Bare-Root Shade Tree Whip Production in Containers with Special Reference to Red Oak

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INTRODUCTION

The Ohio Production System (OPS), a method for producing shade tree whips in containers, was first described in these proceedings (Struve et al., 1987). Under OPS conditions, seeds are germinated and seedlings produced in SpinOut^{TM}-treated quart containers in a heated greenhouse. The greenhouse period lasts 10 weeks, February to May. After the last frost, seedlings are moved outdoors under shade for 1 week and then potted into SpinOut-treated No. 3 nursery containers. After up-canning, whips are produced by tying and staking the terminal shoot as under field production. Growth can be rapid; 2 m (about 6 ft) tall red oak can be produced by October. Whips can be fall transplanted, or overwintered in containers in polyhouses or held as bareroot material in refrigerated storage and then transplanted in spring. Many species can be produced via OPS (Struve et el., 1994).

One disadvantage of OPS whips is their bulk, relative to bare-root whips. If bare-root whips could be produced in containers, then the survival and high re-growth potential of container stock could be combined with the handling ease of bareroot stock. This paper describes media suitable for bareroot whip production, overwintering alternatives, mineral nutrition, transplant survival and re-growth potential of container-produced bareroot whips.

MEDIA

Originally, a pine bark, peat, Comtil (composted municipal sewage sludge, City of Columbus, OH) and sand (3 : 0.5 : 0.5 : 1, by volume) container medium was used. However, the pine-bark-based medium was unsuitable for bareroot production because it did not readily separate from the roots. Several media were developed that would readily separate from a plant's roots (Table 1 and Struve and McCoy, 1996). Plants grown in these media were barerooted by shaking the plants three or four times causing the media to fall off the roots. Because of lower bulk density, rice-hull-based media are preferred over sand-based media. All media had acceptable physical and chemical properties (Struve and McCoy, 1996). The standard medium now used is rice hull and Comtil (3 : 1, v/v).

ROOT SYSTEM MORPHOLOGY

Whips grown in the bareroot media have fibrous root systems with many intact root tips. The increased density of the root system is attributed to a well aerated medium and to the root-pruning effect of SpinOut-treated containers.

OVER WINTERING ALTERNATIVES AND TRANSPLANT SURVIVAL

Bareroot red oak whips can be successful overwintered by lining out in mid October, by placing containerized whips in a polyhouse followed by spring barerooting and lining out, or by barerooting in early winter (December), placing the whips in refrigerated storage, and lining out in spring (Struve, 1996). In one study, red oak whip survival was excellent; only one of 220 whips died (Struve, 1996). Average height increased 97 cm (38 in.) the first season after lining out and 89 cm (35 in.) the second season.

Table 1. List of media suitable for containerized bareroot whip production. All media support rapid growth under Ohio Production System conditions and separate readily from plant root systems.

Media	Ratio of components (by vol)
Sand : Comtil[w] : Isolite[x]	3 : 1 : 1, 2 : 1 : 2, 2 : 2 : 1
Sand : Comtil : Zeolite[y]	3 : 1 : 1, 2 : 1 : 2, 2 : 2 : 1
Rice hull[z] : Comtil : Isolite	3 : 1 : 1, 2 : 1 : 2, 2 : 2 : 1
Rice hull : Comtil : Zeolite	3 : 1 : 1, 2 : 1 : 2, 2 : 2 : 1
Rice hull : Comtil	1 : 1

[w] Comtil is composted municipal sewage sludge obtained from the City of Columbus, OH.
[x] Isolite, Grade CG 2, Sumitomo Corp. of America, Denver, CO.
[y] Zeolite, a crystalline, hydrated alumino-silicate clinoptilolite mineral, Teague Mineral Products, Adrian, OR.
[z] Rice hull, Dock Site, Warsaw, IL.

MINERAL NUTRITION AND EFFECT ON RE-GROWTH POTENTIAL

Various fertilization methods were tested to determine optimum nutrition for whip production (Struve, 1995). A combination of 60 g (4 tbsp) per container of controlled-released fertilizer ($21N-4P_2O_5-10K_2O$, Woodace) supplemented daily with 3.8 liter (1 gal) of 25 ppm N from water soluble fertilizer (Peter's, $15N-16P_2O_5.17K_2O$) resulted in the largest red oak whips. However, the efficiency of plant N recovery ranged from 4.1% to 8.1%. In general, the lower the rate of fertility, the higher the rate of N recovery. Unfortunately, high N recovery (i.e., low fertility treatment) did not yield vigorous growth. Growers have a dilemma; increasing the fertilizer rate increases plant growth, but also increases the potential for nutrient loss. Whips under the higher fertility levels grew taller after lining out than plants grown at lower fertility levels (Table 2). Whips receiving a combination of 60 g slow-release fertilizer per container and season-long 25 ppm N fertigation maintained their first-year height advantage for 2-years after transplanting, even though all whips received 9.8 kg N m^{-2} $year^{-1}$ (2# N 1000^{-1} ft^2 $year^{-1}$) after transplanting (Table 2).

Recent research has indicated that daily fertigation with 3.8 liter of 200 ppm N from $20N-20P_2O_5-20K_2O$ water-soluble fertilizer for 3 to 4 weeks after up-canning followed by fertigating once weekly with 3.8 liters of 200 ppm N gives growth similar to season-long (1 June to 1 Sept.) daily fertigation with 3.8 liters of 200 ppm $20N-20P_2O_5-20K_2O$ (Struve, unpublished data). This fertility program reduces N application by five fold (69.9 g vs. 12.2 g N) without significantly reducing plant growth.

Table 2. Influence of first year fertility program on red oak whip height, plant percent N recovery, and height 2 years after lining out.

Media	Fertilizer treatment	Whip height (cm)	Height (cm) after lining out	
			First year	Second year
Pine bark[z]	SR[y]	42	121	160
	WS[x] + SR	62	170	208
Bare root[w]	SR	40	140	180
	SR + WS	60	170	202

[z] Pine bark medium: 3 : 0.5 : 0.5 : 1 (by volume) pine bark, peat moss, Comtil (composted municipal sewage sludge), and sand.

[y] Woodace 21N-$4P_2O_5$-$10K_2O$ slow-release fertilizer top dressed at 30 g (two 15 g [tablespoon] applications; June and mid July) per container.

[x] Plants were fertilized daily with 3.8 liter day at 25 ppm N from Peter's 15N-$16P_2O_5$-$17K_2O$ water-soluble fertilizer from 1 June 1 to 30 Sept.

[w] Bare root medium: 2 : 2 : 1 or 2 : 1 : 2 (by volume) rice hulls (Dock Site, Warsaw, IL.) : Comtil : Isolite (Grade CG 2, Sumitomo Corp. of America, Denver, Colorado) : or Zeolite (a crystalline, hydrated alumino-silicate clinoptilolite mineral, Teague Mineral Products, Adrian, Oregon).

POSSIBLE REASONS FOR INCREASED SURVIVAL AND RE-GROWTH POTENTIAL OF CONTAINER-GROWN BAREROOT WHIPS

There are at least two reasons for high survival and re-growth potential of container-produced whips: rapid root regeneration and retention of carbohydrates and mineral nutrients.

Rapid Root Regeneration from Intact Root Systems. Plants grown under OPS conditions retain high root regeneration potential. Circling root development is inhibited with the use of SpinOut-treated containers, so corrective root pruning before transplanting is reduced. There are many rapidly regenerating intact root tips present at transplanting (Arnold and Struve, 1987). Thus root regeneration and establishment are rapid.

Retention of Storage Compounds. Root loss at harvest in field-grown plant material is great (Watson and Sydnor, 1987). The great root loss and corresponding diminished water-absorbing ability are factors contributing to transplant shock. Another contributing factor to transplant shock is the significant loss in carbohydrates and mineral nutrients to the plant when roots are pruned. Root pruning red oak seedlings reduces plant weight by 42% to 50% and root dry weight by 48% to 61% (Struve and Joly, 1992). Carbohydrates constitute 20% to 40% of root weight (Farmer, 1975, Larson, 1978) and roots of dormant red oak seedlings contain 80% of the plant's nitrogen (Struve, unpublished data). Thus root loss at harvest reduces the plant's carbohydrate and mineral nutrient reserves.

In conclusion, bareroot whip production in containers combines the high survival and re-growth potential of container stock with the handling ease of bareroot stock, offering a viable alternative to field-produced bareroot liners. Further, difficult-to-transplant species can be successfully produced and transplanted using OPS.

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