Micronutrient Trace Element Composition of Crested Wheatgrass[1,2]

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Highlight

In crested wheatgrass on northern Nevada range, high cobalt with low copper and zinc concentrations present a rather atypical pattern of trace elements. Zinc and manganese were greater in the seed head than in the foliage but no such differences were found for cobalt, copper or iron. Advancing season from April through July did not influence the micronutrient trace element composition of crested wheatgrass. Copper and zinc concentrations were found to be marginal or deficient for bovine nutrition and many zinc concentrations would generally be considered deficient for plant growth.

Eurasian wheatgrasses were introduced into North America during the closing years of the last century. Extensive plantings for improvement of northern Nevada range lands started over thirty-five years ago. Some information is available on the proximal analysis and major mineral content of these *Agropyron* species (Pingrey and Dartignac, 1959; Heinrichs and Carson, 1956; Sotola, 1940). Only one report on the micronutrient trace element composition of these grasses was found (Rauzi, et al., 1968) except for a recent report by this laboratory on their unusually high cobalt concentration (Lambert and Blincoe, 1971).

This study was undertaken to determine the micronutrient trace element composition of range crested wheatgrass in Nevada and to explore some factors affecting it.

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[2] This study was initiated by the late W. B. Dye who supervised the collection of part of the 1963 samples. We thank P. T. Tueller, Division of Renewable Natural Resources, University of Nevada, for assistance with sampling at the SJ location, particularly 1964, the Cooperative Extension Service field personnel for assistance with sampling at all locations and R. E. Eckert, Jr., Agricultural Research Service, U. S. Department of Agriculture, for assistance with preparation of this manuscript.

Methods

Eleven sample locations considered representative of range crested wheatgrass plantings in Nevada were used. Samples were taken in 1963, 1964, and 1967. Several locations were sampled in all three years. At one location, four areas were selected within 6.5 km (4 miles) of each other and sampled eight times between 17 April and 23 July 1964. Samples were taken randomly over a 100 square meter site at each location. The current year's growth was cut 1 cm above the ground. The previous year's growth was avoided. The samples were washed twice with petroleum ether to remove dirt, air dried, dried at 70 C for 24 hours in a mechanical convection oven, and ground in a Cristy-Norris mill.

The ground plant material was wet-digested with a nitric, sulfuric, perchloric (10:1:1 by volume) acid mixture, filtered free of silica and analyzed by colorimetric procedures. The analytical methods used were summarized by Johnson and Ulrich (1959) and by Dye (1962). In a few cases analytical data were also confirmed by atomic absorption spectrophotometry. All data are reported on a dry basis in parts per million (1 ppm = 1 mg/kg).

Results and Discussion

A group of samples from six locations sampled in 1963 were analyzed intact and also the seed head and foliage were analyzed separately. These data are given in Table 1. Analysis of variance indicated that only the manganese and zinc concentrations were significantly different ($P = 0.01$) between the seed head and foliage. In both cases the concentration in the seed head was greater. In the data reviewed by Beeson (1941) zinc was greater in the seeds of most species but the results on manganese were not consistent. Viets (1966) also reported a somewhat greater zinc content in the seeds than in the foliage but found the zinc concentration in the vegetative tissue was more responsive to the level of available soil zinc.

At the one location extensively sampled no consistent trends in micronutrient trace element composition were found. Rauzi et al. (1968) found no effect of advancing season on the iron concentration of western wheatgrass and an increase in manganese only very late in the season. Zinc and copper declined somewhat with advancing season. This is in contrast to Gladstones and Loneragan (1967) who found an increase in zinc, especially in grasses, as the growing season progressed. Miller et al. (1964) could find no effect of season on the zinc concentration in Florida coastal Bermudagrass. For the several locations sampled in June and July of 1963, 1964 and 1967, no consistent trends were noted. Since the effects of season and year were without statistical significance, all data were averaged by location.

The micronutrient trace-element composition of range wheatgrasses at various locations in Nevada is given in Table 2. Since our samples were taken from an extensive area of Nevada, one finds large variations in most of the micronutrient trace elements. Except for zinc, the spread of these data includes the values reported by Rauzi et al. (1968) for one location in Wyoming. However, the Wyoming data included lower zinc concentrations than our data. In fact, zinc concentrations as low as those reported are rarely found in other species (Hodg-

Table 1. Micronutrient trace element composition (ppm, dry basis) of crested wheatgrass separated fractions.

Element	n	Mean concentration: Intact plant	Stems & leaves	Seed head
Cobalt	6	12.0	12.4	12.8
Copper	4	2.1	2.1	2.1
Iron	4	117	115	120
Manganese	4	29.2	29.1*	37.3*
Molybdenum	4	2.4	2.4	2.4
Zinc	5	13.0	6.1*	17.7*

* Difference between parts of the plant statistically significant ($P < .01$).

son et al., 1962). Except for one location, our samples contained somewhat more copper than Rauzi et al. (1968) found. The anomalously high cobalt found was the subject of a separate report (Lambert and Blincoe, 1971). Aside from cobalt, all values reported here are within the range of concentrations found in other plant species. The zinc levels are, on the whole, low and those below 15 ppm would generally be considered deficient for normal plant growth (Hodgson et al., 1962). Zinc deficiency generally results in chlorosis and reduced growth rate and yield. Although usually associated with citrus and vegetable crops, zinc deficiencies have been reported in grasses (Viets, 1966). All micronutrient trace elements other than cobalt and zinc were within the range considered normal in other species.

Since crested wheatgrass is used primarily as a range feed for cattle, Table 2 also indicates the adequacy of the concentrations found for livestock nutrition (Underwood 1962, 1966; Sanchelli, 1969). The copper concentrations at all locations were marginal or deficient in view of the molybdenum concentrations found. Molybdenum increases the copper requirement. At one location, copper would be severely deficient (0.08 ppm) especially since the molybdenum was 3.4 ppm. Zinc would be marginal or deficient at all locations. At least 20 ppm zinc is necessary for grazing cattle and 46 ppm is probably adequate. This is in contrast with earlier reports that zinc deficiency symptoms in ruminants were not observed at 5 or 10 ppm (Hodgson et al., 1962; Dye, 1962). Zinc deficiencies are more common in swine than in ruminants and are characterized by skin lesions and poor weight gain (Follis, 1966). Copper deficiency is well known in cattle, usually resulting from molybdenum toxicity. Several of the deficient copper and zinc concentrations were confirmed by atomic absorption spectrophotometry to minimize the possibility of analytical error.

Table 2. Micronutrient trace element composition (ppm, dry basis) of crested wheatgrass at several locations in northern Nevada.

Location number	County	Mean concentration: Co	Cu	Fe	Mn	Mo	Zn
SJ-1*	Elko (NE)	4.38	3.66[m]	434	52.8	1.40	16.0[d]
SJ-2*	Elko (NE)	4.74	3.79[m]	293	59.9	1.10	15.6[d]
SJ-3*	Elko (NE)	6.63	4.23[m]	313	45.1	1.75	14.9[d]
SJ-4*	Elko (NE)	3.11	3.98[m]	355	51.3	2.14	21.2[m]
SJ-5	Elko (NE)	4.52	3.42[m]	–	46.1	0.84	13.3[d]
KC**	Elko (NE)	9.52	4.52[m]	223	29.3	2.07	16.5[d]
E**	Elko (Central)	7.58	4.98[m]	95	27.1	1.66	12.4[d]
D-1	Elko (Central)	0.83	4.00[m]	80	34.0	3.26	23.9[m]
D-2**	Elko (Central)	8.60	5.38[m]	273	26.3	2.39	15.6[d]
WP	White Pine	23.1	–	802	31.9	–	8.46[d]
H	Humboldt	0.56	0.84[d]	180	19.3	3.42	15.6[d]

[d] Deficient (Underwood 1962, 1966).
[m] Marginal (Underwood 1962, 1966).
* Average of 4 to 10 samples at these locations.
** Average of 2 samples at these locations

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