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Micronutrient Supply from Pine Bark and Micronutrient Fertilizers

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The average water-extractable micronutrient content of pine bark, with the exception of Fe, is similar to Hoagland's micronutrient solution (Ogden et al., 1987). Yet, amending bark with micronutrients is a common nursery practice. Both positive plant growth responses (Penningsfield, 1972; Whitcomb, 1978, 1984) and no growth responses (Conover et al., 1975; Leda, 1986) have resulted from the addition of micronutrients to container media. In one case, response to micronutrient addition was found to depend on addition of lime (Wright and Hinesley, 1991).

The method used for extracting micronutrients is important in assessing micronutrient availability. Berghage et al. (1987) and Handreck (1989) found the extractant diethylenetriaminepentaacetic acid (DTPA) to be a relatively reliable indicator of media micronutrient status. The quality of DTPA-extracted micronutrients was highly correlated with growth (Handreck, 1989).

Container-grown nursery crops are irrigated with as much as 4500 mm of water per growing season, but the effect of this leaching on micronutrient supply has not been documented using DTPA as the extractant. Broschat and Donselman (1985), evaluating several micronutrient fertilizers, showed relatively constant micronutrient supplies over time in irrigated media; however, ammonium acetate, which has been shown to be a relatively poor indicator of media micronutrient status (Handreck, 1989), was used as the extractant.

Handreck (1989) determined the DTPA iron content of *Pinus radiata* D. Don bark, but no reports have documented the DTPA extractable Cu, Fe, Mn, and Zn of pine *(P. taeda* L.) bark, Additionally, there have been no reports documenting DTPA extractable micronutrients from bark amended with micronutrient fertilizers. I, therefore, determined the DTPA-extractable micronutrient supply of pine bark amended with two micronutrient fertilizers (Micromax and Ironite) as influenced by irrigation rate.

Pine bark, amended with 3 kg dolomitic lime/m^3, was amended with 1 kg Micromax/m^3 (recommended rate; Grace-Sierra, Milpitas, Calif.) or 1 or 2 kg Ironite/m^3 (Ironite Products Co., Scottsdale, Ariz.) (Table 1). Micronutrient analysis of bark was (in $mg \cdot g^{-1}$): Cu, 17; Fe, 684; Mn, 63; and Zn, 34. Bark (50 g), including an untreated control, was put into 3.8 × 15.2-cm PVC tubes with one end of tubes covered in cheesecloth to allow for drainage. Tubes were drip-irrigated (distilled water, 1.3 $ml \cdot min^{-1}$) with 0.24, 0.48, 0.72, or 0.96 liters, which, on a volume basis, is equivalent to 30, 60, 90, and 120 applications of 6.3 mm of water, respectively. Five tubes per irrigation × micronutrient treatment were stored at 22C and arranged in a randomized complete-block design. Following each irrigation, a modified saturated medium extraction (Berghage et al., 1987) was performed by adding 40 ml of 0.001 M DTPA to wet bark. After 45 min, the bark solution was vacuum-removed and tested for Cu, Fe, Mn, and Zn using an atomic absorption spectrophotometer.

Irrigation rate had no effect on micronutrients extracted (data not shown); thus, concentrations were pooled over irrigations. Broschat and Donselman (1985) and Handreck (1989) showed a similar result for several micronutrient fertilizers in soilless media.

Copper, Fe, Mn, and Zn concentrations in bark extracts of Ironite and Fe and Zn concentrations of Micromax were essentially the same as those of the unamended bark (Table 2). There were significant differences for Fe and Zn, but the milligram per liter difference most likely would not be physiologically significant in terms of plant growth. In contrast, the Cu concentration in the extract with Micromax was ≈50 times greater than that supplied by the control or the Ironite-amended bark. The Mn concentration in the extract with Micromax was ≈50% higher than that from unamended or Ironite-amended bark. The higher concentrations of Cu and Mn in the extract with Micromax partly reflected the difference in Cu and Mn content of Micromax and Ironite (Table 1).

The similar Fe and Zn concentrations of control and amended bark may explain why there was no growth response to micronutrient additions (Conover et al., 1975; Leda, 1986). Apparently, bark supplies sufficient Fe, Zn, Cu, and Mn to satisfy a plant's requirement for such elements. Cases in which plants respond to micronutrient additions may be explained, in part, by decreased availability or uptake caused by interactions with other fertilizers (Broschat and Donselman, 1985; Handreck, 1989) or pH (Korcak, 1987; Wright and Hinesley, 1991). Extract Fe concentrations of unamended bark were generally higher than those listed by Handreck (1989) for mostly Australian species. Research is needed to determine minimum micronutrient concentrations for other species.

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Table 1. Micronutrient content of Ironite and Micromax[z].

	Content (%)			
Source	Cu	Fe	Mn	Zn
Ironite	0.05	12.0	0.05	1.0
Micromax	1.1	12.0	2.5	1.0

[z]Data supplied by manufacturer.

Table 2. Concentrations of micronutrients extracted from pine bark by means of diethylenetriaminepentaacetic acid.

Amendment	Application rate ($kg \cdot m^{-3}$)	Extract concn ($mg \cdot liter^{-1}$)			
		Cu	Fe	Mn	Zn
None	---	0.10 b[z]	22.7 d	9.7 b	3.9 d
Ironite	1	0.12 b	23.0 c	9.4 bc	4.3 c
	2	0.14 b	23.6 b	9.0 c	4.5 b
Micromax	1	5.0 a	24.0 a	14.4 a	4.8 a

[z]Mean separation within columns by Tukey's (HSD) test, $P = 0.05$.

Literature Cited

Berghage, R.D., D.M. Krauskopf, D.D. Warncke, and I. Widders. 1987. Micronutrient testing of plant growth media: Extractant identification and evaluation. Commun. Soil Sci. Plant Anal. 18:1089-1110.

Broschat, T.K. and H.M. Donselman. 1985. Extractable Mg, Fe, Mn, Zn, and Cu from a peat-based medium amended with various fertilizers. J. Amer. Soc. Hort. Sci. 110:196-200.

Conover, C.A., D.W. Simpson, and J.N. Joiner. 1975. Influence of micronutrient sources and levels on response and tissue content of *Aphelandra, Brassia,* and *Philodendron.* Proc. Fla. State Hort. Soc. 88:599-609.

Handreck, K.A. 1989. Assessment of iron availability in soilless potting media. Commun. Soil Sci. Plant Anal. 20:1297-1320.

Korcak, R.F. 1987. Iron deficiency chlorosis. Hort. Rev. 9:133-186.

Leda, C.E. 1986. Iron and manganese requirements of containerized plants growing in pine bark. MS Thesis, Virginia Polytechnic Inst. and State Univ., Blacksburg.

Ogden, R.J., F.A. Porkorny, H.A. Mills, and M.G. Dunavent. 1987. Elemental status of pine bark-based potting media. Hort. Rev. 9:103-131.

Penningsfield, F. 1972. Macro and micronutrient requirements of pot plants in peat. Acta Hort. 26:81-102.

Whitcomb, C.E. 1978. Micronutrient fertilizers on container-mown *Ilex crenata* 'Hetzi'. Amer. Nurseryman 148:10.

Whitcomb, C.E. 1984. Plant production in containers. 1st ed. Lacebark Publications, Stillwater, Okla.

Wright, R.D. and L.E. Hinesley. 1991. Growth of eastern red cedar amended with dolomitic limestone and micronutrients. HortScience 26:143-145.