G. M. Will

Forest Research Institute
New Zealand Forest Service
Rotorua, New Zealand

and

C. T. Youngberg

Department of Soil Science
Oregon State University
Corvallis, Oregon 97331

Some Foliage Nutrient Levels in Tree and Brush Species Growing on Pumice Soils in Central Oregon[1]

Abstract

Foliar analysis is becoming an important tool in evaluating soil fertility and site quality. During soil-vegetation studies on pumice soils in Central Oregon, foliage samples from six tree species and four shrub species were collected from five sites and analyzed for major and minor nutrient elements. There were marked differences in nutrient levels between species, but none were observed between sites. Tree foliage levels of the nutrients for which analyses were made indicated adequate supplies of everything but sulfur.

Introduction

In several fields of research including plant nutrition, plant ecology, soil fertility and even mineral prospecting, plant foliage analyses have come to play an important role in recent years (Beadle, 1954; Everard, 1973; Malyuga, 1964; Stone, 1968). They are used for the assessment of the nutrient status of plants and soils including the detections of deficiencies and toxicities. Some plants that accumulate metallic elements in particular have become useful means of finding mineral deposits.

Following field responses in ponderosa pine to additions of a sulfur fertilizer, a bioassay was recently made of the amounts of plant-available sulfur in the different layers of volcanic pumice ash present at five sites in central Oregon (Will and Youngberg, 1977). At the time soil samples were being collected, foliage samples were taken from the tree and brush species present.

Methods

Field Sampling

Foliage samples were collected from the five sites—Century Drive (CD), Royce Mt. (RM), Walker Rim (WR), Antelope unit (AU) and China Hat Mt. (CH) in mid-August 1971. Descriptions of these sites have been reported (Chichester *et al.*, 1969). Microsite differences on the sample sites were negligible. Sites were level to gently sloping and horizon thickness and depth to the paleosole were uniform for each site.

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The productivity of the Royce Mt. site is somewhat higher and that of the China Hat site somewhat lower than the other three sites due to higher total precipitation and coarser pumice, respectively.

Ponderosa pine (*Pinus ponderosa* Dougl.), lodgepole pine (*Pinus contorta* Dougl.), white pine (*Pinus monticola* Dougl. ex D. Don), grand fir (*Abies grandis* [Dougl.] Lindl.), silver fir (*Abies amabilis* [Dougl.] Forbes), and hemlock (*Tsuga mertensiana* [Bong.] Carr) were sampled by locating unsuppressed trees up to 10 m in height and clipping current season's shoots from a point 1 to 3 m from the top of each tree. At least 10 trees of each species were sampled at each site to give representative composite samples.

Full size leaves from current season's shoots were collected from snowbrush (*Ceanothus velutinus* Dougl.), manzanita (*Arctostaphylos patula* Greene) and chinquapin (*Castanopsis sempervirens* [Kell] Dudl.), while whole lengths of current shoots were taken from bitterbrush (*Purshia tridentata* [Pursh] DC.). For these brush species composite samples were collected from 15-20 plants at each site. All samples were dried at 60°-70°C before grinding; one composite sample of each species for each site was analyzed.

Chemical Analyses

After dry ashing oven dried samples, an HCl extract of the ash was analyzed as follows: P by colorimetric determination with molybdovanadate and K, Ca, Mg, Zn, Fe, and Mn by atomic absorption. Boron was determined colorimetrically in an ash extract using carmimic acid. X-ray fluorescence was used to determine S in the ground material.

Results and Discussion

The results of analyses are given in Table 1. Because this was not an exhaustive study, no detailed conclusions or long discussion are justified; but where species were present at four or five of the sites, consistent difference in nutrient concentrations almost certainly indicate differences between species:

1) Ponderosa, lodgepole, and white pines have consistently lower foliage levels of Ca and Mg than snowbrush, manzanita, and bitterbrush;

2) Lodgepole and white pine are higher in Mn content than ponderosa pine; and

3) Snowbrush tends to be high in Fe while manzanita and bitterbrush are low in Mn.

Although other species occurred at only one or two sites, the following marked differences are of interest:

1) The firs and hemlock are higher in Ca (but not Mg) than the pines; and

2) The firs, chinquapin, and particularly hemlock have very high Mn levels.

Leaf's (1968) review of the foliar K, Mg, and S levels in forest trees did not include the species reported in this paper. Comparisons with related species, however, indicate that in general, trees in Central Oregon have adequate K, low to adequate Mg, and deficient to low S. The latter agrees with a bioassay of available S in the soil (Will and Youngberg, 1977). The authors consider S levels 0.06 percent to be deficient. In reviewing the trace element contents of tree foliage, Stone (1968) included grand fir. Although the Mn content was in the high range of species in this study, it was well be-low the 2272 ppm cited by Stone for grand fir. All the B, Zn, Fe, and Mn figures reported in this paper appear to indicate adequate levels of supply.

TABLE 1. Foliage nutrient concentrations in tree and brush species from five sites in central Oregon.

Species and Location		P	K	Ca	Mg	S	B	Zn	Fe	Mn
				%				ppm		
Ponderosa pine	CD	0.22	0.90	0.20	0.10	0.06	22	36	25	110
	AU	0.20	1.00	0.20	0.09	0.08	24	35	25	115
	WR	0.23	1.05	0.22	0.10	0.06	21	34	30	185
	RM	0.23	1.30	0.23	0.09	0.08	25	38	35	100
	CH	0.25	0.97	0.21	0.12	0.08	30	47	25	140
Lodgepole pine	AU	0.17	0.85	0.22	0.12	0.08	28	55	40	225
	WR	0.14	0.70	0.21	0.09	0.05	26	35	40	280
	RM	0.16	0.90	0.22	0.09	0.08	20	43	35	330
	CH	0.17	0.68	0.22	0.10	0.06	25	51	35	215
Snowbrush	CD	0.18	0.90	0.55	0.17	0.06	31	36	55	65
	AU	0.14	0.95	0.52	0.15	0.06	21	12	60	120
	WR	0.16	1.00	0.46	0.16	0.07	30	18	50	105
	RM	0.14	0.90	0.52	0.14	0.12	20	30	75	290
Manzanita	CD	0.18	1.00	0.40	0.23	0.06	13	45	30	40
	AU	0.19	1.00	0.40	0.19	—	14	33	35	80
	WR	0.20	1.10	0.41	0.16	—	16	32	35	45
	RM	0.20	1.10	0.38	0.14	0.08	19	40	50	35
Bitterbrush	CD	0.20	0.95	0.40	0.15	—	27	31	50	25
	AU	0.18	0.95	0.38	0.16	—	19	13	55	30
	CH	0.20	0.95	0.37	0.14	—	18	29	50	20
White pine	WR	0.21	1.10	0.23	0.11	—	22	32	35	230
	RM	0.20	1.10	0.24	0.10	0.09	30	45	45	240
Grand fir	RM	0.14	1.00	0.45	0.12	0.06	23	31	50	790
Silver fir	RM	0.18	1.05	0.43	0.12	0.06	26	33	40	825
Hemlock	RM	0.16	0.64	0.33	0.08	0.06	29	15	60	1780
Chinquapin	RM	0.13	0.70	0.38	0.12	0.09	39	16	60	740

Summary

No marked differences in foliar nutrient levels were observed between sites, but there were considerable species differences. The most noticeable of these were (1) high Ca and Mg in snowbrush, manzanita, and bitterbrush, and (2) the great variation in Mn levels between species—lodgepole and white pines having higher contents than ponderosa pine, but not nearly as high as the firs and hemlock. Manzanita and bitterbrush are very low in Mn. Tree foliage levels indicate adequate supplies of all nutrients except S.

Literature Cited

Beadle, N. C. W. 1954. Soil phosphate and the delimitation of plant communities in eastern Australia. Ecology 25:370-375.

Chichester, F. W., C. T. Youngberg, and M. E. Harward. 1969. Clay mineralogy of soils formed on Mazama pumice. Soil Sci. Soc. Amer. Proc. 33:115-120.

Everard, J. 1973. Foliar analysis, sampling methods, interpretation of results. Quart. J. of For. 67:51-66.

Leaf, A. L. 1968. K, Mg, and S deficiencies in forest trees, pp. 88-112, *in* G. Bengston *et al.* (eds.) Forest Fertilization . . . Theory and Practice. Tennessee Valley Authority. Muscle Shoals, Alabama.

Malyuga, D. P. 1964. Biogeochemical Methods of Prospecting. Consultants Bureau, New York.

Stone, E. L. 1968. Microelement nutrition of forest trees, pp. 132-175, *in* G. Bengston *et al.* (eds.) Forest Fertilization . . . Theory and Practice. Tennessee Valley Authority. Muscle Shoals, Alabama.

Will, G. M., and C. T. Youngberg. 1978. Sulfur status of some central Oregon pumice soils. Soil Sci. Soc. Amer. Jour. 41:132-134.

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