Fertilizing Containerized Atlantic White Cedar Seedlings[1]

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Abstract

Containerized Atlantic white cedar [*Chamaecyparis thyoides* (L.) B.S.P.] seedlings were fertilized with five rates (0.0, 2.4, 4.8, 7.2, and 9.6 kg/m^3) (0, 4, 8, 12, and 16 lb/yd^3) of controlled-release fertilizers (CRF) [Osmocote 15N–4.0P–10.0K (15N–9P_2O_5–12K_2O), 12–14 month southern formulation, with micros; and Polyon 18N–2.6P–10.0K (18N–6P_2O_5–12K_2O), 9-month formulation, with micros]. Height, stem diameter, dry mass, and foliar nutrient concentrations were evaluated after 16 weeks. Growth was affected by fertilizer source and application rate, with no interaction. In general, the response to increasing fertilization was quadratic. Osmocote yielded larger plants than Polyon, probably owing to its higher P content. Osmocote (4.8 to 7.2 kg/m^3) (8 to 12 lb/yd^3) or Polyon (7.2 kg/m^3) (12 lb/yd^3) is suggested for container-grown seedlings the first year.

Index words: wetlands restoration, controlled-release fertilizer, juniper, foliar nutrient concentrations.

Species used in this study: Atlantic white cedar (*Chamaecyparis thyoides* (L.) B.S.P.).

Significance to the Nursery Industry

There is strong interest in restoring Atlantic white cedar to sites where it once was abundant, but efforts have been limited by a scarcity of planting stock. Production of containerized planting stock offers potential for increasing the available supply of plants. Most of the potential height growth of containerized seedlings can be realized with 4.8 kg/m^3 (8 lb/yd^3) of CRF, whereas at least 7.2 kg/m^3 (12 lb/yd^3) is required to optimize stem diameter or total dry weight.

Introduction

Atlantic white cedar [*Chamaecyparis thyoides* (L.) B.S.P.] (AWC), known as 'juniper', is an evergreen conifer that grows in fresh water swamps along a narrow coastal belt from Maine to Florida and west to Mississippi (20). Historically, AWC was valuable for its lightweight, fragrant, and decay-resistant wood (1, 18); today, it is also used in landscaping (8). AWC now occupies only a fraction of the original acreage due to logging, wildfires, lack of natural seed sources, and drainage of peatlands (5, 9, 21).

Although restoration of AWC ecosystems is a priority in eastern North Carolina and elsewhere (19, 24), success has been limited by lack of planting stock. While AWC is easy to propagate from stem cuttings (3, 14), labor intensity and costs are high compared to bare-root stock. There are also unanswered questions about the performance and growth of rooted cuttings in long forestry rotations, say 50 to 70 years.

Traditional production of AWC seedlings in outdoor nursery beds is unpredictable owing to sporadic germination (11) and non-uniform bed density (26). Current efforts by the NC Forest Service are focused on production of container-grown AWC seedlings, which appears more efficient than vegetative propagation and/or traditional outdoor nursery beds. In addition, containerized transplants tend to survive a little better in the field compared to bare-root seedlings or transplants derived from rooted cuttings (24). Recent studies have examined the role of container volume, fertilizer source, irrigation frequency, and type of substrate on production of containerized plants (6). The objective of this research was to examine the growth of AWC seedlings in response to varying rates of two controlled-release fertilizers (CRFs).

Materials and Methods

On June 10, 2002, Atlantic white cedar seedlings (source: eastern North Carolina) were transplanted individually into Anderson tree bands (Anderson Die & Mfg. Co., Portland, OR) (7.1 × 7.1 × 22.9 cm) (2.8 × 2.8 × 9.0 in) containing a substrate of pine bark:sphagnum peat moss (3:1, by vol). In year 2001, these plants were seeded and grown in Ropak 45 Multi-Pots (Stuewe and Sons, Inc., Corvalis, OR) (cell volume = 98 cm^3 = 6 in^3). For this experiment, plants were graded for uniformity and had an initial average height of 15.7 cm (se = 0.21) (6.2 in) (n = 90). Stem diameter (average of two measurements, opposite directions, near ground-line) was 1.96 mm (se = 0.025) (n = 90). Initial dry mass after drying to constant weight at 65C (140F) was 0.87 g (se = 0.043), based on a random sample of 10 seedlings.

Prior to planting, two CRFs were incorporated into the substrate at five rates: 0.0, 2.4, 4.8, 7.2, or 9.6 kg/m^3 (0, 4, 8, 12, and 16 lb/yd^3). Fertilizers were Osmocote 15N–4.0P–10.0K (15N–9P_2O_5–12K_2O), 12–14 month southern formulation, with micros) (Scotts-Sierra Horticultural Products Co., Marysville, OH), and Polyon 18N–2.6P–10.0K (18N–6P_2O_5–12K_2O) with micros, 9-month formulation) (Pursell Technologies Inc., Sylacauga, AL)

Planted containers were placed in Anderson deep propagation flats (5 rows × 5 columns = 25 cells) with empty containers as spacers within and between rows, such that no planted container was in contact with another. Trays were blocked and randomized on a gravel nursery pad, and irrigated twice daily with overhead sprinklers. Ambient daily high temperatures during the summer ranged from 29C to 37C (85F to 98F).

After 8 weeks, a small sample of current-year foliage was collected from each plant, bulked into composite samples

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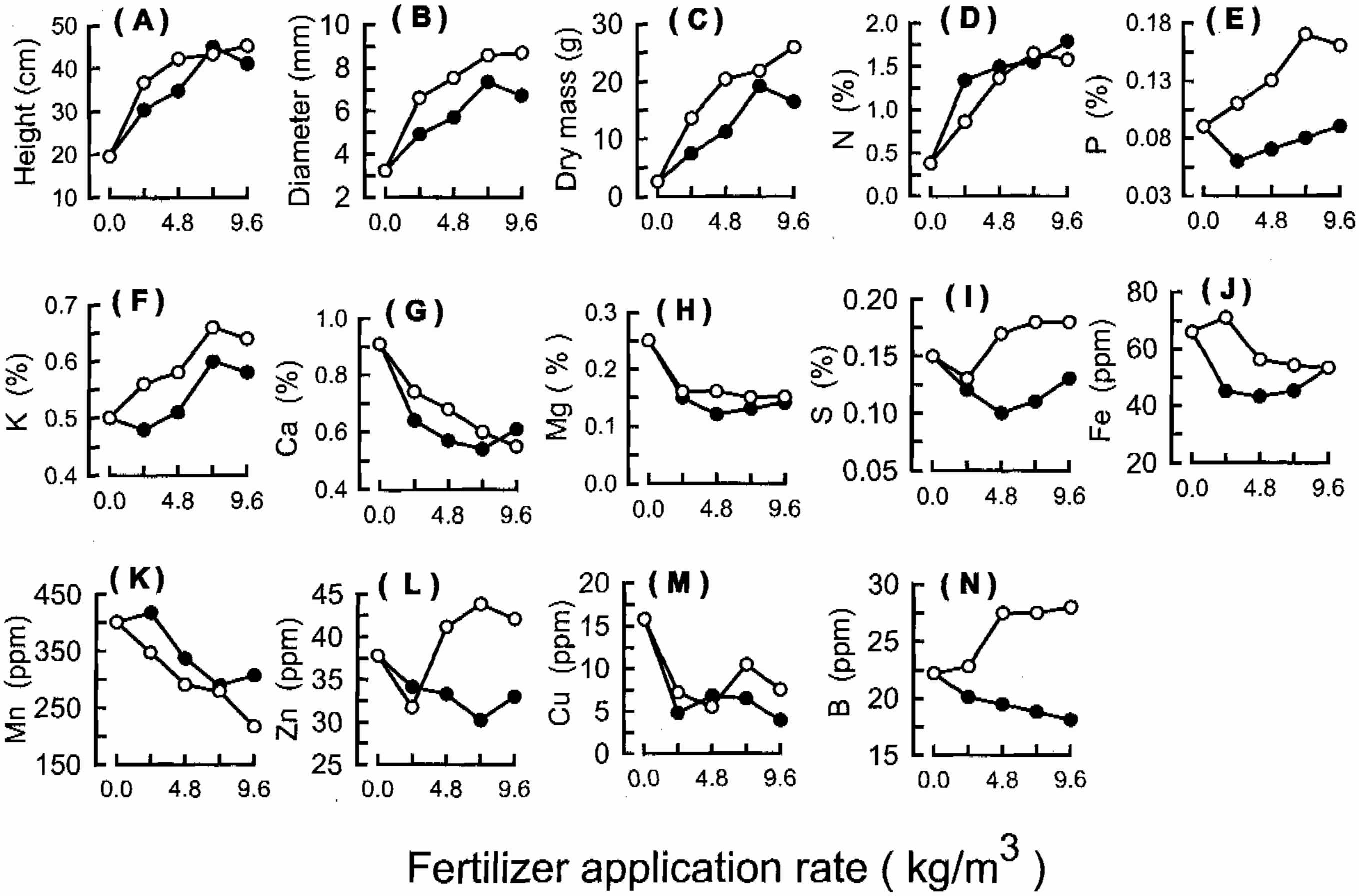

Fig. 1. Growth and foliar mineral nutrient concentrations of containerized Atlantic white cedar in response to two controlled-release fertilizers, Osmocote (○) and Polyon (●), at five rates (0.0, 2.4, 4.8, 7.2, and 9.6 kg/m³) (0, 4, 8, 12, and 16 lb/yd³) after 16 weeks. (A) height, (B) stem diameter, (C) total dry weight, (D) N, (E) P, (F) K, (G) Ca, (H) Mg, (I) S, (J) Fe, (K) Mn, (L) Zn, (M) Cu, and (N) B. Basis: 10 plants for each data point in panels A–C; two composite foliage samples for each data point in panels D through N.

(Reps 1–5 and 6–10 for each treatment), and analyzed by the Agronomic Division of North Carolina Department of Agriculture & Consumer Protection (NCDA), using standard procedures. The experiment was terminated after 16 weeks (October 15, 2002). Total height and stem diameter were measured, and foliage samples were collected and analyzed by NCDA as previously described. After washing roots free of substrate, plants were divided into roots and shoots, dried to constant weight at 65C (140F), and weighed.

The experiment was a randomized complete block design with 10 replications and nine treatments (90 plots), with one plant per plot. Treatments were factorial combinations of two fertilizer materials (Osmocote or Polyon) incorporated at five rates. Data were analyzed using general linear model (GLM) and regression (REG) procedures in SAS (25).

Results and Discussion

Nonfertilized plants grew very little during the 4-month experiment (Fig. 1). Incorporated CRFs increased total height and stem diameter up to 130% and 9-fold, respectively, compared to nonfertilized controls (Fig. 1), and the 'source × rate' interaction was not significant (Table 1). In general, the response to fertilization was quadratic (Table 1, Fig. 1). More than 90% of the final height and about 80% of the final dry mass were realized with 4.8 kg/m³ (8 lbs/yd³) of Osmocote (Fig. 1). Polyon yielded maximum height and dry mass at 7.2 kg/m³ (12 lbs/yd³). Osmocote treatments averaged 11, 20, and 50% more height, stem diameter, and total dry mass, respectively, than Polyon (Figs. 1A–1C).

In the first foliage sample (8 wks), only N, P, and Fe levels were significantly greater than controls, and N was beginning to show a significant positive rate effect (data not presented); after 16 weeks, there were significant differences for all macronutrients (Table 2). Nitrogen concentrations increased linearly with application rate to a maximum of 1.8%, with Polyon usually higher than Osmocote (Fig. 1D). Osmocote increased foliar P levels linearly, with increasing rate, to a maximum of 0.17%, whereas Polyon treatments never exceeded controls (0.09%) (Fig. 1E). Foliar levels of K were highest with Osmocote, although absolute differences were relatively small (Fig. 1E).

Calcium concentrations were highest in controls, and decreased linearly to 0.55% at the highest rate of Osmocote (Fig. 1G). With Polyon, the response was quadratic, reaching its minimum (0.54%) at 7.2 kg/m³. Polyon treatments reduced foliar S concentrations (Fig. 1I) below the 0.15% of controls. Maximum S concentration (0.18%) occurred at the two highest rates of Osmocote; the minimum (0.10%) at 4.8 kg/m³ for Polyon.

The highest concentrations of foliar Mg, Fe, and Cu were in nonfertilized plants, where Cu levels were especially high (Fig. 1). Polyon, which contained more Mn than Osmocote,

Table 1. Analysis of variance for height, stem diameter, and total dry mass of containerized Atlantic white cedar grown with two controlled-release fertilizers incorporated at five rates.

Source	df	Height		Stem diameter		Dry mass	
Rep	9	—		—		—	
Treatment	8						
Control vs. fertilizer	1	**[z]		**		**	
Fertilizer	1	*		**		**	
Rate	3	**		**		**	
linear	1	**	(Osm)	**	(Osm)	**	(Osm)
		**	(Poly)	**	(Poly)	**	(Poly)
quadratic	1	**	(Osm)	**	(Osm)	*	(Osm)
		*	(Poly)	**	(Poly)	NS	(Poly)
Fertilizer × Rate	3	NS		NS		NS	
Error	72	—		—		—	
R^2		0.60		0.67		0.57	

[z]NS, *, ** Nonsignificant or significant at P ≤ 0.05 or 0.01, respectively. Osm = Osmocote; Poly = Polyon.

Table 2. Analysis for foliar mineral nutrient concentrations of Atlantic white cedar seedlings grown for 16 weeks with two controlled-release fertilizer sources incorporated at five rates.

		Foliar mineral nutrient										
Source	df	N	P	K	Ca	Mg	S	Fe	Mn	Zn	Cu	B
Rep	1	—	—	—	—	—	—	—	—	—	—	—
Treatment	17											
Control vs. fertilizer	1	**	**	**	**	**	*	NS	NS	NS	*	NS
Date for Control	1	*	NS	**	**	**	**	NS	**	NS	NS	NS
Date	1	**	**	**	**	**	**	*	*	NS	**	NS
Source	1	*	**	*	NS	NS	**	NS	*	NS	NS	**
Date × Source	1	NS	NS	NS	*	NS	NS	NS	NS	*	NS	NS
Rate	3	**	**	**	**	NS	*	NS	NS	NS	NS	NS
linear	1	**	**	**	**	NS	**	NS	*	NS	NS	NS
quadratic	1	NS	NS	NS	*	NS	NS	NS	NS	NS	NS	NS
Date × Rate	3	NS	NS	NS	NS	NS	NS	*	NS	NS	NS	NS
Source × Rate	3	NS	NS	NS	*	NS	*	NS	NS	NS	NS	*
Date × Source × Rate	3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Error	17	—	—	—	—	—	—	—	—	—	—	—
R^2		0.97	0.93	0.95	0.92	0.89	0.91	0.59	0.74	0.63	0.83	0.87

NS, *, ** Nonsignificant or significant at P ≤ 0.05 or 0.01, respectively.

yielded Mn concentrations about 20% higher than Osmocote, although both declined linearly with increasing rate of application (Fig. 1K). Osmocote treatments averaged about 50% more Zn than Polyon (Fig. 1L), although both CRFs had similar Zn content. Foliar Cu concentrations averaged 16 ppm in controls, and 5 to 10 ppm in fertilized seedlings, with slightly higher values for Osmocote than Polyon (Fig. 1M). Boron was the only micronutrient with a significant fertilizer × rate interaction (Table 2). Osmocote increased foliar B values with increasing application rates, whereas Polyon, which contained no B, decreased concentrations (Fig. 1N).

Growth of containerized plants can be affected by various factors including fertilizer (23, 28), application rate (12, 13, 16), and source of N (7, 17, 27). Both CRFs greatly increased growth, but Osmocote treatments were consistently largest (Fig. 1C). Nitrogen appeared not to account for the difference because the highest foliar N levels were in Polyon treatments (Fig. 1D). Both materials were similar in total N and the ratio of ammonia-N and nitrate-N (1:1). Nutrients that varied the most between CRFs were P (Fig. 1E) and B (Fig. 1N). Of those two nutrients, the higher P levels for Osmocote were likely the most important based on earlier work by Greenwood (10), though the B supplied by Osmocote could also have affected growth (4). While there are no published normal foliar nutrient levels for *Chamaecyparis* spp., comparing these findings to other conifers show P levels in Polyon-treated plants were about 50% below normal (2), while Osmocote treatments were near normal. Similarly, foliar concentrations of B were about 25% lower in Polyon treatments; normal with Osmocote (2).

Both CRFs were described as similar in composition and release time, i.e., 8–9 months at 27C (80F). The 8-week foliage sample did not suggest any major difference between the CRFs at that time (data not presented). More sampling would be required, including destructive harvesting, pour-through analysis, and extended experimental run time to more accurately determine nutrient release patterns. Despite the limitations, this work still provides initial guidelines for operational production of containerized AWC seedlings during the first year. Although this study lasted only 4 months, there was no indication that a long term study would yield different results. In 2003 and 2004, we grew two crops of good quality AWC seedlings (production period = May to January) using 4.8 kg/m^3 (8 lbs/yd^3) of Osmocote.

Native soils for AWC are typically high in peat (histosols), very acidic, and low in available P, often resulting in P deficiencies of crop plants (22). Containerized AWC seedlings grow best in substrates with high peat content (6, 10, 15). When deprived of phosphorus, seedlings typically exhibit very stunted growth and reddish to purplish foliage (10). In our study, nonfertilized plants grew slowly, but apparently received enough P from irrigation water and/or the substrate to avoid the worst symptoms of deficiency.

Among the indicators of seedling quality or grade in forest tree nurseries, e.g., height, stem diameter, or root growth potential; height is one of the most commonly used. Using height as the index for plant grade, and using the CRF formulations employed in this study, we suggest 4.8 to 7.2 kg/ m^3 (8 to 12 lb/yd^3) of CRF for production of containerized AWC in the first growing season. If the goal is to maximize stem diameter and dry weight, the rate should to be near the upper end of that range.

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