EFFECTS OF CHLORIDE RATES AND SOURCES ON WINTER WHEAT IN KANSAS[1/]

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On wheat, and some other cereal grains, chloride has been reported to have an effect on plant diseases, either suppressing the disease organism or causing the plant to be able to withstand infection. It is hypothesized that yield increases are due to these effects. Researchers from several states have been able to show yield increases from chloride containing fertilizers. The most common source is potassium chloride, KCl. In many cases, soil test potassium levels are high, and most soil test recommendations call for no additional K; however, when small increments of KCl are used, some yield increases have been reported.

The objective of this study was to evaluate the effects of added increments of chloride containing fertilizers, potassium chloride and ammonium chloride, on yields of hard red winter wheat in Kansas.

Methods

This study was initiated in 1987 on the Estel Wyatt farm in Shawnee County, Kansas. The soil type at this location is a Eudora silt loam (coarse-silty, mixed mesic Flurentic Hapludolls), a well-drained, neutral to moderately alkaline river bottom soil. The inherit P and K fertility levels are naturally high and the soil has a medium to high available moisture holding capacity. Wheat on this soil type responds well to added increments of nitrogen fertilizer. This location has been in continuous dryland wheat production for ten plus years to hold the soil against the possibility of blowing in winter and early spring. The cooperators' cultural practices were used both years of the study and are summarized in Table 1.

Two sources of chloride containing fertilizers were used, potassium chloride (KCl) and ammonium chloride (NH_4Cl). Chloride rates of 30, 60, and 90 pounds per acre were applied as a spring topdress in 1987, and as a preplant or spring topdress in 1988. Nitrogen was balanced both years to a total of 75 pounds of N per acre for all plots as NH_4NO_3. Soil test results on samples taken in May of 1987, on individual plots, indicated soil test potassium levels in the surface six inches were in

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[1/] Presented at the Eighteenth North Central Extension - Industry Soil Fertility Workshop, November 9-10, 1988.

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the very high category, and test levels for the six to twelve inch increment ranged from the medium to the very high category (Table 2). No additional potassium fertilizer was needed or used by the cooperator on his surrounding field, so K levels were not balanced across the plots. Phosphorus was added at planting by the cooperator at a rate of 50 pounds of 18-46-0 per acre.

Table 1. Cultural practices, planting, harvesting, and treatment dates.

	1987	1988
Variety	Reg. Arkan	Pioneer 2165
Tillage	Tandem disc 2-Field cultiv.	Tandem disc 2-Field cultiv.
Planting Date	9-28-86	9-24-87
Seeding Rate	60 lbs/A	60 lbs/A
Treatment Dates	3-6-87	9-24-87 2-24-88
Tissue Sampling Date	5-10-87	5-12-88
Harvest Date	6-17-87	6-21-88

Table 2. Soil test data, Shawnee County, Kansas - 1987.

Cl Rates lbs/A	Sample depth inch	pH	Bray P lbs/A	Exch. K lbs/A	Cl ppm	KCl-extractable NH_4-N ppm	KCl-extractable NO_3-N ppm
0	0-6	5.2	45	533	2.6	5.6	4.2
	6-12	6.0	21	333	1.9	3.6	3.4
30	0-6	5.3	46	530	2.8	6.0	4.6
	6-12	6.0	28	370	2.0	2.9	1.9
60	0-6	5.2	50	555	4.7	5.2	4.7
	6-12	6.0	35	361	4.0	2.7	1.7
90	0-6	5.2	40	510	4.5	5.8	4.8
	6-12	5.9	21	335	3.6	2.8	1.7

No statistical differences within surface or subsurface samples. Sampling date May 10, 1987.

Soil samples were analyzed for chloride content using a Technicon Autoanalyzer and the mercury (II) thiocyanate method as reported in Methods of Soil Analysis, Part Two by Page, Miller, and Keeney (2).

Whole plant tissue samples were taken approximately at Feekes' Growth Stage 10.2, and analyzed for chloride content. The analytical procedure used for tissue samples was a potentiometric titration of chloride extracts using a chloride ion electrode. The electrode was used to indicate the end point in the titration of the tissue-extracted mixture with $AgNO_3$ (1). Grain yields were taken at maturity and samples were retained for test weight analysis. The plot design was a randomized complete block with three replications. Analysis of variance was run on the results.

Results and Discussion

No significant disease pressure was noted at heading when tissue samples were taken either year. Disease pressure throughout the growing cycle was rated as light both years.

Even though no diseases were detected or measured either year, significant yield differences were measured both years between the check plots that did not receive any additional chloride fertilizer and those plots that did receive chloride fertilizer (Table 3 and 4). In 1987, there was no significance between the three Cl rates averaged over sources, but in 1988, the 60 pound rate was significantly better than the 30 pound rate but not the 90 pound rate at the 95% confidence level.

A significant difference between sources was found in 1987, but not in 1988. The source difference in 1987, occurred because of the significant difference between sources at the 60 pound rate as shown in Table 5. There was no differences at any other rate or between rates in 1988, hence no difference between sources. It would appear that perhaps the measured difference at 60 pounds was an exception as no other rate was significant and there is no reason to expect one source to outperform another source of the chloride ion. Because soil potassium levels were very high, the difference between sources was not attributed to a K response. Nitrogen was balanced, so no advantage to extra nitrogen was given to NH_4Cl.

Concentration of chloride in the tissue was significantly increased both years by the application of chloride fertilizers. A six-fold increase was obtained in 1987, between the check plots and the high chloride rate plots. The response was not as large in 1988, but was certainly significant, indicating that the concentration of chloride in the tissue is directly effected by the application of a chloride containing fertilizer. Concentration of tissue chloride was not statistically significant between fall and spring application times, however, the spring concentration levels did show higher trends than did the fall concentration levels.

Table 3. Chloride rate and source effects on winter wheat, Shawnee County, Kansas - 1987.

Cl Rates lbs/A	Source	Yield bu/A	Test Weight lbs/bu	Tissue Chloride %
0	--	55.4	57	.12
30	NH_4Cl	59.6	58	.45
60	NH_4Cl	58.8	57	.72
90	NH_4Cl	60.5	57	.61
30	KCl	62.6	57	.52
60	KCl	62.9	57	.58
90	KCl	61.5	57	.78
	LSD (0.05)	4.1	NS	.25
Mean Values:				
Source	NH_4Cl	59.6	57	.59
	KCl	62.3	57	.63
	LSD (0.05)	2.2	NS	NS
Cl Rates	30	61.1	58	.48
	60	60.9	57	.65
	90	61.0	57	.70
	LSD (0.05)	NS	NS	.19

Table 4. Chloride source, rate, and application time efects on winter wheat, Shawnee County, Kansas 1988.

Cl Rates lbs/A	Source	Yield bu/A	Test Weight lbs/bu	Tissue Chloride %
0	--	61.8[1]	57	.12
30	NH_4Cl	65.0	60	.34
60	NH_4Cl	69.5	59	.51
90	NH_4Cl	68.4	58	.68
30	KCl	67.5	59	.34
60	KCl	68.5	58	.51
90	KCl	66.2	59	.62
	LSD (0.05)	3.9	2	.11
Mean Values:				
Source	NH_4Cl	67.6	59	.51
	KCl	67.4	59	.45
	LSD (0.05)	NS	NS	NS
Cl Rates	30	66.2	59	.34
	60	69.0	58	.51
	90	67.3	58	.64
	LSD (0.05)	2.0	NS	.06
Time	Fall	67.8	58	.48
	Spring	67.2	58	.52
	LSD (0.05)	NS	NS	NS

[1]Averaged across application times which were not significant.

Table 5. Chloride rate and source effects on winter wheat, Shawnee County, Kansas, 1987 and 1988.

Cl Rates lbs/A	Source	Yield bu/A	Test Weight lbs/bu	Tissue Chloride %
1987 Cl Rates				
30	NH_4Cl	59.6	58	.45
	KCl	62.6	57	.52
	LSD (0.05)	NS	1	NS
60	NH_4Cl	58.8	57	.72
	KCl	62.9	57	.58
	LSD (0.05)	3.4	NS	NS
90	NH_4Cl	60.5	57	.61
	KCl	61.5	57	.78
	LSD (0.05)	NS	NS	NS
1988 Cl Rates				
30	NH_4Cl	65.0	60	.34
	KCl	67.5	59	.34
	LSD (0.05)	NS	NS	NS
60	NH_4Cl	69.5	59	.51
	KCl	68.5	58	.51
	LSD (0.05)	NS	NS	NS
90	NH_4Cl	68.4	58	.68
	KCl	66.2	59	.61
	LSD (0.05)	NS	NS	.05

Time of application in the 1988 study was not significant. (Table 4). Other researchers have shown that topdressed applications have significant effects on yields when disease infections occur in the spring. As indicated earlier, disease pressure was very light both years at this location.

In summary, in both years a response to chloride fertilization was noted in spite of diseases not being detected. The exact reasons for the increased yields are not known and warrant further study. In other studies where diseases are suppressed, yield increases due to chloride additions are more understandable. These increased yields, while not large, are consistent. Producers in this area of Kansas with good management techniques should give consideration to the application of chloride fertilizers with rates of 30 to 60 pounds being the most economical.

References

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PROCEEDINGS OF THE EIGHTEENTH

NORTH CENTRAL EXTENSION - INDUSTRY SOIL FERTILITY WORKSHOP

9-10, November 1988, Holiday Inn St. Louis Airport North

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The professionalism shown by Ms. Barbara Brown in typing portions of this document and in helping organize its preparation is acknowledged and appreciated.

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