parts grade #2 perlite and 1 part fine peat moss. The soil for the liners was 2 parts coarse washed sand, 1 part peat moss and 2 parts pumice. For the one-

gallon containers a soil mix which consisted of 2 parts Cal-Poly Soil Mixture[1], 2 parts fir bark, 2 parts pine shavings and 1 part coarse washed sand was used.

In analyzing the root development, three characteristics of the roots were used: length, symmetry and number of roots. Root length refers to the longest root from the terminal tip to its origin from the stem. In referring to root symmetry, the author used a 1-4 rating system, to evaluate that area of the stem most of the roots occupied. A root system that had roots primarily in one quadrant of a circle would be given a rating of 1, thus showing that the root system was unbalanced. A rating of 4 was used if the root system occupied all four quadrants of a circle thus indicating that the root system was more evenly developing in the container. A rating of 2 or 3 were used accordingly. The number of roots is the measurement of the number of primary roots originating from the stem.

Table 1. Comparison of roots of plants by direct potting vs. liner potting in the production of nursery crops.

	Direct Potted in 1 gallon containers			Liner Pots		
Species	Length (inches)	Symmetry	No. of Roots	Length (inches)	Symmetry	Length (inches)
Buxus japonica	5.6	4	31.6	5.0	4	27
Trachelospermum jasminoides	10.2	3.2	19.2	3.8	3.4	16
Raphiolepis indica 'Rosea'	9.6	2.6	6.0	7.8	3.2	10.8
Viburnum tinus	5.8	3.25	8.4	3.4	3.25	8.4
Weigela florida	8.0	3.6	36.7	5.6	3.25	21.4

[1] Symmetry - Values refer to the four quadrants of a circle which the roots of the plants occupied. A rating of 1 is very poor and a rating of 4 is excellent.

RESULTS AND DISCUSSION

All species except *Raphiolepis indica* could lend themselves to direct potting into one-gallon containers. With *Raphiolepis rosea* the reduction in number of roots and symmetry outweighed the increase of length rooted in the direct planted rooted cuttings. If the number of roots were similar, then root length would have helped in evaluating the difference in the cuttings (Table 1).

Both *Trachelospermum jasminoides* and *Weigela florida* responded favorably to direct potting. The symmetry did not differ significantly between the two treatments, but the number of roots and length of roots were greater with the direct potted cuttings (Table 1).

Buxus japonica and *Viburnum tinus* showed few differences between the two treatments, except that the *Viburnum tinus* did show an increase in length without a decrease in number of roots.

[1] Cal-Poly Soil Mix: Baywood sand: fir bark: clay loam: aged manure (2:2:1:1 by volume) with 3 lb superphosphate; 2 lb hoof and horn meal: 1 lb K_2SO_4: 1 lb dolomitic lime per cu. yd.

It should be noted that if no differences between the two treatments occurred, it would favor direct potting as this is a savings in labor and materials.

While recording the results of this experiment the author noticed three distinct types of root systems: fibrous, stiffly-branched and wirey. *Trachelospermum* and *Weigela* roots fibrous; *Buxus* and *Viburnum* roots were stiffly branched and *Raphiolepis* had a wirey root system. This could be a key that a grower could use to estimate whether a plant could be used for direct canning of rooted cuttings. The two species that were fibrous-rooted showed the best results, with the stiffly branched material showing some increases in root length. The wirey type root system of *Raphiolepis* showed adverse effects from being direct canned and this could indicate that plants with a wirey root system might not lend themselves to being directly canned.

The author believes that the root system should not be overgrown. Smaller roots would permit the plant to grow into the pot with little root damage. Using cuttings with too large roots may be the major reason why some growers have had poor results with direct cannings (1, 2).

There are three major factors that a grower will have to deal with in deciding whether or not he will be successful in direct canning: the environmental conditions, the condition of the plant and roots, and the soil type used.

Vermeulen (10) has done work with soil mixes for the direct canning process. The same requirements of a good rooting medium: aeration, moisture holding capacity and support of the cutting are the three basics that also must be maintained in a mix for direct potting (4) so that the transition between the rooting and growing medium will be small. Soil mixes for direct canning depend upon the region and the materials available. Any mix will work provided adequate care is taken during the growing process.

The environmental conditions that affect water loss are of primary importance. Misting the foliage, shading the plants, using anti-dessicants, and reducing wind velocity all have beneficial effects in reducing water loss. When a root system isn't fully developed when planted into a gallon container, water uptake will be less, thus the grower will have to offset this by using the above-mentioned methods. In a large scale operation misting of the foliage and shading offer the best means to reduce transpiration. Since most nurseries have some type of irrigation system the misting would not add extra cost to the direct canning process.

The condition of the root system at time of planting is critical. Anderson (1) stated that one problem with direct sticking of cuttings relates to the root damage that occurs. Anderson is assuming that the roots will be overly-large during transplanting.

In this brief discussion of direct planting of rooted cuttings many points have not been mentioned or looked into that could offer some benefits. The use of nutrient mist of which Usrey (8) has commented on, as a benefit to propagation could be useful. Also the use of mycorrhizal fungi might add extra water and nutrient absorbing area (7). The use of mycorrhizae in this manner has not been fully researched and no one really knows what benefits will be achieved.

In conclusion it should be noted that some nurseries do direct-pot rooted cuttings. Oki Nursery in Sacramento have gone as far as directly-potting rooted cuttings into five-gallon containers (3), while Green Thumb Nursery has used direct potting of rooted cuttings with some herbaceous, fibrous materials. Only by further study will this method of producing one-gallon container plants be adapted to the present nursery operation scheme.

LITERATURE CITED

1. Anderson, R.D. 1969. Propagation of plants for containers. *Proc. Int. Plant Prop. Soc.* 19:227-228.
2. Blyth, G.P. 1960. The pros and cons of banded versus bare root material. *Proc. Int. Plant Prop. Soc.* 10:72-73.
3. Brown, H.C. 1974. Personal communication.
4. Hartmann, H.T. and D.E. Kester. 1968. *Plant Propagation: Principles and Practices.* 2nd ed. Prentice-Hall, Englewood Cliffs, N.J.
5. Hill, J.B. 1957. Propagating plants directly in containers. *Proc. Int. Plant Prop. Soc.* 7:65-78.
6. Meyers, B.S., Anderson, Bohning and Fratianne. 1973. *Introduction to Plant Physiology.*
7. United States Department of Agriculture, Pub. No. A 1:38:1189. Mycorrhizae. 1971.
8. Usrey, M. 1960. Mist systems and hardening-off procedures at Monrovia Nursery Company. *Proc. Int. Plant Prop. Soc.* 10:301-302.
9. Vermeulen, P.J. 1966. Has modern marketing affected propagation and, if so, how? *Proc. Int. Plant Prop. Soc.* 16:108-111.
10. Vermeulen, P.J. 1965. Rooting — growing media. *Proc. Int. Plant Prop. Soc.* 15:97-99.
11. Worth, P.W. 1958. Growing fall stock hardwood cuttings. *Proc. Int. Plant Prop. Soc.* 8:94-96.