

Development of a Double Crop Production System Using Retractable Roof Houses[©]

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Double cropping containerized tree liners in a retractable roof greenhouse (RRG) increases the incentive for their production in Midwest nurseries. The objectives of this study are to evaluate possible acceleration of tree production using double cropping in a RRG at The Ohio State University, Columbus, Ohio, with subsequent upshifting to a pot-in-pot (PIP) system. Two tree species were selected to be grown in the RRG, red maple (*Acer rubrum* 'October Glory') and greenspire littleleaf linden (*Tilia cordata* 'Greenspire'). All the trees were grown from tissue culture and they had a start height of 20–25 cm. All the plants were put into 11.3-L containers with a soilless mix in the RRG. The roof and sidewalls were programmed to close at 21 °C during the day and 10 °C during the night from October to December and plants were irrigated using aerial irrigation three times per day. From December to March half of the plants were with bottom heat (BH) using low watt propagation mats set at 5 °C and the other at ambient temperature (AT). During winter, plants were watered as needed and protected from freezing temperatures using a propane heater. From March to June the irrigation was applied using cyclic-micro-irrigation two times per day, applying 500 ml per pot. From June to September, irrigation was applied one time per day, applying 250 ml of water per pot. Plants were fertilized two ways starting in April: control release (CR) fertilizer (40 g of 19–5–8) applied at potting and a combination of 20 g of the CR applied at potting and supplemented with liquid fertilizer (LF) (21–7–7 at 400 ppm) delivered with an injection system every 2 weeks. The same total nitrogen was delivered in the CR and the CR + LF treatments. Plants were arranged in a split plot design (main plot: temperature, subplot: fertilizer) with 4 replications. Measures consisted of height, caliper, leaf area, and shoot and root dry weights, EC, pH, and NO₃. No significance differences were found between AT and BH for all the measurements (Table 1). No significance differences were found between the CR and CR+LF treatments for height, leaf area, dry shoot, and root weights (Table 2), EC, pH and NO₃. The caliper was significantly bigger (8.48 mm) in the CR+LF in comparison with the CR (7.82 mm). After 1 year, heights and calipers of linden (107 cm and 8.61 mm, respectively) and maple [95.39 cm and 7.76 mm, respectively (Table 4)] liners were produced at Ohio State University, supporting our hypothesis that RRG liners can be produced in Ohio.

Tables of the results after 1 year of growth.

Table 1. Growth measurements for the main effect of temperature.

Temperature ^z	Height (cm)	Caliper (mm)	Dry root weight (g)	Dry shoot weight (g)	Leaf area (mm ²)
AT	98.83	8.02	17.13	27.65	1776.90
BH	103.10	8.28	15.50	26.48	1807.93
1 year harvest	No significant difference				

^zambient temperature, BH = bottom heat.

Table 2. Growth measurements for the main effect of fertilizer.

Fertilizer ^z	Height (cm)	Caliper (mm)	Dry root weight (g)	Dry shoot weight (g)	Leaf area (mm ²)
CR	99.90	7.82	15.90	28.68	1983.77
CR+LF	102.22	8.48	16.73	25.45	1601.05
1-year-old harvest	No significant difference	Significant difference	No significant difference	No significant difference	No significant difference

^z CR = control-release fertilizer, LF = liquid fertilizer.

Table 3. Chemical analysis of the fertilizers.

Fertilizer ^z	Chem. analysis	EC (mS·cm ⁻¹)	Adequate EC range pH	Adequate pH range	NO ₃ (ppm)	Adequate NO ₃ range
CR	1.03	0.2 to 1	5.04	5.2 to 6.2	252.80	15 to 25
CR+LF	0.95	.75 to 1.5	4.96	5.2 to 6.2	254.92	50 to 100

^z CR = control-release fertilizer, LF = liquid fertilizer.

Table 4. Growth measurements of the species.

Specie	Height	Caliper	Dry root weight (g)	Dry shoot weight (g)	Leaf area (mm ²)
red maple	95.39	7.76	16.80	29.58	2012.62
littleleaf linden	107.74	8.61	15.81	24.55	1572.19
1-year-old harvest	Significant difference	Significant difference	No significant difference	No significant difference	No significant difference