

Foliar Nutrient Characteristics
after Mixed Fertilizer Application
on Boise Cascade Lands in Northeast Oregon

Addendum: Foliar Sulphur Concentrations

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November 6, 1996

In spring of 1995 two fertilizer trials were installed on Boise Cascade lands in northeast Oregon, one at Clear Creek in a young Ponderosa pine plantation, the other at Noregaard in a natural mixed conifer stand. Six growth monitoring plots were established at each site, three of which were treated with a multi-nutrient fertilizer; the other three plots remained untreated for use as experimental controls. The elemental rates of the multi-nutrient fertilizer are shown in Table I.

Table I. Nutrient element rates for the multi-nutrient fertilizer.

Nutrient	Nutrient Rate (lbs/a)	Source	Source Rate (lbs/a)
Nitrogen	200	Urea	387
Potassium	200	Ammonium Phosphate	193
Phosphorus	100	Potassium Sulfate	400
Sulfur	90	Ammonium Phosphate	193
Boron	10	Potassium Sulfate	400
Copper	10	Copper Sulfate	40
Zinc	10	Borate FG	69
Molybdenum	1	Copper Sulfate	40
		Blu-Min-Zinc	55
		Sodium Molybdate	2.5

Foliage collections were made in fall of 1995 and again in fall of 1996. Two trees of each of the dominant species (Ponderosa pine at Clear Creek, Douglas-fir and Grand fir at Noregaard) were selected on each plot. Current year foliage was collected from the third whorl. Samples were oven-dried and sent out for chemical analysis. Statistical analysis of most of the 1995 foliar chemistry data was presented by Terry Shaw (1996). However, laboratory analysis for sulphur concentrations has only just been completed. This addendum reports the results of statistical analysis of this foliar sulphur data. Chemical analysis of the 1996 collections has yet to be done.

Plot averages for sulphur concentration and content, and sulphur/nitrogen ratio were calculated by site, species, and treatment; these, along with nitrogen concentrations and needle weights, are shown in Table II. Analysis of variance of sulphur concentration indicated the neither species nor treatment differences were statistically significant; p-values were 0.1136 for treatment effects and 0.1919 for species differences. The treatment X species interaction was also non-significant (p=0.4408). There was a tendency for higher S concentrations in Grand fir than in Douglas-fir. Ponderosa pine differences with the other species were totally confounded with site differences and thus could not be analyzed; control values were similar to Douglas-fir. The multi-nutrient fertilizer tended to increase S concentrations in Ponderosa pine and Grand fir, but not in Douglas-fir.

Table II. Average sulphur concentration (%) by site, species, and treatment for foliage one growing season after treatment.

	<u>Clear Creek</u>		<u>Noregaard</u>			
	<u>Ponderosa</u>		<u>Douglas-fir</u>		<u>Grand fir</u>	
	<u>Cont</u>	<u>Multi</u>	<u>Cont</u>	<u>Multi</u>	<u>Cont</u>	<u>Multi</u>
S concentration (%)	0.098	0.113	0.098	0.097	0.104	0.126
S content (µg/100 needles)	24853	29053	708.3	756.4	2129	2731
S/N ratio (%)	7.81	6.90	7.85	7.95	9.53	9.44
N concentration (%)	1.27	1.63	1.24	1.23	1.09	1.35
Needle weight (g/100 needles)	25.06	25.87	0.74	0.79	2.09	2.20

Sulphur critical levels found in the literature are 0.11 for Douglas-fir (Webster and Dobkowski 1983), 0.14 for Grand fir (Powers 1981), and 0.15 for Ponderosa pine (Boyer 1978). Thus, all foliar S levels at the two sites, even following treatment with 90 lbs/a of S, were still well below critical.

Sulphur content, expressed in µg/100 needles, differed by species, reflecting the large differences in needle weight among the species. However, unlike concentration, there was statistical evidence of a positive response to multi-nutrient fertilizers: Ponderosa pine S content increased by 17 %, Douglas-fir by 7 %, and Grand fir by 28 %, the later being statistically significant (p=0.001).

Sulphur/Nitrogen ratios showed some species differences: Grand fir, with its higher S concentrations and lower N concentrations, had larger S/N ratios than Douglas-fir (p=0.1061). Ponderosa pine ratios were similar to Douglas-fir. The fertilizer did not produce any significant change in ratios for all species, indicating that any increase in N following fertilization was generally matched by a similar increase in S.

References

- Boyer, P.D. 1978. Unpublished. Bend Nursery Soil Management Plan.
- Powers, R.F. 1981. Response of California true fir to fertilization. p. 95-101 *In* Gessel, S.P., R.M. Kenady, and W.A. Atkinson, eds. Proc. Forest Fertilization Conference, 1979, Institute of Forest Resources Contrib. 40, Univ. of Washington, Seattle.
- Webster, S.R. and A. Dobkowski. 1983. Concentrations of foliar nutrients for trees and the dosage and frequency of fertilizer trials. Weyerhaeuser Res. Rep. No. 1, Project 050-3920/3.