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Balchem® Plant Nutrition Research Paper

Crop Physiology

UTILITY OF INNOVATIVE FOLIAR MICRONUTRIENT SOURCES TO IMPROVE CORN GRAIN YEILD

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OBJECTIVES:

1.) Quantify differential responses to foliar applied micronutrients tank mixed with pesticides when used in intensive corn production systems.
2.) Evaluate different rates and application timings of Metalosate Big 5, Metalosate Boron, and Metalosate Zinc for increased corn productivity.

RESEARCH APPROACH:

The experiment was implemented during 2016 at the Crop Sciences Research and Education Center in Champaign, IL. This location has been maintained weed- and disease-free, is level and well-drained, and is well-suited to provide evenly distributed soil fertility, pH, soil organic matter, and water availability. Experimental units were plots four rows wide and 37.5 feet in length with 30-inch row spacing. Plots were planted on 20 May 2016 in Champaign (silt loam, 3.7% organic matter; 22 meq/100g CEC, 6.4 pH, 39 ppm P, 177 ppm K, 6 ppm S, 1.4 ppm Zn, 50 ppm Mg, and 0.5 ppm B with Mehlich-3 extraction). Soybean was the previous crop and conventional tillage was used. Research plots were 37.5 feet in length with 30-inch row spacing and four rows in width. A corn hybrid responsive to management (DKC64-87 GENSS) was grown at a population of 36,000 plants ac^{-1} to assess the impact of supplemental micronutrient management in more intensive crop production systems. Urea ammonium nitrate (UAN; 32-0-0) was applied pre-plant at a rate of 180 lbs N ac^{-1} to simulate standard agronomic management. Plots were arranged using an RCBD with six replications.

Nutrient Applications

Treatment applications were designed to supply nutrients based on known patterns of nutrient accumulation and are outlined in Table 1. All micronutrient applications were applied in- season, based on the amino acid chelate technology developed by Albion Plant Nutrition. Foliar applications of Metalosate Big 5 (N, S, Zn, B, and Mn) were applied during typical post-herbicide application timing (V6) at three different rates (0.5 pt, 1 pt, or 1 qt ac^{-1}). Foliar applications of Metalosate B (8 or 32 oz ac^{-1}) and Metalosate Zn (16 or 64 oz ac^{-1}) were applied prior to the known stage of rapid increase in B and Zn uptake at V6 or immediately prior to flowering at the VT growth stage. Foliar micronutrient treatments were compared to a control spray of water with no micronutrients applied. All plots received a herbicide (Roundup at 32 oz ac^{-1}) at V6 and a fungicide (Headline AMP at 14.4 oz ac^{-1}) at VT tank mixed with the treatments to mimic a grower's typical foliar spray regimen. Treatments were applied with a backpack sprayer using a 15 GPA application rate on 23 June 2016 and 25 July 2016 at V6 and VT, respectively. There was no surfactant included in the applications.

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Parameters measured

Soil samples (0"-6" deep) were obtained from plot areas prior to planting to confirm fertility levels. The center two rows of each plot were mechanically harvested for determination of grain yield and harvest moisture, and the yield subsequently standardized to bushels acre^{-1} at 15.5% moisture. Subsamples of the harvested grain were evaluated for yield components (individual kernel weight and kernel number) and for grain quality (protein, oil, and starch concentrations) by NIT. Kernel weight is presented at 0% moisture.

Results

The 2016 production year experienced ideal growing conditions in Champaign, IL with average temperatures and timely and adequate rainfall throughout the growing season (Table 2). As a result, corn in this region experienced very little weather- induced heat or moisture stress, and over all the treatments leading to a trial average yield of 250 bu Ac^{-1}.

Although the overall effect of treatment on grain yield, yield components, or grain quality was not significant (Table 3), there were some interesting and significant impacts of the treatments on resulting grain yield and quality (Table 4). All treatments tended to increase grain yield, ranging from 4-10 bu ac^{-1}, compared to the control of 244 bu ac^{-1} (Table 4). Big 5 increased yield at all rates, with two of the rates (0.5 pt and 1 qt ac^{-1}) resulting in significant yield increases when applied at V6 (Table 4). Understanding the determinants of corn yield is important in identifying the physiological causes for these apparent differences in yield. The yield increases observed due to Big 5 applications were derived from a significant increase in kernel number suggesting that the supplemental nutrient application aided in greater assimilate accumulation when kernel number was being determined (Table 4). Boron applied at V6 or VT also increased grain yield when supplied at either rate (Table 4). However, boron applied at V6 tended to have a greater effect on yield then when applied at VT, with the greatest yield achieved when boron was applied early in the season at the higher rate of 32 oz ac^{-1} producing 254 bu ac^{-1} (Table 4). The highest yield from B foliar spray was obtained by significant increases in kernel number without reductions in kernel weight, indicating that the boron supplied during the period of rapid uptake helped with pollen viability and kernel formation (Table 4). Zinc applications tended to have a more significant impact on grain yield when applied at VT compared to V6 (Table 4). Kernel number significantly increased from Zn supplementation compared to the control, suggesting that the additional zinc aided in kernel formation and reduced kernel abortion when applied at VT (Table 4). Interestingly, when comparing rates at the different timings, the higher rate applications tended to yield more at V6 but yielded less at VT (Table 4). When looking at the nutrient uptake patterns of boron and zinc (Bender et al., 2013), V6 is the beginning of a period of rapid accumulation for both nutrients. The need for boron and zinc at VT is just as important, however, the accumulation rate at that period is not as rapid as the prior growth stages and the amount of supplemental nutrition needed may not be as great. Overall, all supplements led to similar yields, regardless of application rates or timings (Table 4).

The results from this trial document the importance of supplemental nutrient applications in high corn yield management systems. Preliminary evidence suggests that foliar applications of Metalosate Big 5 and Metalosate Boron at V6 and Metalosate Zinc at VT tend to increase corn

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grain yield. The compatibility of the Metalosate products developed by Albion Plant Nutrition with herbicides and fungicides increases the economical use of these products as they can be added into a grower's standard foliar application program of a post-emergence herbicide application at V6 followed by a fungicide application at VT without the need for another trip across the field.

Table 1. Eleven treatments used in the evaluation of the effect of foliar applied micronutrients on corn yield at Champaign, IL in 2016. All treatments received herbicide and fungicide applications at V6 and VT, respectively.

Foliar Nutrient Source	Rate (/ac^{-1})	Growth Stage
Control	-	-
Metalosate Big 5	0.5 pt	V6
Metalosate Big 5	1 pt	V6
Metalosate Big 5	1 qt	V6
Metalosate Boron	8 oz	V6
Metalosate Boron	32 oz	V6
Metalosate Zinc	16 oz	V6
Metalosate Zinc	64 oz	V6
Metalosate Boron	8 oz	VT
Metalosate Boron	32 oz	VT
Metalosate Zinc	16 oz	VT
Metalosate Zinc	64 oz	VT

Table 2. Precipitation and temperature during the production season at Champaign, IL in 2016 compared to the 30-year average. Data obtained from the Illinois State Water Survey.

	Precipitation (in)		Temperature (°F)	
Month	2016	30-Year Average	2016	30-Year Average
April	3.8	3.6	53	52
May	4.7	4.9	62	63
June	5.7	4.3	74	72
July	4.4	4.7	75	75
August	4.1	3.9	75	73
September	5.5	3.1	70	66

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Table 3. Test of fixed effects of grain yield, yield components (kernel number and kernel weight), and grain quality (oil, protein, starch) for corn grown at Champaign, IL in 2016.

Source of Variation	Yield	Yield Component		Grain Quality		
		Kernel Number	Kernel Weight	Oil	Protein	Starch
	P > F					
Treatment	0.5182	0.3147	0.1747	0.5807	0.9090	0.5958

Table 4. Grain yield, yield components (kernel number and kernel weight), and grain quality (oil, protein, starch) as influenced by foliar nutrient treatment for corn grown at Champaign, IL in 2016. Grain yield is presented at 15.5% moisture, kernel weight is presented at 0% moisture.

Treatment (rate/ac^{-1})	Growth Stage	Yield	Yield Components		Grain Quality		
			Kernel Number	Kernel Weight	Oil	Protein	Starch
		bu ac^{-1}	seed m^{-2}	mg seed^{-1}	-- % ---		
Control		244	5024	258	3.96	7.08	73.43
Big 5 (0.5pt)	V6	251	5318	251	3.93	7.00	73.55
Big 5 (1pt)		248	5304	249	3.96	7.02	73.53
Big 5 (1qt)		252	5317	252	3.92	7.02	73.50
Boron (8oz)		250	5157	258	3.89	7.03	73.73
Boron (32oz)		254	5227	258	3.88	7.00	73.75
Zinc (16oz)		248	5303	248	3.91	7.00	73.63
Zinc (64oz)		249	5275	251	3.97	7.07	73.48
Boron (8oz)	VT	250	5215	254	3.85	6.95	73.78
Boron (32oz)		248	5208	253	4.07	7.08	73.15
Zinc (16oz)		252	5257	255	3.84	6.97	73.83
Zinc (64oz)		250	5300	250	3.85	6.98	73.62
LSD (α = 0.10)		6	186	7	0.17	NS†	0.48

† NS, non- significant.

REFERENCES

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