CHLORIDE RESEARCH UPDATE

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ABSTRACT

Spring wheat experiments conducted at 24 sites in eastern South Dakota over a 4-year period resulted in grain yield increases at 10 sites and documented foliar disease suppression at 5 sites. Yield response to KCl was, in all but one case, due likely to the Cl in the KCl. Yield responses were influenced by soil Cl level, applied N level, and variety. Broadcast and drill applied KCl were equally effective.

GREAT PLAINS RESEARCH

In the last three or four years, research activity on chloride has increased in several states due in part to the positive responses to Cl reported on winter wheat in the Northwest. The following is a brief summary of current studies compiled from responses obtained from letters sent recently by the author to the Plains States.

Iowa (Killorn et al.) Soybeans - Yield decrease from Cl addition.

Kansas (Claassen et al., Hooker) W. Wheat - Nonsignificant response to Cl at 3 sites, 1984-1985; (Granade et al.) Soybeans - Nonsignificant response to Cl (declining trend).

Montana (Engel) Take-all infected spring wheat - Yield increase due to NaCl if anhydrous ammonia was N source, not with sodium nitrate as N source.

North Dakota (Goos et al.) 1982-1985 Spring Wheat (4 sites) - No yield increases, 2 sites showing trend for common root rot suppression.
Barley (10 sites) - Yield increase at 2 sites, common root rot suppression at 7 sites.
Winter Wheat (6 sites) - No yield increases, Tanspot decrease at 2 sites.
Durum (4 sites) - No yield increases, common root rot suppression at 1 site.

Contact individual researchers for details on these studies. The remainder of this paper deals with ongoing studies in South Dakota.

OBJECTIVES

Experiments on Cl have been conducted in South Dakota since 1982 with the following objectives:

1. Determine the frequency of Cl response by spring wheat.
2. Determine the influence of Cl additions on root and foliar disease incidence and plant water relationships.
3. Compare the effectiveness of broadcast and seed placed KCl.
4. Determine the influence of soil Cl level, N level and cultivar on wheat response to added Cl.

METHODS

Experiments on hard red spring wheat have been conducted at 24 locations in Eastern South Dakota since 1982. Soils at experimental sites have been medium textured Borolls and Ustolls ranging from 6.2 to 7.4 in pH. All sites tested very high or high in ammonium acetate extractable K. Nearly all experiments had 6 replications in randomized complete block designs. The Cl source was KCl (0-0-60) in all cases except where $CaCl_2$ and KNO_3 were used to separate K and Cl responses. The variety used was Butte except where variety was a factor in the experiment. Plant parameters measured included grain yield, plant Cl concentration at heading, root and foliar disease ratings and plant water potential components at selected sites. Routine soil analysis plus water extractable Cl was determined in one foot increments to a depth of 4 feet.

RESULTS AND DISCUSSION

Frequent responses have occurred to KCl addition in these experiments. Grain yield increases have occurred at 42% of the sites tested while foliar disease suppression was detected at 21% of the sites (Table 1). Comparison of KCl, KNO_3 and $CaCl_2$ was made at 7 locations of which 5 responded to K or Cl. In all but one case, KCl response was due to Cl not K (Table 2). At one site that tested 280 lbs/A of NH_4OAc extractable K, a response to both K and Cl was measured.

Plant K concentration has generally been unaffected by KCl addition while Cl concentrations have been doubled (Table 3). This is evidence that responses at sites where no $CaCl_2$ treatment was included were also due to Cl.

Factorial experiments of broadcast KCl rates and 0 or 33 lbs KCl/A applied with the drill in seed contact have been conducted at 6 sites where yield responses were measured. Four of the sites are summarized in Fig. 1. No "starter" benefit was measured at any site and the effectiveness of broadcast-incorporated KCl and seed placed KCl was similar. However, the KCl rate required for maximum yield frequently exceeded the rate that could be safely applied with the seed.

Soil Cl contents to 2 feet and plant Cl concentrations were highly correlated in these studies (1982-1984, 85 analysis not completed at this writing). Approximately 3/4 of the variability in plant Cl was explained by soil Cl content (Fig. 2). Yield increases were measured when whole plant Cl concentration at heading of check plots dropped below 0.15% (Fig. 3).

The responsiveness of 4 varieties was compared at 4 locations in 1984-1985. Yield response occurred at 3 sites (Table 4). The varieties varied considerably in responsiveness with Marshall responding at all 3 sites, Butte and Oslo at 2 sites and Guard showing no KCl response. Marshall had the lowest average yield without KCl but the highest yield with KCl (Table 5).

An N x KCl interaction study conducted in 1985 revealed a significant effect of applied N on KCl response. Response to KCl was 9.6, 6.6 and 2.5 bu/A at N rates of 0, 120 and 240 lbs N/A respectively (Soil NO_3-N = 53 lbs/A-2').

The yield increases measured at responsive sites have been very economical (Table 6). The average return per $ invested on KCl was $3.71.

Table 1. Frequency of spring wheat response at Cl sites, in South Dakota. 1982-1985.

Year	Number of Sites: Total	Yield Increase	Disease Suppression	Yield Incr. or dis. sup.
1982	3	2	0	2
1983	3	2	0	2
1984	8	2	1	2
1985	10	4	4	5
Total	24	10	5	11
Percent	100	42	21	46

Table 2. Spring wheat yield response to KCl and $CaCl_2$ in Eastern South Dakota at responsive sites, 1983-1985.

Treatment[1/]	Site: 83A	83L	84N	84S	85S	Average
	bu/A					
Check	29	34	73	45	65	49
KCl	36	39	80	51	69	55
$CaCl_2$	36	39	78	51	68	54

1/ 167 lbs KCl/A in 1983 and 120 lbs KCl/A in 1984-1985; $CaCl_2$ at equivalent Cl rate.
Fixen et al., 1986a.

Table 3. Influence of KCl fertilization on wheat plant K and Cl concentrations.

Treatment	Plant Concentration[1/]: K	Cl
	%	
Check	3.2	0.35
+ KCl[2/]	3.2	0.74
Change	0.0	0.39

1/ Whole plant at heading: average of 13 sites, 1982-1984.
2/ Varying rates of KCl.
Fixen et al., 1986a.

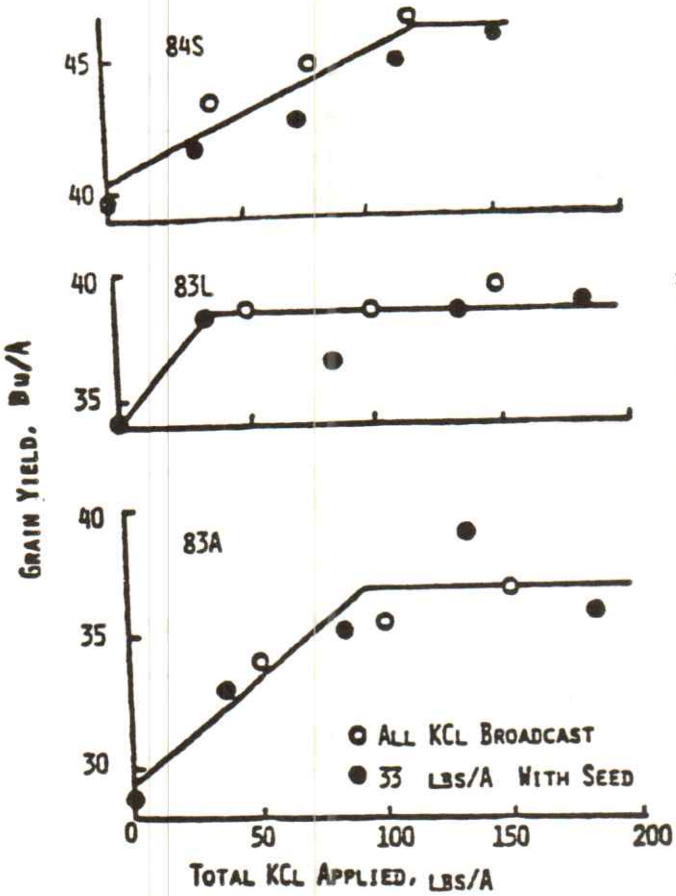
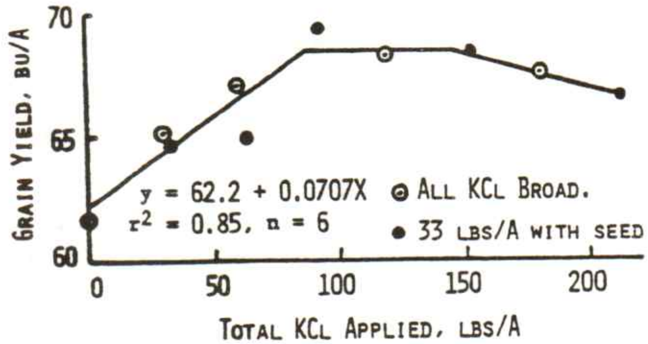


Fig. 1. Wheat grain yield response to KCl rate and placement, 1983-1984. (Fixen et al. 1986a).



Grain yield response to seed placed and broadcast KCl, 85S.

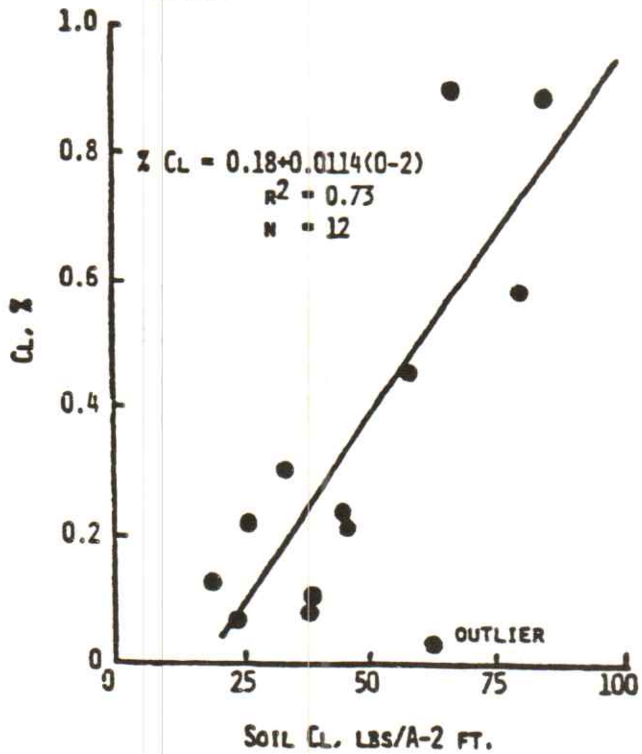


Fig. 2. Influence of soil chloride to a 2 foot depth on plant chloride concentration, 1982-1984. (Fixen et al. 1986b).

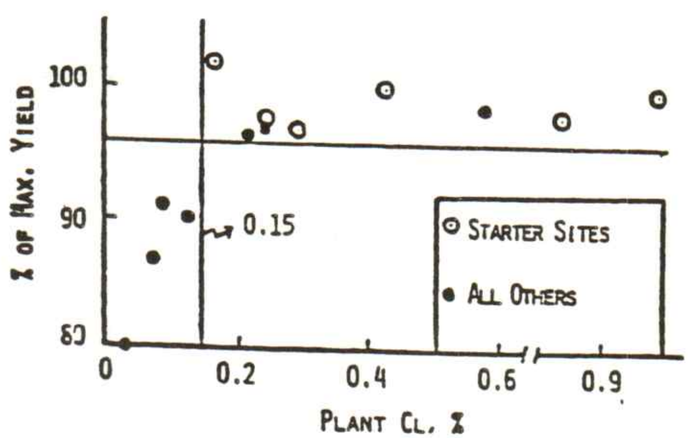


Fig. 3. Cate-Nelson analysis of plant Cl concentrations.

Table 4. Influence of spring wheat variety on yield response to KCl fertilization in South Dakota.

Variety	Site 84N	Site 84S	Site 85S	Average Response
	------------bu/A1/------------			
Marshall	4.2	7.7	9.2	7.0
Butte	0.0	5.3	6.1	3.8
Oslo	3.0	4.9	1.0	3.0
Guard	0.4	-0.9	-0.3	-0.3

1/ Difference between 120 lbs KCl/A and 0 lbs/A.
Fixen et al.

Table 5. Average grain yield of four spring wheat varieties, with and without KCl.

Variety	KCl, lbs/A 0	KCl, lbs/A 120	Response
	----------bu/A----------		
Marshall	58.3	65.3	7.0
Butte	60.5	64.3	3.8
Oslo	60.0	63.0	3.0
Guard	60.3	60.0	-0.3

Average of 3 site-years in Eastern South Dakota, 1984-1985.
Fixen et al.

Table 6. Rate of KCl required at responsive sites for maximum spring wheat yield in Eastern South Dakota, 1982-1985.

Site	KCl Response1/	Rate Required	Return per $ invested2/
	bu/A	lbs/A	$
82H	5	86	2.91
82A	5	84	2.98
83A	7	92	3.80
83L	4	33	6.06
84S	6	121	2.48
85S	6	88	3.41
85B	5	77	3.25
85D	5	135	1.85
85W	4	30	6.67
Avg.	5	83	3.71

1/ Variety = Butte. 2/ Calc. at $3.50/bu wheat and $0.07/lb KCl.
Fixen et al., 1986a and unpublished data.

LITERATURE CITED

Fixen, P.E., R.H. Gelderman, J.R. Gerwing, and F.A. Cholick. 1986a. Response of spring wheat, barley and oats to Cl in KCl fertilizers. Agron. J. (Submitted).

Fixen, P.E., G.W. Buchenau, R.H. Gelderman, T.E. Schumacher, J.R. Gerwing, F.A. Cholick, and B.G. Farber. 1986b. Influence of soil and applied chloride on several wheat parameters. Agron. J. (Submitted).

Ibid. Unpublished data.

ONGOING SOIL FERTILITY RESEARCH IN SOUTH DAKOTA

1. Nitrogen management as influenced by tillage systems in Eastern South Dakota (3 sites).
   Objectives: 1) Determine the influence of tillage on the N fertilizer requirements of corn, wheat, and oats under South Dakota growing conditions. 2) Compare topdressed N to knifed N for common tillage systems. 3) Gather calibration data for the NO_3 soil test.

2. Influence of water stress and tillage on nutrient uptake by corn (line source - 1 site, 3 other field sites, greenhouse).
   Objectives: 1) Determine the influence of moisture stress on the nitrogen level in the soil and in plant tissue required for maximum yield. 2) Determine the influence of moisture stress and tillage on tissue concentrations of the essential elements and resulting DRIS indices.

3. Management of urea fertilizers for reduced-till winter wheat (3 sites).
   Objectives: 1) Compare conventional granular urea, coarse granular urea, broadcast UAN, and dribbled UAN. 2) Determine the influence of timing on nitrogen use efficiency for the materials being tested.

4. Phosphorus management as influenced by tillage systems in eastern South Dakota (3 sites).
   Objectives: 1) Determine the influence of tillage systems on the optimum soil test P level for corn and oats. 2) Determine the optimum P fertilizer placement for common tillage systems as influenced by soil test P level. 3) Determine the influence of tillage systems on the chemistry and availability of P fertilizer residues.

5. Residual effects of fertilizer phosphorus on an Eagan silty clay laom (1 site).
   Objectives: 1) Determine the effects of residual fertilizer phosphorus on crop yields. 2) Monitor changes in soil test P as phosphorus is removed by crop growth.

6. Zinc requirements of corn and flax in eastern South Dakota (1 site).
   Objectives: 1) Determine the soil Zn requirements of corn and flax as influenced by P placement. 2) Determine the influence of $ZnSO_4$ additions on DTPA extractable Zn in the persistence of such treatments. 3) Compare the Zn requirements of common flax varieties.

7. Soil Testing Lab. Recommendation Comparisons (2 sites).
   Objective: Compare soil test recommendations from several laboratories and evaluate their effect on crop yields and profitability.

8. Nitrogen mineralization Studies (20 sites).
Objective: Determine if several soil nitrogen availability indices are related to nitrogen uptake by small grain.