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MONTANA FERTILIZER eFACTS

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Biofortification of Durum and Spring Wheat with Zinc to Improve Yield and Nutritional Quality

by Reza Keshavarz Afshar and Chengci Chen, Eastern Agricultural Research Center, Sidney, MT

INTRODUCTION

Zinc (Zn) deficiency is considered one of the most important micronutrient deficiencies in the human diet (Zou et al., 2012). A big proportion of Montana wheat products are exported to other countries including developing countries in Asia. Therefore, improving the quality of the product through biofortification with micronutrients such as Zn could increase the nutritional value and marketability of Montana's wheat in international markets. Positive yield response to Zn application is also expected (Liu et al., 2016). Foliar application of Zn is more effective at increasing grain Zn concentration than soil application at a much lower application rate and lower cost (Zhang et al., 2012). Previous work at Eastern Agricultural Research Center found that seed-applied plus foliar Zn increased grain Zn content more than seed-applied Zn alone or the control, yet Zn treatments had no effect on yield (Eckhoff, 2010). The objective of this experiment was to improve yield and nutritional quality of dryland durum and spring wheat in areas of eastern Montana with Zn deficiency.

METHODS

A field experiment was conducted at Eastern Agricultural Research Center's dryland farm (Williams clay loam soil) in 2016. The field was fallowed in 2015. Soil test results (Table 1) illustrate that the soil Zn level is below the MSU critical level of 0.5 ppm (Jacobsen et al., 2005).

Precipitation received between April – August was 9.7 inches, which matches the long-term average. Durum (cv. Joppa) and spring wheat (cv. Velva) were seeded at 60 lb/acre on April 3 and harvested on July 25, 2016. The experiment included a control (no Zn application) and one-time foliar application of Zn (zinc sulfate monohydrate containing 35.5% Zn sprayed) at a rate of 0.9 lb Zn/acre at Feekes 10.1 growth stage (heading). Full Deck™ and Discover® were used for weed control and fungi were controlled using Avaris™.

RESULTS

Zinc application increased durum yield by 3.2 bu/acre, but Zn application did not increase spring wheat yield (Table 2). Protein and test weight showed no response to Zn application. However, harvest index (the ratio of grain to total biomass) in durum was significantly improved in Zn-treated plots.

Foliar application of Zn significantly enhanced Zn concentration in durum and spring wheat grain and straw. The concentration of Zn in grain increased by 25 and 49% in durum and spring wheat, respectively, whereas the increase in straw was 295 and 325% (Table 2). This indicates that foliar application of Zn at heading stage considerably enhanced Zn concentration in stem and leaf, however, much of the Zn couldn't translocate to the grain. Since grain Zn concentrations should be around 35-45 ppm to have a measurable biological impact on human health (Cakmak et al., 2010), further study is needed to screen durum and spring wheat germplasm for enhanced Zn translocation from straw to grain. The study will be repeated in 2017 to confirm the Zn effects.

Table 1: Soil test results from 0-6" soil depth.

Location	Zn	Fe	Mn	Cu	Mo	B	P	NH_4-N	pH	OM (%)	NO_3-N (lb/acre)
	ppm										
Sidney	0.4	7	6	0.6	<1	0.6	29	2.2	7.7	2.8	55

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- Foliar Zn application (0.9 lb Zn/acre) at heading stage increased grain yield of durum wheat by 3.2 bu/acre, yet did not increase spring wheat grain yield.
- Protein was not significantly affected by Zn application.
- Zn concentration in grain increased by 5 and 8.4 ppm in durum and spring wheat, respectively, yet final concentrations were still not considered adequate for people whose main source of essential minerals is wheat.
- Straw Zn concentrations increased greatly with foliar Zn application, suggesting future work should focus on increasing straw Zn translocation to grain.

ACKNOWLEDGEMENTS

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Table 2. Effect of Zn foliar application on durum and spring wheat.

	Durum					
Treatment	**Yield bu/ac**	**Harvest index**	**Test weight lb/bu**	**Protein %**	**Grain Zn ppm**	**Straw Zn ppm**
Control	38.5 b	0.45 b	64.0	8.9	19.4 b	6.7 b
Zn-treated	41.7 a	0.55 a	64.1	9.0	24.4 a	26.5 a
Level of significance	*	**	ns	ns	*	*
CV (%)	3.8	6.3	0.44	2.62	13.6	52
	Spring wheat					
Treatment	**Yield bu/ac**	**Harvest index**	**Test weight lb/bu**	**Protein %**	**Grain Zn ppm**	**Straw Zn ppm**
Control	55.4	0.48	63.9	10.8	17.2 b	5.6 b
Zn-treated	56.1	0.52	63.5	10.8	25.6 a	23.8 a
Level of significance	ns	ns	ns	ns	*	*
CV (%)	4.6	8.3	0.29	1.1	18.5	52

* significant at $P \le 0.05$; ** significant at $P \le 0.01$; ns - non-significant. Different letters indicate significant differences with 95% confidence. CV - coefficient of variation

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