Effects of Container Medium Peat Content and Bed Surface on Plant Growth During Capillary Irrigation[1]

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Abstract

Rhododendron indicum 'Formosa' (Formosa azalea), *Buxus sempervirens* (Common boxwood), and *B. microphylla koreana* (Korean boxwood) were grown on capillary irrigation beds of fine mortar sand kept moist with water distributed through drip tubing. The proportion of peat in the pine bark:peat:sand container medium had a significant effect on plant growth, with growth generally increasing as peat content increased from 0 to 40%. Covering the sand beds with Visqueen ground cover film to control weeds and to prevent root growth from the pots into the sand reduced plant growth, apparently by interfering with capillary flow of water from the sand to the container medium. Spraying the sand surface with Surflan A.S. (oryzalin) at 3.36 kg/ha (3 lbs ai/A) reduced weed establishment early in the growing season, but had little effect on weeds or growth of Korean boxwood roots into the sand 4 months after study initiation.

Index words: ground cover material, sub-irrigation, weed control, root pruning

Species used in this study: *Rhododendron indicum* 'Formosa' (Formosa azalea), *Buxus sempervirens* (Common or American boxwood), *Buxus microphylla koreana* (Korean boxwood).

Significance to the Nursery Industry

Capillary irrigation is a viable alternative to overhead sprinklers for irrigation of container-grown woody plants; however, in the pine bark/peat/sand medium used in this study, 30 to 40% peat was generally needed to obtain growth comparable to that obtained with the overhead irrigation system. The expense of the additional peat may be justified by the fact that 40% less water was needed with the capillary system compared with a comparable area covered by overhead sprinklers.

A Surflan (oryzalin) spray over the sand surface was effective in controlling weeds during the first part of the growing season, but weeds emerged later in the season. A second application or a higher application rate may have been beneficial. The Surflan treatment at the rate and time applied was also ineffective in preventing Korean boxwood roots from growing into the sand. Visqueen ground cover over the sand was effective in controlling weed establishment and root growth into the sand, but it had an inhibitory effect on plant growth.

Introduction

Water is the most immediately limiting factor in the production of container-grown nursery stock. Concern for increasingly-limited availability of irrigation water and the inefficiency of conventional overhead irrigation methods led us to investigate the use of, and factors involved in capillary irrigation. Capillary irrigation is a method of providing water to container-grown plants through the bottom of the pots from a moist supporting surface. If the container medium has sufficiently fine pore spaces, capillary action will draw water up to the roots through openings in the bottom of the pot. Other researchers have demonstrated a need for sphagnum peat as a component of the container medium to increase the absorption of water; however, recommendations for proportions of peat vary. Smith and Treaster (4) showed that a soil:peat:sand (1:1:1 by vol) medium performed better than bark:sand (1:1 by vol). Havis (3) used equal parts peat and sand, and Auger et al. (1) utilized a medium of bark:sand:peat (2:1:1 by vol). We are unaware of any studies that show how varying proportions of peat in a bark medium affect plant growth on a capillary irrigation system. Therefore, one objective of this study was to determine the effect on plant growth of increasing proportions of peat in the container medium.

On a capillary irrigation system, roots of some plants will grow through the bottom of the pots and into the moist support material below (usually sand). Weeds also tend to grow on the support surface, especially in outdoor beds. Smith and Treaster (5) found that a sanitizing agent, Gloquat C, was an effective root-pruning and weed preventative agent, but this product is not readily available in the United States. In a preliminary experiment (2) we evaluated a variety of landscape materials as surface coverings over moist sand for prevention of root penetration and weed establishment. As a second objective in the present study the most effective material, Visqueen ground cover, was evaluated for its effect on plant growth. Visqueen-covered sand was compared with plain sand, and with sand that had been sprayed with the pre-emergent herbicide, Surflan.

Materials and Methods

Capillary beds were prepared by constructing frames of pressure treated lumber, each frame being 1.8 × 15.2 m (6 × 50 ft), 8.9 cm (3.5 in) deep. These frames were placed over a soil base with a slight grade to one side. The frames and graded soil were lined with 6 mil black polyethylene which was extended up the sides of the frames and stapled in place. Holes 1.5 cm (9/16 in) in diameter were made in

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the polyethylene along the inside of the frames about 5 cm (2 in) up from the base, and approximately every 60 cm (2 ft) for drainage of excess water. The frames were filled with fine mortar sand which was leveled to provide a sand depth of 8.9 cm (3.5 in). Irrigation water was provided by drip tubing installed on the surface of each bed, extending along the periphery of the bed about 50 cm (20 in) in from the edge. This was connected to a pressure control valve, solenoid, and 24 hour electronic timer. At 7032 kg/m^2 (10 psi) this system provided a total of 530 l (140 gal) to the 55 m^2 (600 ft^2) of bed surface applied over two, 2 hour irrigation periods per day. The beds were divided into 12 sections of 1.8 × 2.5 m (6 × 8.3 ft). The sand surface of each section was either uncovered, covered with Visqueen 4-mil black ground cover film (Ethyl Corp.), or treated with Surflan A.S., 0.34 g per m^2 (3 lbs ai/A). Each surface treatment was replicated 4 times. An adjacent area with a graded, gravel-covered surface and overhead sprinkler irrigation was used as a comparison. The overhead irrigation system provided 882 l (233 gal) in 30 min each day for an area comparable to that of the capillary beds (55 m^2).

In mid-April, rooted liners of Formosa azalea, common boxwood, and Korean boxwood were planted in 2.8 l (3 qt) containers in pine bark:peat:sand media having the following compositions (by vol.) 9:0:1, 8:1:1, 7:2:1, 6:3:1, and 5:4:1. Dolomitic limestone was incorporated into the boxwood media at 2.35 kg/m^3 (4 lbs/yd^3). The plants were grown initially on benches in a greenhouse, minimum temperature 18°C (65°F), where they were fertilized with soluble 20N-8.6P-16.7K (20-20-20) 400 ppm N on April 21, May 1, and May 15. On April 25, Osmocote Plus tablets of 16N-3.4P-10K (16-8-12 plus trace elements) slow release fertilizer were inserted into the medium of each container to a depth of 4 cm (1.5 in). One tablet (approximately 7 g) was used per 2.8 l container.

On May 30, the plants were moved out of the greenhouse and onto the capillary irrigation beds or overhead irrigation area where they were given a final hand watering with Soluble 20N-8.6P-16.7K (400 ppm N). All water thereafter in the capillary beds was supplied by sub-irrigation, or natural rainfall [rainfall averaged 3.5 cm (1.4 in)/week during the experiment].

Each capillary bed surface was replicated 4 times with 3 plants (1 plant/pot) for each medium treatment of each species per replicate. A split-plot arrangement was used with surface treatments assigned to the main plots and medium treatments to the sub-plots. The data were subject to analysis of variance procedures through the use of SAS. Each plant species was treated as a separate experiment in the analysis. The media treatments placed in the overhead irrigation area were also replicated four times. However, because the overhead irrigation system was not replicated and randomized with the capillary treatments, statistical comparisons with the overhead system were not made. These data are included only to provide a general reference as to the relative effectiveness of the capillary system.

On June 30, weeds that had established naturally on the capillary bed surfaces were counted, harvested and weighed.

On October 19, plant height and width were recorded. Growth of roots from the bottom of the pots and into the capillary bed was also noted at this time. After recording the size, the plant shoots were cut off at the soil surface, dried and then weighed.

Results and Discussion

Azaleas. On the capillary bed surfaces plant dry weight, height, and growth index increased linearly as the proportion of peat in the medium increased (Table 1). Growth of the azaleas was low on all capillary surfaces when little or no

Table 1. Growth of Formosa azalea, Korean boxwood, and common boxwood on three capillary bed surfaces, with varying proportions of peat in the container medium.

	Azalea			Korean Boxwood		Common Boxwood	
Treatment	Dry Wt. (g)	Plant Ht. (cm)	Growth[z] Index	Dry wt. (g)	Plant ht. (cm)	Dry wt. (g)	Plant ht. (cm)
Capillary Bed Surface[y]							
Sand	20.9	22.9	24.7	5.4	25.8	3.5	19.4
Sand + Surflan	21.4	21.3	23.1	5.5	24.5	3.3	18.3
Sand + Visqueen	15.6	20.3	21.4	4.7	22.0	2.6	16.2
Medium (% Peat)[x]							
0	11.2	18.8	19.1	4.1	22.5	2.4	14.6
10	15.3	19.9	21.0	4.4	22.9	2.4	16.1
20	17.3	20.2	22.2	5.0	23.8	2.8	18.3
30	24.0	24.9	26.7	6.0	25.7	3.5	18.1
40	28.7	23.6	26.2	6.7	25.5	4.5	22.5
F Values							
Bed Surface	NS	NS	8.18*	7.35*	55.20**	18.12**	11.12**
Medium	51.32**	16.77**	32.21**	41.62**	5.29**	36.02**	16.46**
Linear	199.87**	52.26**	116.57**	161.98**	19.00**	129.38**	59.02**
Quadratic	NS	NS	NS	NS	NS	14.60**	NS
Surface × medium	2.18*	2.84*	2.24*	NS	NS	3.04**	2.59*

[z]Growth index = height + mean of 2 width measurements/2.

[y]Averaged over medium treatments.

[x]Averaged over bed surface treatments.

NS, *, ** Nonsignificant (NS) or significant at 5% (*), 1% (**) level.

peat was included in the medium. On hot, dry days, wilting of the azaleas in the media containing 20% or less peat was observed, suggesting that these plants were receiving insufficient water. However, at 30 and 40% peat no visible wilting occurred and on the sand and Surflan-treated-sand surfaces growth was comparable to that obtained with overhead irrigation (Fig. 1). There was a significant medium × capillary bed surface interaction effect on azalea growth. Increased growth obtained with increasing peat content was

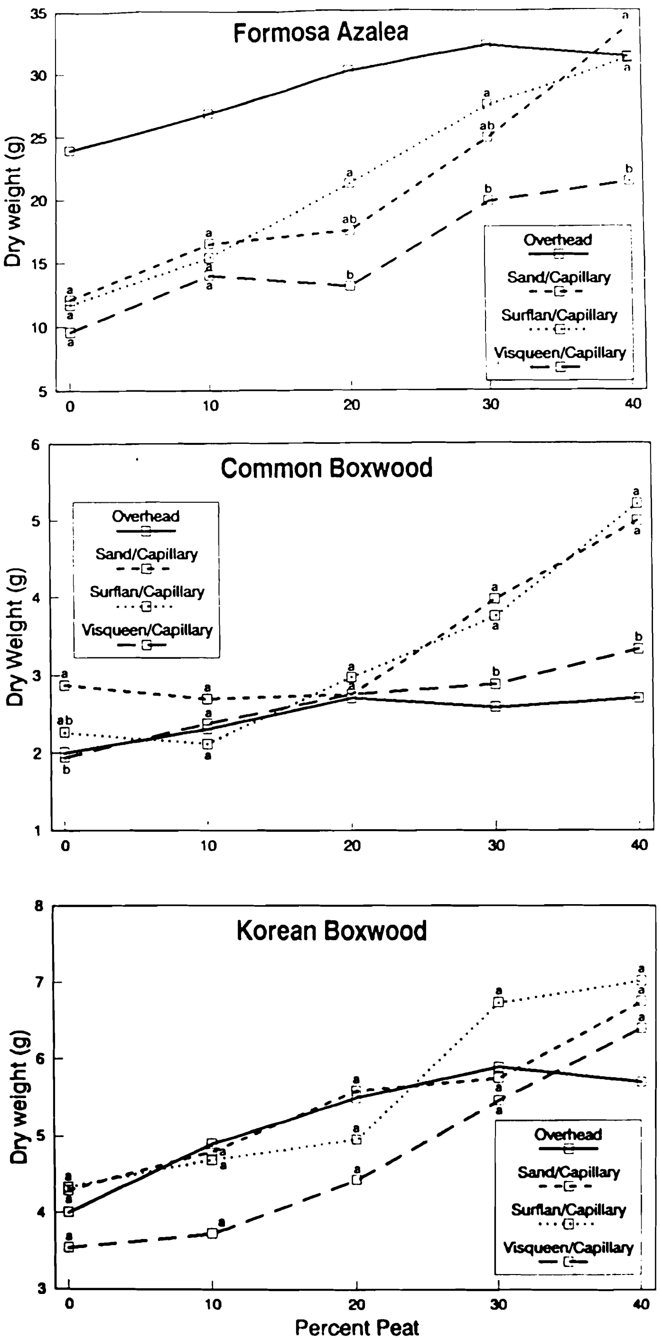

Fig. 1. Dry weight of Formosa azalea, Korean and common boxwood as affected by percentage of peat in the container medium, capillary bed surface and irrigation method. Within each level of peat, means with the same letter are not significantly different (p = .05, LSD). Statistical comparisons with the overhead irrigation system were not made.

Table 2. Percent of Korean Boxwood containers with roots extending out of the bottom of the containers and into the support surface below.

Surface material	Percent (%)
Gravel (overhead irrigated)	22
Sand	98
Sand + Surflan	90
Sand + Visqueen	15

significantly less for the plants on the Visqueen surface than on the two sand surfaces (Fig. 1). This suggests inhibition of capillary water flow through the Visqueen even with high levels of peat in the medium.

Korean Boxwood. The growth of Korean boxwood also increased on all capillary surfaces as media peat content increased to 40%, with 30 and 40% peat providing growth at least comparable to that obtained with overhead irrigation (Fig. 1). No capillary surface × medium interaction effect was seen with this plant. However, the capillary surface treatment did have a significant effect (Table 1) with growth obtained on the Visqueen surface being consistently lower than on the two sand surfaces.

Common Boxwood. The growth response of common boxwood showed a medium × capillary surface interaction similar to that obtained with the azaleas. Growth on the capillary beds generally increased as medium peat content increased, but at medium peat contents of 30 and 40%, growth on the Visqueen surface was significantly less than on the sand and Surflan-treated-sand (Fig. 1). This again indicates an inhibition of capillary water flow through the Visqueen surface.

Root and weed establishment. By the end of the growing season only the roots of Korean boxwood were emerging from the base of the containers. Almost all of the Korean boxwood roots on the sand and most on the Surflan-treated-sand were starting to grow into the capillary bed (Table 2). However, most of the roots of the plants on the Visqueen or on the gravel (overhead irrigation) were impeded when they reached these surfaces.

Early in the growing season both Surflan and Visqueen were effective in controlling weeds on the bed surfaces (Table 3). However, by late summer the Surflan treatment was no longer effective.

Table 3. Weights and numbers of weeds growing on various sufaces of a capillary irrigation system one month after study initiation.

Surface material	Weed fresh wt. (g)	Weed numbers
Sand	221.8 a[z]	64.3 a
Sand + Visqueen	16.2 b	26.3 ab
Sand + Surflan	1.7 b	8.0 b

[z]Mean separation within columns by LSD test, 5% level. Data are means of 4 capillary bed sections each 1.8 × 2.5 m.

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Cold Storage of Rooted *Taxus* Cuttings on Subsequent Summer Regrowth[1]

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Abstract

After one growing season, root systems of *Taxus media* 'Nigra' and 'Densiformis' were similar, whether or not these fall-propagated rooted liners were given a cold treatment [−2.2°C (28°F) for 8 weeks] or left in the propagating beds until spring. However, storage did make propagation space available for two months for other uses. Outdoor spring propagated cuttings had more roots and a greater root shoot/ratio than indoor fall rooted cuttings, whether the latter were cold-treated or not.

Index Words: *Taxus*, Yew, propagation, cold storage

Significance to the Nursery Industry

There does not appear to be enough gain in growth to warrant the additional labor cost involved in harvesting and cold storing rooted cuttings for two months unless bench space is in great demand. While very few nurseries have labor to spare to make cuttings in April (5) it does remain an option which will produce vigorous liners (1). The outdoor bed is also an option for the smaller company which might need to expand but not want to construct propagating houses and incur the resultant cost of heat during the cooler months.

Introduction

Work at the Rhode Island Agricultural Experiment Station has demonstrated the feasibility of propagating *Taxus* cuttings in April, outdoors in insulated bottom heated mist beds. The winter temperature apparently affects *Taxus* shoots so that they grow faster once they are rooted. Vigor is carried over into the second year as well (3). Lathrop and Mecklenberg (2) observed *Taxus* shoots had a dormancy which could be broken by exposure to −2.2°C (28°F) for 3 weeks. Shugert (4) reported a stimulating effect on shoot growth after stored cuttings were held at 0.6–3.3°C (33–38°F) for 8 weeks.

Work was initiated at this station to determine if exposure of rooted *Taxus* cuttings to low temperatures [−2.2°C (28°F)] for 8 weeks would result in stimulated root and/or shoot growth and to determine how these compare with non-cold treated cuttings and with the previously observed growth stimulation we found in cuttings that were propagated in April. Removal of cuttings from indoor propagating beds 8 weeks earlier than normal would free the space but would also result in a smaller initial root system at planting time.

Materials and Methods

Rooted cuttings of *Taxus media* 'Densiformis' and 'Nigra' were obtained from a local nursery in February 1989. They were placed in a plastic bag and kept in the dark in a growth chamber (Hotpack model 352642 controlled environment chamber) where a temperature of −2.2°C ± 1° (28°F ± 1.8°) was maintained for 8 weeks. A similar group of unrooted cuttings was obtained from the same source in April and rooted in outdoor mist beds as previously described (3).

On May 12, 1989, cuttings were removed from the growth chamber and planted in a shaded liner bed along with a third group of rooted cuttings which were obtained from the nursery. The latter group was fall propagated and remained in the propagating bed until this date. On June 26, 1989, spring propagated cuttings were removed from the outdoor mist bed and planted in the liner bed. Ten cuttings from each of the three groups were randomly selected and used to count average root number and total root length (Table

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