FOLIAR COMPOSITION OF JACK PINE AND RED PINE AS RELATED TO VULNERABILITY OF THESE TO NEEDLE CAST DISEASE

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Investigations conducted in the control of needle cast disease of tree planting stock by Manzate fungicide included the foliar analyses of 2-year-old red pine and jack pine seedlings. Fungicide was not used on the nursery beds. The jack pine seedlings were included in analyses with the intention of detecting characteristics of this tree species responsible for its immunity to needle cast disease, *Lophodermium pinastri* (Baxter 1952).

The samples of nursery stock were collected in the Boscobel, Griffith, and Hugo Sauer State forest nurseries of Wisconsin and the USDA Forest Service nursery at Eveleth, Minn. Foliar tissues were dried at 75° C., ground in a Wiley mill equipped with stainless steel knives, and ashed overnight at 500° C. (Wilde *et al.* 1964). The ash was dissolved in approximately 1.0 N HNO_3 containing Li as an internal standard. The concentration of elements in the ash solution was determined by means of an emission spectrometer (Christensen *et al.* 1968).

The results (table 1) provide a clear-cut picture of the difference in the composition of the foliage of the two tree species, a difference suggesting several tentative conclusions.

The resistance of jack pine to needle cast disease may be attributed to the greatly increased concentration of manganese in the foliage of this trees as compared with that of red pine. This assumption is supported by the fact that manganese is the essential ingredient of Manzate, a fungicide controlling the

1 Contribution from Soil Science Dep., University of Wisconsin, in cooperation with and supported by the Wis. Dep. of Natural Resources. Publication approved by the Director of the Wis. Agricultural Experiment Station.

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TABLE 1.—*Composition of foliar tissues of 2-year-old nursery grown red pine and jack pine seedlings*

Nurseries	Oven dry wts. of plants g	N	P	K	Ca	Mg	B	Fe	Mn	Al
		Percent					Parts per million			
		Red pine, *Pinus resinosa*								
Griffith, Wis.	2.81	1.34	.11	.45	.23	.17	5.5	80	185	167
"	2.80	1.24	.14	.65	.28	.16	10.4	54	246	173
"	2.32	1.40	.12	.50	.27	.14	7.7	68	190	181
Boscobel, Wis.	2.09	1.62	.07	.29	.35	.16	8.0	200	111	245
Hugo Sauer, Wis.	2.32	1.44	.11	.45	.23	.13	5.0	85	102	82
Eveleth, Minn.	1.39	1.45	.15	.40	.19	.12	5.5	58	180	133
"	1.56	1.61	.15	.44	.22	.11	5.0	50	268	133
Average	2.18	1.44	.12	.45	.25	.14	6.1	76	182	159
		Jack pine, *Pinus banksiana*								
Griffith, Wis.	1.82	1.63	.15	.45	.22	.13	8.7	95	350	500
"	1.98	1.58	.15	.40	.24	.14	9.2	122	495	492
Hugo Sauer, Wis.	2.50	1.50	.19	.44	.27	.17	11.1	180	446	420
"	2.62	1.49	.14	.38	.20	.12	10.2	107	378	328
"	1.70	1.60	.17	.40	.24	.14	7.8	92	402	412
Average	2.12	1.55	.16	.41	.23	.14	9.4	119	414	431

Lophodermiuni fungi. The results of manganese analyses of jack pine foliage are in close agreement with previous determination, which reported a variation between 412 p.p.m. (Gerloff *et al.* 1964) and 470 p.p.m. (Nemec 1948).

Of no lesser significance may be the vary high concentration of aluminum in jack pine foliage, another element of pronounced fungicidal properties. In this connection, we should point out the not readily explainable phenomenon: namely, that Manzate treatments increase in the foliage of red pine not only the concentration of manganese, but also in that of aluminum. In most cases, the foliage of treated seedlings contains from 400 to 500 p.p.m. of Mn and from 300 to 400 p.p.m. of Al (Wilde and Iyer 1970).

Other deviations in the foliar composition of the two tree species are not statistically significant, although there is an indication that jack pine foliage contains a higher concentration of both iron and boron, the two constituents of cell sap, which may exert unfavorable influence on fungi.

For more than' a century, the needle cast disease has hindered the European forestry enterprise, dependent considerably upon disease-vulnerable Scotch pine, *Pinus silvestris.* However, our European colleagues believe *Lophodermium pinastri is* largely a facultative parasite responsible for a "deficiency disease" of stock on depleted soils (Dengler 1930). Damage by *Lophodermium* fungi is reduced by an adjustment of the soil productive potential. This study shows that a correction of nutrient deficiencies must take into account not only the supply of the major nutrient elements, but also that of exchangeable manganese and available boron. Moreover, a maintenance of an adequate content of organic matter and a reasonably acid reaction of the soil, assuring the presence of ferrous iron and active aluminum, may also be of critical importance.

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