

SHORT COMMUNICATION

Copper Deficiency in Douglas Fir (*Pseudotsuga menziesii* (Mirb.) Franco)

On various sites in the Netherlands deformation on the shoots occurs in Douglas fir, giving rise to "pendula" forms. This may be accompanied by die-back of the top. In order to determine the cause of the deformation several tests have been made.

In May, 1964, a 3² factorial Cu-B fertilizer experiment with three replications was laid down with four-year-old transplants of Douglas fir showing severe deformation, in a nursery of the State Forest Service at Gees. The following treatments were applied per ha: 75 kg of copper sulphate (Cu₁), 150 kg of copper sulphate (Cu₂), 15 kg of borax (B₁), 25 kg of borax (B₂) and the combinations Cu₁B₁, Cu₁B₂ etc. In April 1964, soil and needle samples were taken from sites with and without deformed Douglas fir.

On another site (Oranjewoud) foliar sprays of copper sulphate, zinc sulphate and borax (200 ml of a 1% solution per tree, applied twice) were tested in an eight-year-old plantation showing the same symptoms as described above.

The results of soil and needle analyses of samples taken before the application of fertilizers are given in Table 1.

The copper content of the needles proved to be very low in the deformed trees; the phosphate content of the soil supporting them was relatively high. The copper level of the soil was low in all cases.

The response to copper was found to be very strong, whereas application of zinc sulphate and borax had no effect. In the course of the year following application, normal growth of the shoots was obtained where copper sulphate was applied either to the soil or as a foliar spray. A procedure by which a solution of copper sulphate was absorbed by the trunk, also proved to be effective.

At Oranjewoud the copper content of the needles of previously deformed Douglas firs increased from 1.7 to 3.4 ppm. Needles of Douglas fir plants of the Gees experiment were sampled at different dates during the 1965 growing season. Copper and boron contents are given in Table 2.

Table 2 shows that the recovery of the deformed plants is associated with a higher copper content of the needles. These data suggest that "pendula" forms of Douglas fir are caused by copper deficiency.

To date little is known of copper-deficiency symptoms in conifers. Ben z i a n



Plate 1. Symptoms of copper deficiency in Douglas fir. Site: Oranjewoud

A



B



Plate 2. Site: Gees. **A:** Douglas fir treated with 75 kg CuSO_4 per ha. **B:** No Copper.

TABLE 1

Soil and needle analyses before treatment						
Site	pH (KCl)	Organic matter %	P ₂ O ₅ mg/100 g soil		Cu** (soil) ppm	Cu (needles) ppm
			Water* soluble	Total		
Gees (site with deformed plants)	3.2	10.5	1.01	22.1	2.5	2.6
Gees (site with normal plants)	3.4	9.1	0.36	14.1	1.0	4.7
Oranjewoud (site with deformed plants)	2.5	38.4	1.01	61.0	1.7	1.7
Oranjewoud (site with normal plants).	2.6	17.0	0.45	19.0	0.7	5.2

* Extraction of 2½ g soil with 100 ml distilled water, shaking time 1 hour, temp. 20°C.

** Extraction of 10 g soil with 100 ml 0.4 N NHO₃, shaking time 2 hours.

TABLE 2

Copper* and boron** contents (ppm) of Douglas fir needles, sampled at different dates at Gees nursery (+) = all plants recovered from deformation								
Treatment	One-year-old needles		Current year's needles					
	29-4-65		28-6-65		6-8-65		30-9-65	
	Cu	B	Cu	B	Cu	B	Cu	B
O	1.9	40.0	2.1	12.9	2.3	18.4	2.6	36.0
Cu ₁ (+)	2.1		2.1	15.3	3.8	16.9	4.5	27.2
Cu ₂ (+)	3.1		4.5	13.4	4.8	17.1	5.9	27.6
B ₁		61.2	3.1	20.1	3.0	22.9	3.9	37.6
B ₂		72.0	1.7	15.7	2.6	23.1	2.4	41.8
Cu ₁ B ₁ (+)			4.8	10.9	3.6	17.2	5.2	31.5
Cu ₂ B ₂ (+)			3.3	17.5	3.0	23.4	4.2	37.5

* Sodiumdiethyldithiocarbamate method.

** Carmine method.

and Warren¹ succeeded in eliminating "needle tip-burn" in Sitka spruce seedlings by foliar application of copper sulphate, as a result of which the copper content of the needles was increased from 2.3 to 4.2 ppm. In Sitka spruce the copper-deficiency symptoms are different from those of Douglas fir (die-back of shoots of copper-deficient Douglas fir is probably caused by winter frost).

Current year's needles (sampled in autumn) of Douglas fir well supplied with copper contain at least 4.5 ppm Cu. Generally in copper-deficient trees the content is lower than 2.6 ppm.

In the Netherlands there are indications that 'pendula' forms of Douglas

fir due to copper deficiency may occur on heathland soils especially when the phosphate and nitrogen levels of the soil have been raised by fertilization.

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LITERATURE

- 1 Benzian, B. and Warren, R. G., *Nature* **178**, 864-865 (1956).