Copper Deficiency in Prairie Soils

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Alberta researchers suspect significant areas of the prairie provinces may be copper (Cu) deficient. Field studies conducted in Alberta since 1987 are showing wheat and barley grown on light textured, high organic matter soils can be highly responsive to Cu fertilization.

COPPER DEFICIENCY has rarely been reported in the wheat growing regions of the Northern Great Plains. However, research is now showing significant areas of Alberta mineral soils are potentially Cu responsive. These Cu deficient areas frequently occur in Black Chernozems (Borolls) or transitional soils on sandy hilltops and light loamy lower slopes with high organic matter (6 to 10 percent) and deep surface horizons.

Alberta Studies

Six years of field and laboratory studies in Alberta have evaluated diagnostic methods, fertilization and crop response related to Cu deficiency. Tissue testing has not proven as effective as soil analysis. Results show DTPA extractable Cu to be a reliable indicator of soil Cu deficiency. However, critical levels are higher than the 0.2 parts per million (ppm) standard accepted in many areas. In Alberta soils, response to Cu fertilization occurs between 0.4 and 0.8 ppm DTPA extractable Cu, and symptoms of Cu deficiency have been observed in heavily manured fields with greater than 1 ppm soil test Cu.

Deficiency Symptoms

Copper deficiency symptoms in cereals are numerous. They include:

- limpness or wilting at mid-tillering or stem elongation
- pale yellow, curled leaves at tillering
- pig tail, whip tail and death of leaf tip
- retarded stem elongation
- excessive tillering, high mortality rate of late tillers and delay in heading
- aborted heads and spikelets
- normal heads with empty spikelets or shriveled grain
- delayed maturity and senescence
- head bending
- increased susceptibility to disease
- reduced yields

Individually, symptoms are easily confused with those resulting from herbicide, insect or frost damage, but collectively they are an effective diagnostic tool. Unfortunately, yield losses commonly occur even when early visual symptoms are not evident. Depending on the severity of the symptom, loss in grain yield can range from 5 to 100 percent and can be variety sensitive.

BARLEY growing on a peat soil responded dramatically to applied Cu. Dead area on the left received no soil-applied Cu.

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All common wheat and barley varieties grown in Alberta are sensitive to Cu deficiency and respond to Cu fertilization, **Figure 1**.

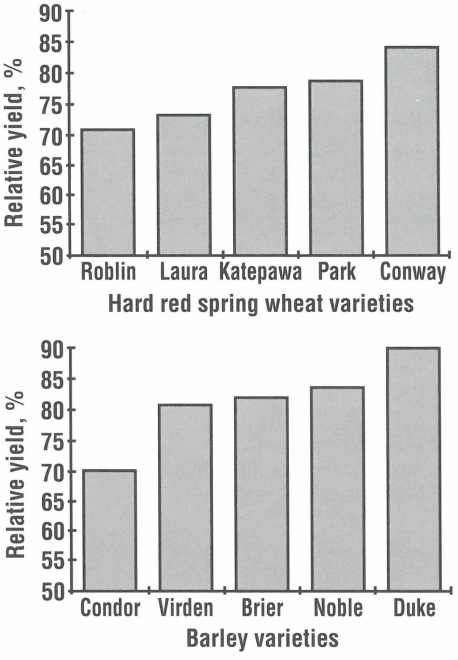

Figure 1. Relative yield (Cu−/Cu+) of several wheat (7 site-years) and barley (4 site-years) varieties grown on Cu deficient soils.

Wheat is the most sensitive of the cereals. There appears to be little difference among wheat varieties. Barley can be as sensitive to insufficient Cu as wheat, but varieties are much more variable in their response.

Table 1. Park wheat response to Cu fertilization[1] near Tofield, Alberta.

		Yield, bu/A			
	Method	1990	1991	1992	Avg.
Control		45	41	46	44
Cu Chelate	Soil spray	58	61	57	59
Cu Sulfate	Seed-row	50	58	60	56
	Band	50	44	54	50
	Broadcast	60	61	61	60

[1]One-time application of Cu chelate (1 lb Cu/A as Cu-EDTA) and Cu sulfate (3 lb Cu/A as Cu sulfate)

Correcting Deficiencies

Because Cu is very immobile in the soil, broadcast and incorporation is generally the best way to correct a deficiency. **Table 1** compares broadcast and incorporation to band and seed-placement in spring wheat. Both the Cu chelate and the Cu sulfate were equally effective in increasing yields, and both produced 10 bu/A more than the band application.

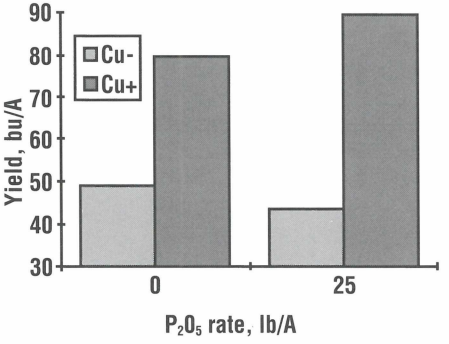

Figure 2. Copper and P influence barley yields in Alberta.

Copper deficiency can inhibit the response of other nutrients, and other nutrients may aggravate Cu deficiency. **Figure 2** shows how applied phosphorus (P) increased barley yields when Cu levels were not limiting and decreased yields when Cu was limiting.

Summary

Copper deficiency is being detected in increasing areas in Alberta soils. It may be limiting cereal yields, especially wheat, in many other prairie soils, including those in the U.S. The problem is easily corrected with a small amount of Cu fertilizer (5 to 10 lb Cu/A). Our research suggests a single application should be effective for at least 7 to 10 years. In addition to dramatic yield increases, our studies also show Cu fertilization effectively controls several diseases common to prairie cereals. ■