CHLORIDE'S ROLE IN MAXIMIZING WHEAT VARIETY PERFORMANCE

Brandon Research Station: 1996 Report

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Objectives:

1) To understand the interactions of major wheat varieties and promising releases with chloride fertilization
2) To evaluate effects of chloride fertilization on wheat plant pathology
3) To document effects of chloride on plant maturity and thousand kernel weight
4) To increase awareness of dealers and growers of the benefits of appropriate chloride fertilization to wheat yield and profitability.

Project Protocol:

A) Variety Study

-15 varieties of spring wheat, including Hard Red Spring, Amber Durum and Canadian Prairie Spring wheat cultivars

-Cultivars sown with and without Cl applied at 40 lb Cl per acre as KCl, applied as a pre-plant spring banded application

B) Rate study

-Chloride rates of 0, 10, 20, 40 and 80 lb/acre were applied to Biggar wheat, a variety that has been responsive in the past.

Site Selection:

Two sites were selected which tested low in Cl and were located on two contrasting soil types, a clay loam and a fine sandy loam. Samples were to Ag Vise for soil Cl determination.

Experimental Design:

A) Variety Study: Split plot design with 6 replications, for a total of 180 plots per site. Subplots were 2 metres by 5 metres.

B) Rate study: Randomized complete block design with 6 replications for a total of 30 plots per site. Plots were 2 metres by 5 metres.

Sampling:

1) Whole plant samples were taken at heading. Analysis for N, K, and Cl is in progress.
2) Plant pathology evaluation was conducted by barley breeder Dr. Mario Therrien. Plots will be rated for leaf disease incidence.
3) Thousand kernel weight will be measured on all plots, but has not been completed yet. Protein content and cadmium concentration will be assessed on selected plots.
4) Information on final grain yield, harvest index and disease incidence is included in this report.

RESULTS

Fine Sandy Loam

After a wet spring, no significant rainfall was received until after the middle of July. This led to severe drought stress on the fine sandy loam site. Drought stress superimposed on natural variation in the soil led to high variability in the study. However, significant difference did occur in all variables measured (Tables 1-3).

Grain yield was increased by application of KCl when averaged over all cultivars (Tables 1 and 2). Yield also varied with cultivar. It is interested to note that the cultivars which normally produce high grain and biomass yield produced the lowest grain yield on this site. This is presumably due to depletion of available water early in the season by the higher biomass production, which led to enhanced drought stress during grain fill. Although there was no significant KCl by cultivar interaction, I chose to break out the results by cultivar because of the large variability on this site. Yield was significantly increased by KCl application for Karma, Majestic and Roblin and tended to increase with Plenty ($p<0.0639$) and Cora ($p<0.0787$).

Leaf disease incidence was severe on this location. Leaf disease was not influenced by KCl application when averaged over all cultivars. There was a strong effect of cultivar but no significant cultivar by KCl interaction. When KCl effects on cultivars were considered individually, disease incidence was reduced significantly only in Karma and tended to be slightly higher in Domain with the application of KCl ($p<0.0925$).

Table 1: Effect of cultivar and KCl treatment on grain yield, leaf diseases and harvest index of wheat grown on a fine sandy loam soil in 1996.

	Grain Yield (Bu/acre)			Disease Rating (0-9)			Harvest Index		
Cultivar	Control	KCl	Mean	Control	KCl	Mean	Control	KCl	Mean
Marshall	41.8	41.4	41.6	5.66	5.50	5.58	0.61	0.60	0.60
Pioneer 2375	32.7	39.3	36.0	6.50	6.17	6.33	0.59	0.6	0.59
Majestic	29.9	40.8	35.3	5.66	5.00	5.58	0.57	0.6	0.59
Karma	27.4	42.3	34.9	6.83	5.00	5.92	0.53	0.59	0.56
CDC Teal	35.0	34.3	34.7	5.50	6.00	5.75	0.55	0.54	0.54
Grandin	37.1	31.6	34.4	5.50	6.00	5.75	0.53	0.56	0.55
Taber	35.9	29.9	32.9	5.33	5.67	5.50	0.53	0.51	0.52
Cora	28.8	33.8	31.3	6.00	6.17	6.08	0.53	0.58	0.56
Barrie	27.1	34.6	30.9	6.00	5.67	5.83	0.5	0.51	0.50
Domain	28.1	33.1	30.6	6.17	7.00	6.58	0.52	0.57	0.54
Roblin	27.1	32.0	29.6	7.50	7.50	7.50	0.54	0.55	0.54
Guard	28.9	28.9	28.9	7.00	7.17	7.08	0.57	0.58	0.57
Glenlea	29.3	25.4	27.4	5.33	5.33	5.33	0.49	0.45	0.47
Kyle	25.2	32.6	27.1	6.33	5.83	6.08	0.47	0.48	0.48
Plenty	22.5	31.5	27.0	6.83	6.33	6.58	0.45	0.49	0.47

Harvest index tended to be increased by application of KCl when averaged over the

cultivars ($p<0.0661$) and differed among cultivars (Tables 1 and 2). There was no cultivar by KCl interaction. When considered separately, there was a significant increase in harvest increase with KCl application in Karma and Domain (Table 3).

Table 2: ANOVA table for effect of cultivar and KCl applications on grain yield, disease incidence and harvest index on a fine sandy loam soil (1996)

Source	DF	Grain Yield	Disease Rating	Harvest Index
Treatment	1	0.0034	ns	0.0661
Cultivar	14	0.0276	0.0001	0.0001
Treat x Cult	14	ns	ns	ns
MSE		721255	0.7697	0.0025

Table 3: Probability values associated with treatment effect for individual cultivars for grain yield, disease rating and harvest index on a fine sandy loam soil in 1996.

	Grain Yield	Disease Rating	Harvest Index
Barrie	ns	ns	ns
CDC Teal	ns	ns	ns
Cora	0.0787	ns	ns
Domain	ns	0.0925	0.0353
Glenlea	ns	ns	ns
Grandin	ns	ns	ns
Guard	ns	ns	ns
Karma	0.0024	0.0060	0.0278
Kyle	ns	ns	ns
Majestic	0.0296	ns	ns
Marshall	ns	ns	ns
Pioneer 2375	ns	ns	ns
Plenty	0.0639	ns	ns
Roblin	0.0063	ns	ns
Taber	ns	ns	ns

Clay Loam Soil

Dry conditions after seeding also occurred on the clay loam soil, but the ability of the soil to hold more available moisture than on the fine sandy loam soil reduced the impact of the drought. Therefore, crop yields were high and variability low on this site.

Grain yield was not increased by KCl application, when averaged over cultivars (Table 4

and 5). However, cultivar significantly affected crop yield and there was a cultivar by KCl interaction. Grain yield was only significantly increased by KCl application in Karma, a high yielding soft white wheat (Tables 4 and 6). Grain yield was reduced by KCl application in Marshall and Teal and tended to be reduced by KCl application in Roblin ($p<0.0773$). The reason for the reduction in yield with KCl application on this soil escapes me, although in growth chamber studies that I did a number of years ago on this soil type I saw the same tendency.

Table 4: Effect of cultivar and KCl treatment on grain yield, leaf diseases and harvest index of wheat grown on a clay loam soil in 1996.

	(Bu/acre)			(0-9)					
Cultivar	Control	KCl	Mean	Control	KCl	Mean	Control	KCl	Mean
Plenty	65.2	67.1	66.1	2.83	1.83	2.33	0.35	0.37	0.36
Kyle	61.2	63.9	62.6	5.00	1.33	3.17	0.34	0.34	0.34
Karma	57.9	66.4	62.1	5.83	3.00	4.42	0.41	0.41	0.41
Taber	60.7	60.3	60.5	2.17	3.00	2.58	0.41	0.42	0.42
Pioneer 2375	60.3	57.0	58.7	4.67	5.50	5.08	0.47	0.46	0.46
Marshall	60.6	56.7	58.6	3.83	4.33	4.08	0.43	0.42	0.42
Glenlea	57.6	58.8	58.2	3.83	2.67	3.25	0.35	0.32	0.34
Majestic	56.7	59.5	58.1	3.33	2.67	3.00	0.39	0.42	0.40
Cora	56.6	56.5	56.5	3.67	3.50	3.58	0.42	0.46	0.44
Guard	54.4	54.9	54.7	4.83	3.00	3.92	0.40	0.42	0.41
CDC Teal	56.4	51.2	53.8	3.83	4.00	3.92	0.44	0.47	0.46
Grandin	52.6	52.1	52.3	4.33	3.67	4.00	0.35	0.36	0.36
Domain	51.6	52.9	52.3	5.50	4.67	5.08	0.41	0.45	0.43
Barrie	52.5	51.5	52.0	2.83	3.00	2.92	0.37	0.39	0.38
Roblin	47.6	44.0	45.8	4.83	4.83	4.83	0.43	0.44	0.44

Disease incidence was affected by treatment and cultivar and a treatment by cultivar interaction occurred (Tables 4 and 5). Disease was generally reduced by KCl application, with significant reductions occurring in Domain, Glenlea, Guard, Karma, Kyle and Plenty (Tables 4 and 6). A significant increase in disease with KCl application occurred in Taber. The reason for the increase in this cultivar was unclear. The greater tendency for differences in disease with KCl on this soil as compared to the fine sandy loam soil may be because the disease pressure, while measurable, was lower on the clay loam. The KCl may have been more effective in reducing disease when the pressure was not as severe as on the fine sandy loam soil.

Table 5: ANOVA table for effect of cultivar and KCl applications on grain yield, disease

incidence and harvest index on a clay loam soil (1996)

Source	DF	Grain Yield	Disease Rating	Harvest Index
Treatment	1	ns	0.0001	0.0003
Cultivar	14	0.0001	0.0001	0.0001
Treat x Cult	14	0.0015	0.0001	0.0130
MSE		90061	0.7919	0.0004

Harvest index was affected by treatment and cultivar and a treatment by cultivar interaction occurred (Tables 4 and 5). Harvest index increased with KCl application in Cora, Domain, Guard and Majestic, tended to increase in Barrie ($p<0.0786$) and Plenty ($p<0.0954$) and tended to decrease with KCl application in Glenlea ($p<0.0688$). Significant effects on harvest index were not related to changes in grain yield.

Table 6 : Probability values associated with treatment effect for individual cultivars for grain yield, disease rating and harvest index for a clay loam soil (1996)

	Grain Yield	Disease Rating	Harvest Index
Barrie	ns	ns	0.0786
CDC Teal	0.0075	ns	ns
Cora	ns	ns	0.0080
Domain	ns	0.0041	0.0353
Glenlea	ns	0.0335	0.0688
Grandin	ns	ns	ns
Guard	ns	0.0478	0.0100
Karma	0.0164	0.0001	ns
Kyle	ns	0.0027	ns
Majestic	ns	ns	0.0276
Marshall	0.0433	ns	ns
Pioneer 2375	ns	ns	ns
Plenty	ns	0.0409	0.0954
Roblin	0.0773	ns	ns
Taber	ns	0.0422	ns

Effect of Rate of Chloride Fertilizer on Biggar Wheat

Biggar wheat was selected to use as an indicator cultivar in rate studies as it had been reported to

be responsive to Cl application in other trials (Flaten - personal communication). However, appliction of KCl did not influence growth of Biggar on either soil, although there was a tendency towards lower yield with application of KCl on the clay loam site ($p<0.0705$) (Tables 7 and 8). Disease and harvest index showed no reponse or tendency to response to KCl application. Based on the lack of reponse of Biggar in 1996, it may be desirable to change the cultivar used in this portion of the study to Karma, since Karma seems to be mores sensiteve to low Cl levels than Biggar.

Table 7: Effect of rate of KCl fertilizer (kg Cl ha^{-1}) on grain yield (kg ha^{-1}), leaf disease (0 to 9 scale) and harvest index on two soil types (1996)

	Fine Sandy Loam			Clay Loam		
Cl Rate	Grain Yield	Disease	Harvest Index	Grain Yield	Disease	Harvest Index
0	2004	6.17	0.58	4608	3.17	0.44
20	2228	6.00	0.57	4625	2.50	0.45
40	2228	6.00	0.58	4457	3.33	0.45
60	2157	5.83	0.58	4598	2.83	0.46
80	2230	5.83	0.58	4402	2.83	0.44

Table 8: ANOVA for effects of rate of KCl on grain yield, disease incidence and harvest index of Biggar wheat on two soil types (1996)

		Fine Sandy Loam			Clay Loam		
Source	DF	Grain Yield	Disease	Harvest Index	Grain Yield	Disease	Harvest Index
Rate	1	ns	ns	ns	0.0705	ns	ns
Rep	5	0.0001	0.0007	0.0008	0.0001	ns	ns
CV		10.66	8.60	5.30	4.14	32.0	4.44

Summary

Grain yield was increased by KCl application in Karma wheat on both a fine sandy loam and a clay loam soil. Responses were more frequent on the fine sandy loam soil, with increases in yield with KCl occurring in 1/3 of the cultivars evaluated. On the clay loam soil, a yield increase occurred only in Karma, while decreases occurred on two cultivars with a tendency to a decrease in a third. The beneficial effect of KCl on disease was greater on the clay loam than the fine sandy loam soil, possibly due to the lower variability or the lower disease incidence on the clay loam soil. Harvest index tended to increase with KCl application on both sites although this did not relate closely to

changes in grain yield.

Sent to Terry Roberts on November 28, 1996