

WHEAT ZINC NUTRITION: AGRONOMIC BIOFORTIFICATION THAT DELIVERS YIELD AND BETTER GRAIN NUTRITION

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ABSTRACT

Low Zn availability in calcareous soils is a common issue in the Canadian prairies, where much of the wheat is exported, making Canada one of the world's largest wheat exporters. Globally, 19% of the population, mostly pregnant women, infants, and children, suffers from Zn deficiency, highlighting the need to enhance Zn bioavailability in wheat grain. Agronomic biofortification offers a promising strategy to improve grain nutrient density while optimizing plant health and development. While many studies have examined Zn fertilization, either alone or with biostimulants, its effects on phytate concentration and Zn bioavailability in wheat grain remain underexplored. Previous research has shown that high soil or foliar-applied Zn rates can enhance grain Zn bioavailability, but economic and environmental concerns have limited widespread adoption. This underscores the need for alternative fertilization strategies that align with existing cropping systems and sustainability goals.

This study tested practical agronomic biofortification to raise grain zinc and its bioavailability and evaluated yield impacts in Canadian context. Over two years at four site-years on calcareous clay and sandy loam in southern Manitoba, we compared phosphorus and zinc sources (MAP, MAP + granular zinc sulfate, co-granulated phosphorus-sulfur-zinc; MicroEssentials® SZ®) and placements (broadcast-incorporation, side-band, seed-row) with or without foliar zinc, potassium, and biostimulants applied at 2-leaf and anthesis stages. Grain and straw nutrients were quantified after acid digestion, and zinc bioavailability was indexed by the phytic acid to zinc molar ratio.

Across site-years, zinc fertilization increased wheat yield by 8.3% (3.8 bu/ac) compared with the Zn unfertilized control, with banding at seeding out-yielding broadcast-incorporation. The largest and most consistent gains in grain zinc concentration were achieved when the co-granulated product was placed in the seed-row and supplemented with foliar zinc, raising grain zinc by ~27–60% at the two most responsive site-years (to ~41–43 mg kg⁻¹). Adding potassium or the biostimulant mix produced small effects but were not significant. The phytic acid to zinc ratio ranged ~27–38 and improved by about 25% with foliar zinc application, while phosphorus fertilization did not systematically increase phytic acid. Integrating seed-row co-granulated with well-timed foliar zinc application is a practical strategy to improve grain zinc bioavailability in Canadian prairie wheat systems. However, stronger and more consistent gains may require higher foliar zinc rates.