Horticultural Research Institute

This Journal of Environmental Horticulture article is reproduced with the consent of the Horticultural Research Institute (HRI – www.hriresearch.org), which was established in 1962 as the research and development affiliate of the American Nursery & Landscape Association (ANLA – http://www.anla.org).

HRI's Mission:

To direct, fund, promote and communicate horticultural research, which increases the quality and value of ornamental plants, improves the productivity and profitability of the nursery and landscape industry, and protects and enhances the environment.

The use of any trade name in this article does not imply an endorsement of the equipment, product or process named, nor any criticism of any similar products that are not mentioned.

Copyright, All Rights Reserved

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-07-19 via free access

6. Rosenberg, N.J. 1966b. Influence of snow fence and corn windbreaks on microclimate and growth of irrigated sugar beets. Agron J. 58:469-475.

7. Rosenberg, N.J., B.L. Blad and S.B. Verma. 1983. Microclimate: The Biological Environment. John Wiley and Sons, New York.

8. Rosenberg, N.J., D.W. Lecher and R.E. Neild. 1967. Response of irrigated snap beans to wind shelter. Proc. Amer. Soc. Hort. Sci. 90:169-179.

9. Schlichting, H. 1979. Boundary Layer Theory McGraw Hill, New York.

10. Standard Dictionary of Meteorological Science. 1971. McGill-Queen's University Press. Montreal.

11. van Eimern, J.R., L.A. Karschon, L.A. Razumova and G.W. Robertson. 1964. Windbreaks and shelterbelts. WMO Tech. Note No. 59. Geneva.

12. Witherspoon, D.M. and C.C. Harrell. 1980. Evaluation of drip irrigation for production of woody landscape plants. HortScience 15:488-489.

Growth and Chemical Composition of *Populus deltoides* x *nigra* Grown in Field-grow Fabric Containers[1]

C. Chong,[2] G.P. Lumis,[3] R.A. Cline[2] and H.J. Reissmann[2]
Ministry of Agriculture and Food
Horticultural Research Institute of Ontario
Vineland Station, Ontario, Canada L0R 2E0

Abstract

Growth and chemical composition of popular (*Populus deltoides* x *nigra,* DN 69) grown in field-grow fabric containers (FGFC) was evaluated. Unrooted hardwood cuttings were grown in 0.6, 2.4, 6.0, and 14.0 L (0.2, 0.6, 1.6, and 3.7 actual gal) custom-made FGFC inserted in 3, 6, 12 and 24 L (#1, 2, 3 and 6 trade size) plastic nursery containers, resp. A 3.5 cm (1.4 in) layer of the same medium was placed under the between the FGFC and the walls of the nursery container. Each bag was filled with a medium of pine bark; spruce bark (3:1 by vol.). Control plants were grown in containers of all sizes without FGFC in the same medium. Plant growth increased with increasing container size. Root dry weight of plants grown in FGFC were 21% less than plants without FGFC. However, there was no difference in top growth between FGFC and control plants. Soluble sugars concentration was 7% higher in leaves of FGFC grown plants, but leaf N, P, and K concentrations were similar. Roots outside the FGFC contained more N, P, and K than roots inside the FGFC. Soluble sugars and starch concentrations were greater inside the FGFC than outside.

Index words: Container culture, root studies, mineral nutrients, carbohydrates

Introduction

One of the newest techniques to be introduced to the nursery industry has been the production of trees and large shrubs in field-grow fabric containers (FGFC) or "root control bags" (3, 4, 5). These fabric containers have the same basic shape as commonly used nursery containers. Walls are constructed of a strong, black non-woven polypropylene geotextile fabric that allows water and nutrients to flow through freely. The bottom is a clear, low-density polyethylene which prevents root growth beneath the container. Plant roots penetrating the non-woven fabric are restricted, thus resulting in a more compact, fibrous root system (3).

This study investigated the relationship of top and root growth of poplar plants grown with and without FGFC nursery containers.

Materials and Methods

In early May, 1985, 23 cm (9 in) long, unrooted hardwood cuttings of hybrid poplar (*Populus deltoides* x *nigra,* DN 69) were planted in 0.6, 2.4, 6.0, and 14.0 L (0.2, 0.6, 1.6, and 3.7 actual gal) FGFC inserted inside 3, 6, 12 and 24 L (#1, 2, 3, and 6 trade size) plastic nursery containers under lath. The FGFC were custom-made (Fig. 1), so that a 3.5 m (1.4 in) of potting medium could be placed around the outside and under each bag. The potting medium used was 3 parts pine bark and 1 part spruce bark (by vol) screened through a 5 cm (2 in) mesh screen. Control plants grown in containers without FGFC were also included.

In late May, plants were moved to full sun and spaced 60 x 60 cm (24 x 24 in) to minimize inter-plant effects.

[1]Received for publication August 11, 1986; in revised form January 16, 1987. This paper was presented at the joint 22nd International Horticultural Congress and 83rd Annual Meeting of the American Society for Horticultural Science, University of California, Davis, August 12, 1986. The field-grow fabric containers used in this study were supplied by Braun Nursery Ltd., Mount Hope, Ontario. The bark medium was supplied by John Connon Nurseries Ltd., Waterdown, Ontario. The technical assistance of Bob Hamersma is appreciated.

[2]Research Scientists.

[3]Associate Professor, Department of Horticultural Science, University of Guelph, Guelph, Ontario, Canada N1G 2W1.

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-07-19 via free access

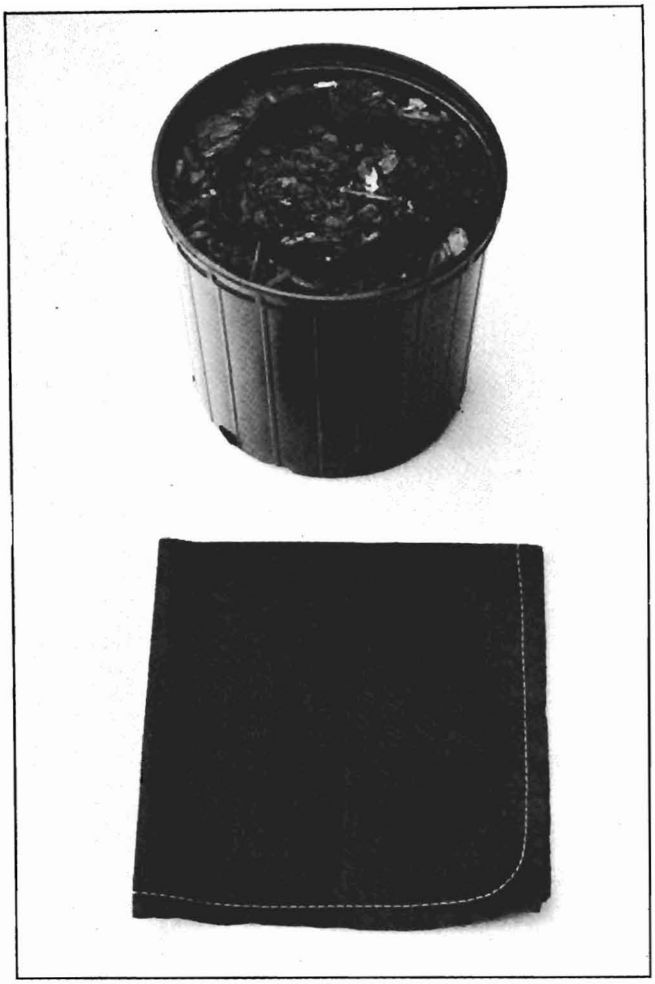

Fig. 1. A custom-made FGFC before insertion (lower) and after insertion in the nursery container (upper).

The plants were arranged in a factorial completely randomized block with and without FGFC; 4 container sizes; replicated 4 times. There were 5 plants per treatment per replicate. Plants were fertilized with 200, 87, and 166 mg/L of N, P, and K as needed.

In early June, plants were pruned to 2 shoots each, and in July the shoots were staked and containers anchored to the ground. Leaf samples were taken in mid August, dried 72 hrs at 70°C (158°F) and ground through a 40-mesh screen.

In mid-September, plant height, stem caliper measured 5 cm (2 in) above pot rim, and number of side shoots were recorded from 3 plants within each experimental treatment unit. Plant tops were pruned at pot level and leaves and stems were separated, dried and weighed. Roots inside and outside the FGFC, or whole root system in control containers, were dried and weighed after repeated washing and(or) removal of the fabric material. Portions of dried roots which had developed just inside (1.5-2.5 cm or 0.6-1.0 in long) or just outside (2.0-3.0 cm or 0.8-1.2 in long) the FGFC were selected. Roots collected from the same area from plants of each experimental unit were combined. These roots were easily recognized by the swelling at the junction inside or outside (Fig. 2) the FGFC. Root samples from approximately the same location were taken from control plants.

All leaf and root samples were analyzed for N, P, and K. Soluble sugars were determined by the method of Dubois et al. (2), and starch by the method of Carter and Neubert (1).

Results and Discussion

Plant Growth. Plant height and dry weight of tops and roots increased with increasing container size (Table 1). There was no significant difference in plant height or

Fig. 2. Roots just outside the fabric container.

Table 1. Effect of FGFC and container size on top and root growth of year old poplar plants.

Container size		Plant ht (cm)		Top dry wt (g)		Root Dry wt (g)	
(L)	(gal)	FGFC	Control	FGFC	Control	FGFC	Control
3	1	123	128	98	115	24	32
6	2	152	152	171	154	40	48
12	3	168	165	244	276	69	100
24	6	183	185	388	360	104	119
Mean		156	158	225	226	59	75
LSD 5%	Container type	NS[z]		NS		7	
	Container size	7.2		26		10	
	Interaction	NS		NS		NS	

[z]Not significantly (NS) different at the 5% level.

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-07-19 via free access

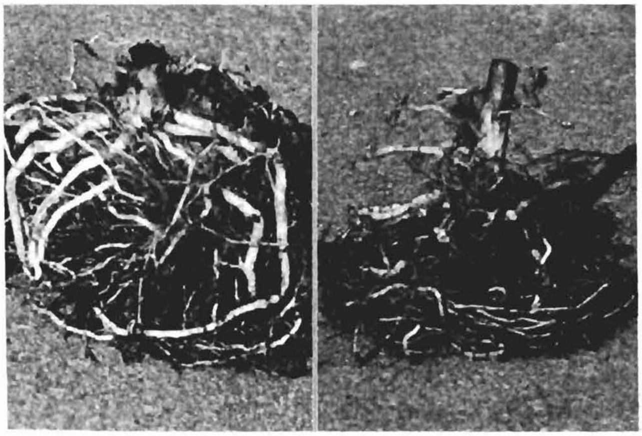

Fig. 3. Washed root system of a control plant (upper) and of a FGFC plant (lower).

top dry weight (Table 1) and in related growth parameters (data not shown) with or without FGFC; however, root dry weight of FGFC plants was 21% less. Large roots with larger diameters and more roots circling in the side walls, were more evident in the 12 and 24 L containers (Fig. 3).

Roots penetrating the fabric were swollen just inside and outside the FGFC (Fig. 2), as described by Reiger and Whitcomb (3); outside roots were considerably smaller than those inside. The amount of roots retained within the FGFC increased linearly with increasing container size from 33.6% in the 3 L container to 66.4% in the 24 L size (Table 2). Root development outside the FGFC was the opposite.

Table 2. Relative proportions of roots in year old poplar plants in terms of dry weight inside and outside the FGFC.

Container size		Percent (%)	
(L)	(gal)	Inside	Outside
3	1	33.6	66.4
6	2	48.3	51.7
12	3	54.8	45.2
24	6	66.4	33.6

Chemical Composition. Leaf N and K concentrations increased with increasing container size, and were not influenced by the FGFC (Table 3). Leaf P was not affected by any treatment. Soluble sugars concentration in leaves decreased with increasing container size and was higher in FGFC plants (Table 3). Starch concentration in leaves decreased with increasing container size but was not influenced by FGFC.

When data were averaged for inside and outside roots (Table 4), concentrations of root N and K only increased with increasing container size. N, P, and K concentrations in roots of FGFC plants were higher than those of control plants but the concentration of starch was lower. Roots growing outside the FGFC contained more N, P, and K than inside roots, while roots within the FGFC contained higher concentrations of soluble sugars and starch (Table 5).

These results support observations by Reiger and Whitcomb (3) that FGFC plants produce a more compact root system. The fabric through which the roots grew caused them to swell inside as well as outside the bag and, similar to a girdling effect, restricts the flow of carbohydrate to the roots outside the FGFC. There was no difference in the concentration of soluble sugars in root samples from the same location in control plants (Table 4). Starch concentrations were lower in roots (Table 4), both inside and outside the FGFC (Table 5). Since nutrients flow from the roots to the leaves, a similar mechanism would account for the accumulation of nutrients in roots outside the FGFC (Table 5).

There was no visible difference between relative amounts of fibrous roots inside the FGFC and those grown without FGFC, as reported by Reiger and Whitcomb (3). This difference in response could be due to the age and type of planting material used, or fibrous roots may have been destroyed during extraction and washing. There was also no apparent difference in root branching within the FGFC and control containers. The fact that the more restrictive root systems of FGFC

Table 3. Effects of FGFC and container size on N, P, K, soluble sugars and starch in leaf tissue of year old poplar plants.

Container size		% dry wt						mg/g dry wt			
		N		P		K		Soluble sugars		Starch	
(L)	(gal)	FGFC	Control	FGFC	Control	FGFC	Control	FGFC	Control	FGFC	Control
3	1	3.54	3.63	0.53	0.56	2.19	2.25	79	75	5.04	4.04
6	2	3.77	3.74	0.56	0.57	2.41	2.30	72	71	3.84	4.20
12	3	3.74	3.86	0.58	0.56	2.47	2.36	73	66	3.80	3.64
24	6	4.39	4.27	0.57	0.58	2.50	2.53	66	58	3.36	3.32
Mean		3.86	3.88	0.56	0.57	2.39	2.36	73	68	4.00	3.76
LSD 5%	Container type	NS[z]		NS		NS		4		NS	
	Container size	0.24		NS		0.09		6		0.68	
	Interaction	NS		NS		NS		NS		NS	

[z]Not significantly different at 5% level.

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-07-19 via free access

Table 4. **Effects of FGFC and container size on N, P, K, soluble sugars and starch in root tissue of year old poplar plants.**

		% dry wt						mg/g dry wt			
Container size		N		P		K		Soluble sugars		Starch	
(L)	(gal)	FGFC	Control	FGFC	Control	FGFC	Control	FGFC	Control	FGFC	Control
3	1	1.42[z]	1.29	0.48	0.40	1.08	0.97	52	49	186	201
6	2	1.46	1.27	0.45	0.40	1.09	0.98	51	53	187	221
12	3	1.24	1.35	0.46	0.40	1.21	1.05	54	53	204	229
24	6	1.51	1.48	0.50	0.43	1.36	1.11	50	52	162	206
Mean		1.42	1.29	0.48	0.41	1.19	1.03	52	52	185	214
LSD 5%	Container type	0.11		0.03		0.06		NS[y]		20	
	Container size	0.15		NS		0.08		NS		NS	
	Interaction	NS		NS		NS		NS		NS	

[z]Mean concentration in inside and outside roots.

[y]Not significantly different at 5% level.

plants supported tops of similar size to the control suggests that the FGFC plant is more efficient.

Significance to the Nursery Industry

The use of FGFC provides a technique for growing relatively large plants with a restricted root size. The technique may also serve as a basis for future work aimed at further reduction in rootball size. In spite of extensive girdling of the root system and although chemical changes due to the presence of the bag were evident after one growing season, there was no visual evidence of top decline. However, more information is needed on the long-term effect of the root system in FGFC and such studies are underway.

Table 5. **Increase (+) or decrease (-) in nutrients and carbohydrates in roots inside and outside roots of FGFC plants expressed as percent relative to concentration in roots of control plants.**

Roots	N	P	K	Soluble sugars	Starch
Inside	0	+7	+10	+6	-12
Outside	+18	+22	+20	-8	-16

Literature Cited

1. Carter, G.H. and A.M. Neubert. 1954. Rapid determination of starch in apples. J. Agr. Food Chem. 21:1070-1072.

2. Dubois, M., K.A. Gilles, J.K. Hamilton, P.A. Rebers, and F. Smith. 1956. Colorimetric method for determination of sugars and related substances. Anal. Chem. 28:350-356.

3. Reiger, R. and C.E. Whitcomb. 1983. Growers can now confine roots to in-field containers. Amer. Nurseryman 158(8):31-34.

4. Whitcomb, C.E. 1985. Innovations and the Nursery Industry. J. Environ. Hort. 3:33-38.

5. Whitcomb, C.E. 1986. Fabric field-grow containers enhance root growth. Amer. Nurseryman 163(7):49-52.

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-07-19 via free access