CONIFER SEEDLING GROWTH IN LIMED PEAT IN COPPER NAPHTHENATE-TREATED FLATS

Do not add more than 2-3 ounces of limestone to a bushel of peat. In general, do not treat flats with copper naphthenate.

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Seedling culture in beds or containers of fresh sphagnum peat is normally very successful. Nevertheless. unexplained declines in vigor accompanied by chlorosis or purpling of foliage can occur in crops where normally good management practices have been followed. Problems of this nature have been especially prevalent in red pine in local nurseries. Frequent isolations and inoculations revealed little evidence of pathogenic fungi, and seedlings often did not respond to applications of nitrogen or balanced fertilizers. Therefore, micronutrient imbalances or other toxic factors were suspected.

Addition of limestone to peat, prior to planting, could lead to micronutrient imbalances. In container or peat bed plantings, dolomitic limestone is often added at rates of 1 to 10 ounces per bushel (1 to 10 grams per litre) of sphagnum peat. While this raises the pH only slightly (pH 3.5-4.0 to pH 4.5-5.5), the addition of calcium and magnesium could affect the availability of certain trace elements (*1*).

Toxic effects could result from the treatment of containers with wood preservatives. Carlson and Nairn (*2*) demonstrated the effects of pentachlorophenol. Earlier studies at the Maritimes Forest Research Centre (*6*) indicated excess copper uptake in seedlings growing in copper naphthenate treated flats.

Use of woods with natural decay resistance also could create toxicity problems. The fungistatic extractives common to such woods could leach into the planting medium and might in certain instances be phytotoxic. Cedar is used widely for its natural decay resistance and is known to lose some of its resistant properties through leaching (*5*).

The following experimental results demonstrate the possible effects of limestone amendments and container treatment on the growth and nutrition of seedlings raised on fresh sphagnum peat media.

Methods

Wooden flats, inside dimensions, 30 by 50 by 6 cm were constructed from local lumber supplies of ½ -inch cedar or spruce. Three months prior to planting, some of the flats were painted, inside and out, with Green Pentox (2.34 percent copper naphthenate plus 0.075 percent bis tributyl tin oxide) and allowed to dry 24 hours. Some of the treated flats were stored outdoors and exposed to the autumn and early winter weather while the remainder were stored in an unused greenhouse. The outdoor weathering treatment was expected to remove unbound copper from the wood surfaces.

Immediately prior to seeding, ground dolomitic limestone was thoroughly mixed with shredded Fafard sphagnum peat at the rates of 0, 1, or 10 grams per litre of unpacked peat, and the peat was placed loosely in the flats. Evenly spaced rows of 50 seeds each of red pine (*Pinus resinosa* Ait.), jack pine (*Pinus banksiana* Lamb), and black spruce (*Picea mariana* (Mill.) B.S.P.) were planted in each flat. Flats were placed in three replicate blocks in a plastic greenhouse maintained at 16 hour day-length and 15-25° C temperature. After primary needle development, seedlings were fertilized weekly with a modified Ingestadt's solution (3).[1]

Seven months after seeding (6-6½ months after emergence), seedlings were lifted, washed, and oven-dried at 70°C. After determination of dry weights, tissues were ground in a Waring blender and analyzed for nitrogen, phosphorus, sulfur, potassium, calcium, magnesium, iron, manganese and copper (*4*).

Result And Discussion

Germination and early growth were similar in all treatments. Two months after emergence, growth retardation began to be evident in the high limestone treatments. In the presence of

[1] NH_4NO_3 -203 ppm, KNO_3 - 162 ppm, $(NH_4)_2SO_4$ - 38 ppm, plant starter (10-52-10) -57 ppm, Fe EDTA - 0.55 ppm, $MnSO_4$ - 0.12 ppm, $ZnSO_4\ 7H_2O$ - 0.02 ppm, Cu EDTA - 0.03 ppm, NH_4 molybdate - 0.09 ppm.

Table 1. — *Survival and dry weight of 7-month-old seedlings grown in limed and unlimed peat in copper naphthenate treated and untreated flats of spruce or cedar wood*

Wood used in flats	Copper napthenate treatment	Weather -ing	Limestone amendment g/l)	Seedlings Survival[1] (Percent)			Seedling Dry Weight[1] (mg)		
				Red pine	Jack pine	Black spruce	Red pine	Jack pine	Black spruce
Spruce	Yes	No	10	36^{ab}	60^{a}	50^{a}	98^{a}	171^{a}	403^{a}
			1	66^{cd}	66^{a}	58^{a}	785^{cd}	1314^{b}	818^{b}
			0	68^{d}	60^{a}	60^{a}	837^{cd}	1488^{b}	807^{b}
		Yes	10	26^{ab}	54^{a}	66^{a}	105^{ab}	188^{a}	398^{a}
			0	42^{b}	62^{a}	76^{a}	862^{d}	1440^{b}	746^{b}
	No	No	10	44^{bc}	58^{a}	60^{a}	310^{bc}	385^{a}	509^{a}
			1	72^{d}	66^{a}	68^{a}	817^{cd}	1389^{b}	756^{b}
			0	44^{bc}	64^{a}	66^{a}	1038^{d}	1478^{b}	766^{b}
Cedar	Yes	No	10	34^{ab}	66^{a}	60^{a}	66^{a}	183^{a}	330^{a}
		Yes	10	18^{a}	58^{a}	64^{a}	98^{a}	145^{a}	355^{a}
			0	66^{cd}	68^{a}	72^{a}	852^{a}	1414^{b}	718^{b}
	No	No	10	28^{ab}	54^{a}	50^{a}	271^{b}	269^{a}	461^{a}
			1	66^{cd}	70^{a}	70^{a}	835^{cd}	1395^{b}	725^{b}

[1]Figures within a column followed by the same letter not significantly different at P = 0.05 using Duncan's Multiple range test.

high limestone levels, the pines became chlorotic and many red pine seedlings developed purple discoloration of primary needles. After 5 months, there was some mortality of the most severely affected red pine (table 1). In all species, growth reduction by high limestone levels was accentuated by copper naphthenate treatment of flats, but at low limestone levels or in unamended peat, there were no measurable effects of copper naphthenate. Weathering of treated flats for 3 months did not reduce the copper naphthenate effect.

The use of cedar as opposed to spruce wood for the construction of flats did not significantly affect growth although seedlings were slightly smaller in cedar flats in 14 out of 15 instances (table 1).

Addition of limestone at 10 grams per litre raised the pH of peat from 4.1-4.3 to 5.8-5.9, initially. Final pH values were 3.9-4.0 and 5.0-5.4, respectively. Limestone at 1 gram per litre did not measurably affect pH. Levels of total calcium were raised from 0.2 to 1.6 percent and levels of magnesium from 0.1 to 0.9 percent by the 10 grams per litre amendment. Likewise, the levels of calcium and magnesium in seedlings, were considerably increased by high limestone treatment (table 2). Potassium levels were also enhanced but this could have been a dilution effect in view of the extreme difference in seedling weight. In spruce, nitrogen levels were lower in the high lime treatment and sulfur levels were suppressed by limestone + copper naphthenate.

Trace element levels, praticularly in the roots, appeared to be most closely related to

Table 2. — *Major element analyses of seedlings grown 7 months in sphagnum peat in spruce-wood flats.*

Species and Treatment[1]	Shoots[2]						Roots			
	Ca	Mg	K	N	P	S	Ca	Mg	K	P
	(Percent)						*(Percent)*			
Red pine										
1	0.58	0.48	1.32	3.16	0.40	—	0.45	0.37	0.64	0.32
2	0.16	0.14	1.05	2.86	0.34	0.46	0.12	0.14	1.22	0.48
3	0.40	0.32	1.18	2.10	0.29	0.41	0.67	0.54	1.40	0.39
4	0.16	0.14	0.99	2.76	0.32	0.40	0.21	0.16	1.30	0.60
Jack pine										
1	0.50	0.40	1.30	2.05	0.33	0.57	0.50	0.64	1.54	0.51
2	0.14	0.14	1.15	2.91	0.36	0.51	0.12	0.16	1.22	0.48
3	0.46	0.36	1.39	2.09	0.30	0.74	0.72	0.74	1.50	0.48
4	0.16	0.13	1.23	2.55	0.33	0.51	0.14	0.16	1.16	0.47
Black spruce										
1	0.77^{c}	0.61^{c}	2.14^{b}	2.22^{a}	0.38^{a}	0.39^{a}	0.74	0.94	2.02	0.50
2	0.25^{a}	0.15^{a}	1.40^{a}	2.99^{b}	0.43^{a}	0.64^{b}	0.18	0.15	1.22	0.44
3	0.62^{b}	0.49^{b}	1.73^{ab}	2.21^{a}	0.34^{a}	0.59^{b}	0.88	0.82	1.70	0.54
4	0.23^{a}	0.14^{a}	1.33^{a}	2.86^{b}	0.42^{a}	0.55^{b}	0.20	0.14	1.20	0.46

[1] Treatment 1 — flats treated with copper naphthenate, and peat limed with 10g/l of dolomitic limestone.
Treatment 2 — flats treated with copper naphthenate, peat unlimed.
Treatment 3 — flats untreated, peat limed with 10g/l of dolomitic limestone.
Treatment 4 — flats untreated, peat unlimed.

[2] Figures within a group followed by the same letter not significantly different at P = 0.05 using Duncan's Multiple range test. Groups not followed by letter could not be analyzed due to bulked samples.

observed differences in growth (table 3). Roots of seedlings grown in preservative treated flats contained more than 100 ppm of copper. Roots of seedlings from limestone amended peat contained 1/8 to 1/4 the concentrations of maganese as those grown. in unlimed peat. Iron levels in roots from limed and copper naphthenate treated flats were less than those from other treatments.

It is clear that great care must be exercised in pH adjustment and preservative treatment of containers when growing conifer seedlings in peat. Limestone should not be added in quantities greater than 2-3 ounces per bushel (2-3 percent of dry weight) an it might be safer to use small quantities of hydrated lime instead of limestone if it is considered necessary to adjust the pH. In any case, the material should be thoroughly mixed into the peat to avoid pockets con taining excessive amounts.

If there is any likelihood of high cation levels or other causes of trace element imbalances being introduced into the system, copper naphthenate wood preservatives should not be applied. This is especially important when small or shallow containers are being used. It might be preferable to use decay resistant woods in

Table 3. — *Trace-element levels in seedlings grown 7 months in sphagnum peat in spruce-wood flats*

Species and Treatment[1]	Shoot[2]			Roots		
	Fe	Cu	Mn	Fe	Cu	Mn
	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
Red pine						
1	72	20	164	232	320	96
2	39	15	93	480	200	640
3	32	8	92	560	28	120
4	35	8	92	480	16	960
Jack pine						
1	24	16	96	320	172	128
2	39	15	145	480	112	960
3	33	7	92	480	16	148
4	33	17	97	400	16	800
Black spruce						
1	31[a]	15[c]	129[a]	480	132	152
2	39[a]	9[b]	280[a]	640	136	640
3	29[a]	8[b]	105[a]	480	16	204
4	48[a]	4[a]	265[a]	560	20	800

[1] Treatment 1 — flats treated with copper naphthenate, and peat limed with percent by weight of dolomitic limestone.
Treatment 2 — flats treated with copper naphthenate, peat unlimed.
Treatment 3 — flats untreated, peat limed with 10 percent dolomitic limestone.
Treatment 4 — flats untreated, peat unlimed.

[2] Figures within a group followed by the same letter not significantly different at P = 0.05 using Duncan's Multiple range test. Groups not followed by letter could not be analyzed due to bulked samples.

construction of flats but it cannot be concluded from this study that such woods have no phytotoxic properties. It has been noted that decay resistant properties of cedar, and hence the likelihood of toxic extractives, vary considerably among sources (5).

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