Effect of Foliar Phosphite on Growth and Yield of Corn

Apurba Sutradhar[1], Brian Arnall[1], Kefyalew Desta[2], Jagadeesh Mosali[3], Muaid Ali[1], Michael Reinert[1], and Ma Lourdes Edano[1]

[1] Plant and Soil Sciences, Oklahoma State University, Stillwater, OK, USA; [2]Crop and Soil Sciences, Washington State university, Prosser, WA, USA; [3]Soils and Crops, The Samuel Roberts Noble Foundation, Ardmore, OK, USA

Background

Phosphorus is the second most limiting essential nutrient for plant growth. Phosphorus plays an important role in photosynthesis, protein formation, growth, reproduction, and energy transfer. Plants primarily uptake P through roots as orthophosphate (HPO_4^-). Phosphate is chemically stable and quickly binds with soil, calcium, aluminum, and iron that makes less available for plant uptake results lower P use efficiency [1]. Foliar application of phosphate fertilizer is not effective due to poor absorbance by the cereal leaves [2]. Phosphite is a compound consists of a phosphorus atom chemically bound to three oxygen atoms. Because of its oxidation state, phosphite is less stable and highly soluble in water. This may help easily absorb by cereal leaves.

Objective

The study was designed to assess the effects of foliar phosphite fertilization on growth and yield of corn.

Method

- A field trial was initiated in 2011 at Lake Carl Blackwell near Stillwater, Oklahoma, and a greenhouse study at Oklahoma State University in Stillwater, Oklahoma.
- Phosphorus deficient soil was used in both studies. Soil test Mehlich 3 P value at LCB and the greenhouse were 20 ppm and11 ppm respectively.
- Experimental design was a RCBD with three replications.
- Treatments included foliar phosphite and traditional TSP fertilizer. Urea was applied to meet N deficiency. Also, a combination of foliar phosphite and soil applied P fertilizers were used.
- "Nutriphite Take Off"- a formulation of phosphite and organic acid was used as a source of phosphite which contains 3%N, 20%P_2O_5, and 7% K_2O. A 2% solution was used per spray.
- Pioneer corn hybrid "P0902XR" was used at the rate of 32000 plants/acre. In the greenhouse, two corn seeds were planted in each pot.
- Foliar applications were made at V6 and VT growth stages at a flow rate of 150 L ha^{-1}.
- Data were collected and analyzed in SAS using PROC GLM and PROC MIXED procedure.

Figure 1: A leaf in the greenhouse trial that shows P deficiency.

Results

Table 1: Influence of foliar phosphite on yield, N and P conc. in grain, leaf, and stem. Lake Carl Blackwell in 2011.

Treatments	Estimate						
	Grain Yield [kg/ha]	Grain Total N [%]	Grain P [%]	Leaf Total N [%]	Leaf P [%]	Stem Total N [%]	Stem P [%]
Control	932.51	1.23	0.39	1.22	0.23	0.30	0.23
N	2465.15	1.39	0.37	1.52	0.22	0.40	0.19
V6	269.95	1.44	0.4	1.04	0.25	0.38	0.27
V6+VT	814.28	1.38	0.38	1.09	0.25	0.38	0.29
N+V6	1772.92	1.39	0.42	1.47	0.25	0.38	0.26
N+V6+VT	1808.43	1.43	0.45	1.86	0.27	0.49	0.19
N+P	2680.26	1.37	0.41	1.53	0.25	0.38	0.22
Contrasts							
N+V6 vs. Control	**	*	*	**	NS	**	*
N+V6+VT vs. Control	NS	*	NS	NS	NS	NS	NS
V6 vs. N	NS	NS	NS	NS	NS	NS	NS
V6+VT vs. N	NS	NS	NS	NS	NS	NS	**
N+V6 vs. N+P	**	NS	**	**	NS	*	**
N+V6+VT vs. N+P	NS	NS	NS	NS	NS	NS	NS
N+V6 vs. N+V6+VT	**	NS	*	**	NS	NS	**

Note: NS, *, and ** denote non-significant or significant at P ≤0.05 or P ≤ 0.01 respectively. N = soil applied full N fertilizer as urea, P = soil applied full P fertilizer as TSP, V6 = foliar phosphite spray at V6 growth stage, and VT = foliar phosphite spray at VT growth stage.

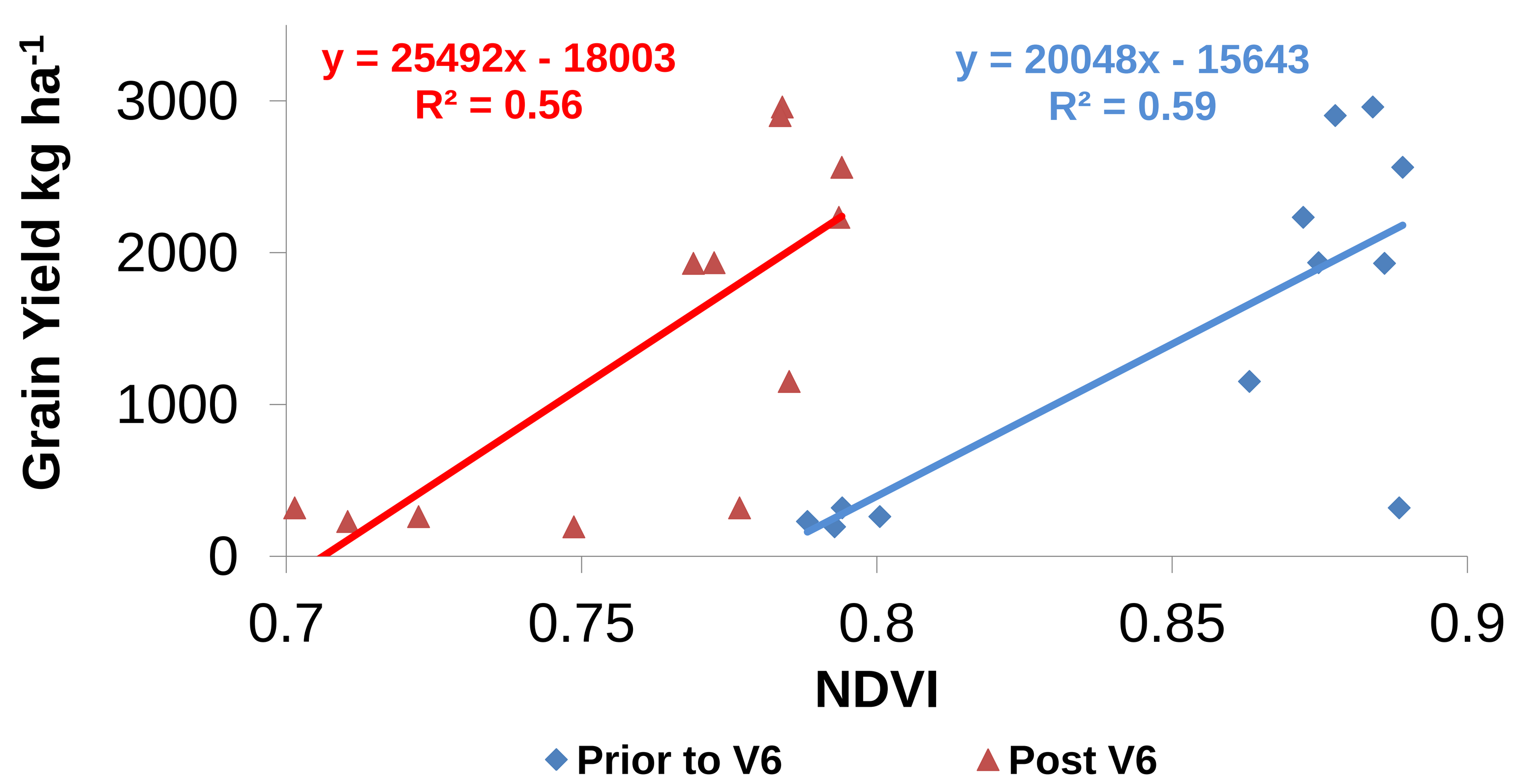

Figure 2: Corn grain yield [kg/ha] as a function of NDVI. Lake Carl Blackwell in 2011.

Figure 3: A section of a corn leaf that shows damage caused by foliar spray.

Table 1: Influence of foliar phosphite on yield, N and P conc. in grain, leaf, and stem. Greenhouse in 2011.

Treatments	Estimate						
	Relative Yield	Grain Total N [%]	Grain P [%]	Leaf Total N [%]	Leaf P [%]	Stem Total N [%]	Stem P [%]
Control	-	-	-	0.85	0.21	1.67	0.07
N	0.33	2.01	0.18	1.58	0.21	2.10	0.08
V6	-	-	-	0.74	0.21	1.84	0.08
V6+VT	-	-	-	0.77	0.21	1.69	0.07
N+V6	0.27	1.87	0.22	1.62	0.24	2.29	0.1
N+V6+VT	-	-	-	1.6	0.22	2.87	0.05
N+P	0.84	1.86	0.2	1.02	0.22	1.27	0.13
Contrasts							
N+V6 vs. Control	-	-	-	**	NS	**	NS
N+V6+VT vs. Control	-	-	-	NS	NS	NS	NS
V6 vs. N	**	NS	NS	**	NS	*	NS
V6+VT vs. N	-	-	-	NS	*	NS	NS
N+V6 vs. N+P	-	-	-	**	NS	**	NS
N+V6+VT vs. N+P	-	-	-	NS	NS	NS	NS
N+V6 vs. N+V6+VT	-	-	-	**	NS	**	NS

Note: NS, *, and ** denote non-significant or significant at P ≤0.05 or P ≤ 0.01 respectively.

Conclusion

Treatment effects were minimal due to severe heat and drought in 2011. In the field study; grain yield, N and, P concentration significantly increased when foliar phosphite was sprayed with nitrogen fertilizer. Grain yield, grain P concentration, leaf total nitrogen, and stem P concentration were significantly higher when phosphite was applied at V6 and VT growth stages compare to single application at V6 growth stage. Traditional soil applied TSP and urea resulted in the highest yield. This is because, the amount of foliar applied P was below total plant need. This study suggest that, in low P soils, foliar P alone is not sufficient.

Acknowledgement

- I would like to acknowledge my advisor Dr. Brian Arnall for continuous help and support
- Other committee members for their kind advising
- Graduate students who helped me during data collection and processing samples
- The study was partially supported by Biagro Western LLC

References

[1] Sander, D. H., E. J. Penas, and B. Egball. 1990. Residual effects of various phosphorus application methods on winter wheat and grain sorghum. Soil Science Society of America Journal. Vol. 54, pp. 1473-1478.

[2] Girma K., K. L. Martin, J. Mosali, K. W. Freeman, R. K. Teal, S. M. Moges, D. B. Arnall, and W. R. Raun. 2007. Determination of optimum rate and growth stage for foliar applied phosphorus in corn. Common. Soil Sci. Plant Anal. Vol. 38 (9&10): 1137-1154.