

SOIL/WATER RESEARCH

South Dakota State University

2008 Progress Report

Agricultural Experiment Station
Plant Science Department
South Dakota State University, Brookings, SD 57007

Soil Test Potassium, Sulfur, Zinc, Phosphorus, Boron and Lime Effects on Corn (1208 and 6008)

A. Bly, R. Gelderman and R. Berg

INTRODUCTION

Some farmers in South Dakota are using phosphorus, potassium, sulfur, zinc, or lime on soils with high soil tests. Research by soil fertility staff at South Dakota State University during the last 30 years has not shown consistent economical responses to these fertilizer nutrients or lime when soil test levels are high. Therefore, the SDSU Soil Testing Lab does not recommend fertilizer nutrient application unless soil test levels are lower. The studies reported here were established in 1988 and 1990 to determine the effects of each of these commonly used nutrients and lime on corn and soybean yields and soil test levels when applied to high testing soils.

MATERIALS AND METHODS

Two experimental sites were established, one on the SE experiment farm near Beresford in 1988 and another on the agronomy farm near the SDSU campus in Brookings in 1990. Fertilizer treatments have continued at each location on the same plots since establishment. A corn-soybean rotation was followed at both locations. Corn was the 2008 crop. The soil at the SE Farm site is an Egan silty clay loam. Egan soils are well drained soils formed in silty drift over glacial till. The soil at the Brookings Agronomy Farm is classified as a Vienna loam. Vienna soils are well drained

medium textured loam and clay loam soils formed from glacial till. Both soils are typical upland soils for their respective areas in the state. Fertilizer treatments were not applied in 2007, but treatments were applied again in 2008 and were 50 lbs K₂O, 25 lbs sulfur (as gypsum), 5 lbs zinc (as zinc sulfate) and lime at both locations (Table 1). In addition, the Brookings site had a 40 lb P₂O₅ treatment and the Beresford site a boron treatment (2 lb/a). The fertilizer treatments were applied each spring since the establishment year (1988 at Beresford and 1990 at Brookings) on the same plots. An exception is the boron treatment at Beresford that was initiated in 1997. Lime was applied only twice (1988 & 2003) at the SE Farm location and twice (1990 & 1992) at Brookings. All fertilizer treatments were broadcast and followed by either disking or field cultivation. Herbicides were applied as needed at both locations. A randomized complete block design with four replications was used at both sites. Plot size was 15 by 65 feet at Beresford and 20 by 40 feet at Brookings. Harvest was done with a plot combine at both locations.

RESULTS AND DISCUSSION

Soil test results from soil samples taken before 2008 fertilizer applications are presented in Table 2. The check treatment potassium soil tests were in the very high range at Beresford and the high range at Brookings. Adding 50 lb/a of K₂O per year since 1988 at Beresford and 1990 at Brookings raised the K soil test by 178 and 25 ppm respectively. The Brookings soil test K levels are not increasing at the rate expected. The check treatment sulfur soil test in the check plots was low at Beresford and medium at Brookings. Adding 25 lb/a sulfur each year had a residual effect at each site, raising the soil test 22 lb/a and 9 lbs/a at Beresford and Brookings,

respectively. The zinc soil test of the check was medium at Beresford (0.74 ppm) and very high at Brookings (1.68). Applying 5 lb/a zinc each year raised the soil test to 10.20 and 9.3 ppm at Beresford and Brookings respectively. The lime treatments made during this study had residual effect on soil pH. The check pH at Beresford was 6.1 and where lime was applied it was 6.8. At Brookings the check pH was 6.3 and limed treatments 6.6. The phosphorus soil test level at the Brookings site was 11 ppm without the phosphorus applications. The 40 lb/a annual phosphorus applications raised the Olson soil test level to 31 ppm. There was no phosphorus treatment at Beresford and all plots receive phosphorus as needed. The 2 lb/a boron treatment started at Beresford in 1997 raised the boron soil test from 1.21 ppm to 2.35 ppm. The check soil test was in the high range (>0.50 ppm) and no boron would have been recommended.

Corn yields averaged 150 bushels per acre at Beresford (table 3). No treatment significantly increased yield over the check. At Brookings corn yields averaged 136 bushels per acre (table 4) the P treatment significantly increased yield when contrasted with the other treatments. The Olsen P test of the check plot was 11 ppm which is in the medium soil test range. There is a 40-60 % chance of P response when P soil tests are medium. Most other soil tests were generally high for the nutrients tested at these locations, little or none of the nutrients in question would have been recommended and little or no response was expected.

Acknowledgments: Support for these studies came from various sources including the Ag Experiment Station, Plant Science Dept, Extension Service and the SDSU Soil Testing Lab.

Table 1. Fertilizer Treatments applied from 1988 at Beresford and 1991 at Brookings until 2006, Fertilizer and Lime Study, 2008.

Treatment	Fertilizer Rates	
	Beresford ¹	Brookings ²
	----- lb/A -----	
Check	0	0
Phosphorus (P ₂ O ₅)	----- ³	40
Potassium (K ₂ O)	50	50
Sulfur	25	25
Zinc	5	5
Boron	2	----- ³
Lime	----- ⁴	----- ⁵

¹ Applied each spring, 1988 - 2006, and 2008 except boron applied only since 1997.

² Applied each spring, 1990 - 2006, and 2008.

³ Not a treatment at this location.

⁴ 4000 lb and 3800 lb CaCO₃ equivalent applied spring 1988 and 2003 respectively.

⁵ 2500 lb and 2400 lb CaCO₃ equivalent applied spring 1990 and 1992 respectively.

Table 2. Soil Test Levels, Fertilizer and Lime Study, Beresford and Brookings.

Soil Test	Soil Test Level			
	Beresford ^{1,3}		Brookings ²	
	Check	Treatment	Check	Treatment
Potassium ppm	188	366	127	152
Sulfur, lb/A, 0 - 6 in	6	10	5	11
lb/A, 6 - 24 in	12	30	15	18
Zinc, ppm	0.74	10.20	1.68	9.30
pH	6.1	6.8	6.3	6.6
Olson Phosphorus, ppm	21	-----	11	31
Boron	1.21	2.35	-----	-----
NO ₃ -N, lb/A 2 ft	44	-----	60	-----
Organic Matter, %	3.1	-----	3.1	-----
Salts, mmho/cm	0.3	-----	0.3	-----

¹Sampled 04/1708
²Sampled 04/23/08
³160 lb P₂O₅ applied 11/19/01 and 4/01/03

Table 3. Nutrient soil test effects on Corn Yield, Beresford, 2008.

Fertilizer Treatment	Yield
	bu/A
Check	146.1
Potassium	150.8
Sulfur	147.9
Zinc	152.2
Boron	153.1
Lime	153.7
Prob of > F	0.35
C.V. %	3.6
LSD .05	NS

Table 4. Nutrient Soil Test Effects on Corn Yield, Brookings, 2008.

Fertilizer Treatment	Yield	Orthogonal Contrast ¹
	bu/A	Pr>F
Check	130.2	
Phosphorus	148.4	0.02
Potassium	140.0	0.43
Sulfur	135.7	0.87
Zinc	130.8	0.93
Lime	133.3	0.66
Prob of > F	0.78	
C.V. %	7.2	
LSD .05	NS	

¹ contrast between nutrient treated plot and all other treatments without that nutrient.