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Antagonistic effect of Cu+Zn on low phosphorus soils

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The combined application of Cu + Zn had a significant negative effect on wheat yield grown under phosphorus (P) deficient soil conditions on a Dark Grey Chernozem Tisdale soil. This indicates that if Cu and Zn deficiencies are going to be corrected, P fertility should be first addressed.

Balancing micronutrients and phosphorus (P) under varying soil moisture conditions can be a challenge. Plant availability of copper (Cu) and zinc (Zn) could be affected by antagonism between the two nutrients, and can also be reduced when large applications of P fertilizer are applied. These factors can be further impacted by soil moisture deficits.

The objective of this research was to evaluate P and soil moisture effects and interactions with soil applied Cu and Zn fertilizers. It was anticipated that high levels of soil P and moisture stress would induce Cu and Zn deficiency by reducing nutrient availability.

Two experiments were conducted. The first used a Dark Grey Chernozem soil (Tisdale association) collected from northeastern Saskatchewan to evaluate P fertilization and micronutrient interactions. In this experiment, two P rates of a control (0) and a high rate of 89 lbs P_2O_5/ac (100 kg

P_2O_5/ha) were compared. Recommended application rates for nitrogen (N), potassium (K), and sulfur (S) were applied in the first year to wheat.

The second experiment used Black (Oxbow association) and Brown (Fox Valley association) Chernozems from southern Saskatchewan to assess moisture-micronutrient interactions. In this experiment, two soil moisture conditions of 60% and 100% of field capacity were maintained. Mono-ammonium phosphate (MAP) was applied at 17.8 lbs P_2O_5/ac (20 kg P_2O_5/ha) to all treatments in the first year to wheat.

The extractable micronutrient levels in the soils were in the marginal to sufficient range, greater than 0.5 ppm. In both experiments, four micronutrient treatments were soil applied in the first year, and these included a control (0 micros), Cu at 4.5 lbs/ac (5 kg/ha), Zn at 4.5 lbs/ac (5 kg/ha), and Cu+Zn at 4.5 lbs/ac (5 kg/ha) each. Treatments were applied as dissolved sulfate salts in a subsurface layer ¾ inch (2 cm) below the soil surface.

Both experiments followed a cereal-pulse rotation with hard red spring wheat grown in the first year, and yellow field pea in the second year. The crops were grown in plastic containers in a controlled greenhouse setting at the University of Saskatchewan. In the field pea year, potassium sulfate and MAP were applied again but without urea fertilization.

Little impact for micronutrient treatments

Overall, wheat yield was not increased with Cu and Zn fertilization, which is consistent with the soil test levels ranging from marginal to sufficient. Significantly higher wheat grain and straw yield occurred with P fertilizer addition on the P deficient Tisdale soil, and without moisture stress conditions on both the Oxbow and Fox Valley soils. Conversely, wheat grown without P fertilization on the Tisdale soil, and with moisture stress soil conditions in the second experiment resulted in reduced plant growth and tillering, and ultimately low grain yield.

The combined application of Cu + Zn had a significant negative effect on wheat yield grown under P deficient soil conditions on the Tisdale soil. This indicates that if Cu and Zn deficiencies are going to be corrected, that P fertility should be first addressed.

Yield of the following pea crop was not influenced by any of the micronutrient, P or moisture treatments imposed in the wheat crop.

Tissue and soil analysis found that Cu and Zn fertilization increased their concentrations in wheat and pea straw and grain, and an increase in after-harvest availability and supply in soils. The researchers concluded that this meant that if deficiencies are identified, they could be corrected through fertilization with residual benefits up to three years after application.

Chemical and spectroscopic speciation analysis was also conducted. These found that added Cu and Zn ends up associated with carbonate and clay minerals and, in the case of copper, soil organic matter as well.

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Noabur Rahman & Jeff Schoenau (2022) Zinc and copper interactions under variable soil phosphorus and moisture conditions in selected Saskatchewan soils, Journal of Plant Nutrition, 45:3, 311-331, DOI: 10.1080/01904167.2021.1952223

