Roundup in gel to a limited number of leaves of certain herbaceous perennial weeds can provide effective control of roots from which regrowth may occur. It seems that 7% Roundup in gel is near the optimum concentration for satisfactory kill of field bindweed. Incomplete control of Japanese honeysuckle and Canada thistle with treatments herein reported suggests that complete control under field conditions may require the treatment of more leaves per plant and/or repeat applications.

There were no striking differences between gels in their effectiveness as a herbicide carrier, although CMC gave less visual injury on field bindweed than did SGP at 1% Roundup. There were, however, marked differences in stability of the 2 gels when stored over 3 months. SGP stored at room temperature (21°C) underwent no change in viscosity with 1% to 10% Roundup incorporation, although microbial growth was evident after 2 months. CMC stored at room temperature with or without Roundup showed not only microbial growth but substantial reduction in viscosity after one month, thus rendering the gel unsuitable for application to plant foliage. When stored at 3° for 3 months, neither CMC nor SGP supported microbial growth or showed any appreciable increase in rate of movement on a vertically inclined surface (data not shown). Maintenance of high viscosity with prolonged storage at room temperature should be an important factor in selection of gel type as a herbicide carrier. Incorporation of a preservative to limit microbial growth might improve the useful longevity of the gelled Roundup solutions.

Results of this preliminary study indicate that Roundup herbicide can be applied using gel as a carrier for control of certain perennial weeds. This technique could prove useful especially for the homeowner or for those in commercial landscape maintenance who face the problem of costly removal of perennial weeds growing in close contact with ornamental plants. Further research will be required in: selection of gel type, refinement of herbicide/gel rates, determination of optimal treated leaf surface area, improvement of room temperature shelf life, and in packaging to facilitate convenient application.

### Literature Cited


1. Agrichemical Age. 1982. Monsanto seeks more Roundup labels. Agrichem. Age 26:36–37.
2. Ashton, F.M. and A.S. Crafts. 1981. Mode of action of herbicides, 2nd ed. Wiley, New York.
3. Claus, J.S. and R. Behrens. 1976. Glyphosate translocation and quackgrass rhizome bud kill. Weed Sci. 24:149–152.
4. Segura, J., S.W. Bingham, and C.L. Foy. 1978. Phytotoxicity of glyphosate to Italian ryegrass (*Lolium multiflorum*) and red clover (*Trifolium pratense*). Weed Sci. 26:32–36.
5. Sprankle, P., W.F. Meggitt, and D. Penner. 1975. Absorption, action, and translocation of glyphosate. Weed Sci. 23:235–240.
6. Wyrill, J.B. and O.C. Burnside. 1976. Absorption, translocation and metabolism of 2,4-D and glyphosate in common milkweed and hemp dogbane. Weed Sci. 24:557–566.
7. Zandstra, B.H. and R.K. Nishimoto. 1977. Movement and activity of glyphosate in purple nutsedge. Weed Sci. 25:268–274.


HortScience 20(1): 66–67. 1985.

# Stair-step Container for Improved Root Growth


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*Additional index words.* root branching, container design, stress

***Abstract.*** **A container was designed with 4 internal stair-step sections that prevent roots from growing in circles, and stimulates root branching. The additional root branching increased root growth away from the container following transplanting of Virginia pine (*Pinus virginiana* Mill.), and improved the number of branches per plant on *Gardenia jasminoides* Ellis., Pyracantha x 'Mojave', Photinia x 'Fraseri' and *Lagerstroemia indica* L.**

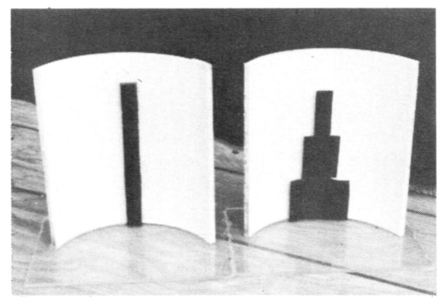

Fig. 1. Cross section of container made with the vertical rib **(left)** and stair step rib with recessed edge **(right)**. If a container with the stair-step rib is manufactured, it would have many more steps than was used in these experiments.

Research by Birchell and Whitcomb (1) and Dickinson and Whitcomb (3) has shown that a container designed with internal vertical ribs prevents roots from circling; however, as the roots contact the vertical ribs they are directed downward. Consequently nearly all actively growing root tips accumulate near the bottom of the container. Likewise, the bottomless containers on raised wire benches used by Dickinson and Whitcomb (4) and Hathaway and Whitcomb (5) also stimulate root branching, but mostly in the bottom of the container.

The recently developed vertical air-root-pruning container by Whitcomb (6), air prunes root tips at a series of narrow vertical openings in the container sidewall. This container must have an offset in the sidewall in order to create the narrow vertical openings that force the root tips to grow into the opening. This type of container can be manufactured by blow-molding with relative ease; however, it is not practical to manufacture with injection molding machinery. Most containers are manufactured by injection molding, and many nurserymen prefer this type container due to greater sidewall rigidity. There is, therefore, a need for a container that stimulates root branching that can be produced using this method. The purpose of these studies was to compare a new container design concept with conventional containers on woody plant performance.

*Expt. 1 on 20 May 1982*. Experimental containers were constructed from 15 cm PVC thinwall drain pipe 15 cm long. The internal surface of the container was: 1) left smooth, 2) fitted with 4 vertical ribs about 9 mm wide and 4 mm thick, 3) fitted with 4 stair-step sections about 2 mm thick, or 4) fitted with 4 stair-step sections about 4 mm thick. The 4 sections added to the interior container surface were spaced equally around the container (Fig. 1). The bottom edge of all containers had 4 notches to provide drain holes and this edge was glued onto a flat plexiglass section for a bottom.

All containers were filled with a growth medium of 3 parts ground pine bark : 1 part peat : 1 part sand (by volume) amended with 8.2 kg Osmocote 17N–2.6P–9K (17-7-12), 3.6 kg dolomite, and 0.9 kg Micromax micronutrients/$m^3$. The test plant was Virginia pine, *Pinus virginiana*. The study was conducted as a randomized block design with 6 replications. All plants were grown in full sun and were watered by overhead sprinklers as needed.

On 12 Sept. 1982, the Virginia pines were transplanted into 8 liter containers and allowed to grow for 22 days. At that time, the number of root tips reaching the side or bottom of the container were determined.

*Expt. 2*. In April of 1983, additional containers were constructed with the thick stair-step insert, the vertical rib and conventional

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smooth interior sidewalls. Growth medium, nutrition, and watering practices were the same as in Expt. 1. Test plants were gardenia, *Gardenia jasminoides*, pyracantha x 'Mojave', red top photinia, (*Photinia* x 'Fraseri') and crapemyrtle, *Lagerstroemia indica*. All plants were grown in full sun. Rooted cuttings were planted on 30 May and were evaluated on 15 Oct. 1983. Branch counts and fresh top weights were taken for all species. Root weights could not be obtained because of the heavy root development of all species. The gardenia and pyracantha were transplanted into 11 liter containers on 16 Oct., and allowed to grow for 18 days. At that time, the plants were removed from the containers, and counts of roots growing into the new growth medium were taken. The experiment was conducted as a randomized block design with 6 replications.

*Expt. 1*. Counts of white root tips on the perimeter of the root mass of Virginia pine after 4 months were greatest where the thick stair-step rib was present (Table 1.) Numbers of white root tips was increased both on sides and bottoms of the containers as a result of the stair-step barrier (Table 2, Fig. 2). The conventional round container had the smallest number of roots at the bottom of the container.

Twenty-two days after repotting, the number of roots reaching the container bottom were greatest within the standard container, whereas the container with the thick rib had 26% less root number at the bottom than the standard container. On the other hand, the container with the stair-step rib had 213% more roots on the sides compared to the standard container (Table 2).

*Expt. 2*. Top weights of all species were not affected by the container design. Yet, the number of branches per plant for gardenia, photinia and crapemyrtle increased when the stair-step container was used as compared to the conventional or vertical rib container (Table 3). Pyracantha showed a similar trend. Stem caliper of photinia also was increased by the stair-step container (Table 3).

Counts of active root tips were impractical due to the massive 'pot-bound' root system.

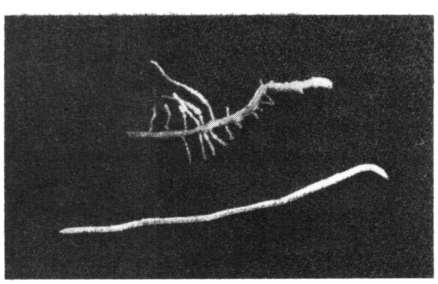

Fig. 2. Root development in containers with the stair-step apparatus when the root tip is trapped **(top)** and a root growing around the side of a smooth conventional container **(bottom).**

Table 1. Effects of container design on number of white root tips of Virginia pine on the sides or bottoms of 15 cm plastic containers.

| Root tip location | Container type: Round (no ribs) | 4 vertical ribs | 4 shallow stair-step ribs | 4 thick stair-step ribs |
|---|---|---|---|---|
| | *No. of root tips* | | | |
| Bottom | 75 a[z] | 144 c | 108 b | 253 d |
| Sides | 69 a | 77 a | 121 b | 187 c |
| Total | 144 a | 221 b | 229 b | 440 c |

[z]Numbers in a row followed by the same letter are not statistically significant at the 5% level.

Table 2. Effects of container design of the number of white root tips of Virginia pine in 15 cm containers reaching the sides or bottoms of 8 liter containers 22 days following transplanting.

| Root tip location | Container type: Round (no ribs) | 4 vertical ribs | 4 shallow stair-step ribs | 4 thick stair-step ribs |
|---|---|---|---|---|
| | *No. of root tips* | | | |
| Bottom | 48 c[z] | 42 b | 38 a | 36 a |
| Sides | 66 a | 99 b | 123 c | 141 d |
| Total | 114 a | 141 b | 161 bc | 177 c |

[z]Numbers in a row followed by the same letter are not statistically significant at the 5% level.

Table 3. Effects of container design on growth characteristic of 4 woody species.

| Container type | Gardenia Branches/plant | Photinia Branches/plant | Photinia Stem caliper (mm) | Pyracantha Branches/plant | Crapemyrtle Branches/plant |
|---|---|---|---|---|---|
| Round | 22 a[z] | 6 a | 8 a | 142 a | 12 a |
| 4 vertical ribs | 21 a | 5 a | 9 a | 152 a | 13 a |
| 4 thick stair step ribs | 33 b | 11 b | 11 b | 165 a | 16 b |

[z]Numbers in a column followed by the same letter are not statistically significant at the 5% level.

Table 4. Effects of container design on the number and location of active roots of gardenia and pyracantha 18 days following transplanting.

| Container type | Gardenia Side[z] | Gardenia Bottom | Pyracantha Side | Pyracantha Bottom |
|---|---|---|---|---|
| Round | 101 a[y] | 75 a | 18 a | 8 a |
| 4 vertical ribs | 108 a | 98 c | 20 a | 10 a |
| 4 stair step ribs | 129 b | 83 b | 31 b | 16 b |

[z]Location of roots on root ball.
[y]Numbers in a column followed by the same letter are not statistically significant at the 5% level.

Eighteen days after the gardenia and pyracantha were transplanted into larger containers, however, both had more roots on the side perimeter of the root ball with the stair-step design (Table 4). Pyracantha also showed increased root development on the bottom of the ball with the stair-step design, whereas gardenia had the most roots on the bottom of the root ball with the vertical ribs (Table 4).

These data suggest that branching of 4 shrub species and the number of active roots extending into the surrounding soil immediately after transplanting can be increased by the design of the container. The effects of this root control container may reduce the need for pruning some woody ornamentals. Since some nurseries prune 3 to 5 times during the production of some species, reducing pruning by one time per crop would be a substantial savings. Since the moisture status of the growth medium from a container quickly becomes unfavorable following planting into the landscape (2), the increase in the number of roots growing into the surrounding soil should increase plant survival.

## Literature Cited


1. Birchell, R. S. and C.E. Whitcomb. 1977. Effects of container design on root development and regeneration. Okla. Agr. Expt. Sta. Res. Rpt.
2. Costello, L. and J.L. Paul. 1975. Moisture relations in transplanted container plants. HortScience 10(4):371–372.
3. Dickinson, S. and C.E. Whitcomb. 1977. Effects of container design on root quality. Okla. Agr. Expt. Sta. Res. Rpt.
4. Dickinson, S. and C.E. Whitcomb. 1982. Root development of transplanted seedlings in bottomless milk cartons. J. of Arboriculture 8:323–324.
5. Hathaway, R.D. and C.E. Whitcomb. 1978. Effects of root malformation during propagation on growth and survival of Bur Oak. Okla. Agr. Expt. Sta. Res. Rpt.
6. Whitcomb, C.E. 1981. A vertical-air-root-pruning container. Proc. Intl. Plant Prop. Soc. 31:591–597.