

CHLORIDE'S ROLE IN MAXIMIZING WHEAT VARIETY PERFORMANCE
1998 Interim 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 testing low in Cl were selected in 1996 on two contrasting soil types, a clay loam and a fine sandy loam. In 1997, two similar soil types at different locations were used. The fine sandy loam soil tested low in Cl while the clay loam tested moderate. In 1998, a fine sandy loam and a clay loam again were selected, again containing low and moderate levels of Cl, respectively. 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, Cl and micronutrients is in progress.

2) Plant pathology evaluation was conducted by barley breeder Dr. Mario Therrien in 1996, by pathologist Curtis Rempel in 1997 and by pathologist Debbie McLaren in 1998. Plots were 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

1996 Growing Season

Fine Sandy Loam

A wet spring was followed by severely dry conditions, leading 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 interesting 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 ($p < 0.0787$).

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.

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

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

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 ($p < 0.0925$).

Harvest index tended to increase with 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 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 CDC 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.

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

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)

	<u>Grain Yield</u>	<u>Disease Rating</u>	<u>Harvest Index</u>
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 1996

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, application 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 response or tendency to response to KCl application.

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)

Cl Rate	Fine Sandy Loam			Clay Loam		
	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)

Source	DF	Fine Sandy Loam			Clay Loam		
		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

1996 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.

1997 Growing Season

Clay Loam Soil

As in 1996, a wet spring was followed by dry conditions, leading to severe drought stress on both soils during the grain filling period. A hail storm just prior to heading damaged wheat at the clay loam site, but the crop recovered well. The clay loam soil contained greater than 30 kg Cl ha⁻¹, yet wheat grown on this site showed a significant increase in grain yield with KCl application.

Table 9: P-values from ANOVA for effect of cultivar and KCl applications on grain yield, straw yield, harvest index and disease incidence on a clay loam soil (1997)

<u>Source</u>	<u>Grain Yield</u>	<u>Straw Yield</u>	<u>Harvest Index</u>	<u>Disease 1</u>	<u>Disease 2</u>
Treatment	0.0001	ns	0.0022	ns	ns
Cultivar	0.0001	0.0001	0.0001	ns	0.0001
Treat*Cultivar	0.0006	ns	0.0448	ns	0.0207
MSE	77535	1554689	0.0010	0.1574	0.2617
CV	7.1	17.3	6.7	43.0	19.9

Grain yield and harvest index on the clay loam soil were increased by application of KCl when averaged over all cultivars, while straw yield was not affected (Tables 9 and 11). All three yield parameters varied with cultivar. Disease incidence was relatively low at the first assessment and there was no effect of treatment or cultivar. At the second assessment, disease incidence varied with cultivar but not with treatment. A treatment by cultivar interaction occurred for grain yield, harvest index and disease incidence at the second sampling, indicating that response to KCl application differed among cultivars. Therefore, analysis was conducted for each cultivar separately (Table 10).

Table 10: P-values for analysis of variance for effect of KCl treatment on grain yield, leaf diseases and harvest index of wheat grown on a clay loam soil in 1997.

<u>Cultivar</u>	<u>Grain Yield</u>	<u>Straw Yield</u>	<u>Harvest Index</u>	<u>Disease 1</u>	<u>Disease 2</u>
Barrie	ns	ns	ns	ns	ns
CDC Teal	ns	ns	ns	ns	ns
Cora	ns	0.0306	0.0576	ns	ns
Domain	ns	ns	ns	ns	ns
Glenlea	ns	ns	ns	ns	ns
Grandin	ns	ns	ns	ns	0.0004
Guard	0.0738	ns	ns	ns	ns
Karma	0.0065	ns	0.0128	ns	ns
Kyle	0.0150	0.0978	0.0053	ns	ns
Majestic	ns	0.0769	ns	ns	ns
Marshall	0.0008	ns	ns	ns	0.0798
Pioneer 2375	0.0420	ns	0.0017	ns	ns
Plenty	ns	ns	ns	ns	ns
Roblin	ns	ns	ns	ns	ns

Taber	0.0562	ns	ns	ns	0.0001
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Table 11: Effect of cultivar and KCl treatment on grain yield, straw yield and harvest index of wheat grown on a clay loam soil in 1997.

Cultivar	Grain Yield (Bu/acre)			Straw Yield (Kg/ha)			Harvest Index		
	Control	KCl	Mean	Control	KCl	Mean	Control	KCl	Mean
Barrie	54.7	54.5	54.6	4092	4233	4163	0.47	0.46	0.47
CDC Teal	57.3	56.1	56.7	4029	3988	4009	0.49	0.49	0.49
Cora	52.6	53.0	52.8	5325	4417	4871	0.40	0.45	0.42
Domain	50.8	53.2	52.0	3554	3958	3756	0.49	0.47	0.48
Glenlea	54.6	59.6	57.1	4080	4871	4476	0.47	0.45	0.46
Grandin	60.1	60.5	60.3	4517	4738	4628	0.47	0.46	0.47
Guard	57.0	62.8	59.9	4154	4538	4346	0.48	0.48	0.48
Karma	53.8	64.0	58.9	3533	3517	3525	0.51	0.55	0.53
Kyle	61.9	69.2	65.6	6186	5870	6028	0.40	0.44	0.42
Majestic	50.2	48.4	49.3	4204	3467	3836	0.45	0.48	0.46
Marshall	61.9	67.8	64.9	4471	4254	4363	0.48	0.52	0.50
Pioneer 2375	59.6	66.4	63.0	3546	3367	3457	0.53	0.57	0.55
Plenty	68.6	72.5	70.6	5467	5325	5396	0.46	0.48	0.47
Roblin	51.4	48.1	49.8	3867	3679	3773	0.47	0.47	0.47
Taber	58.6	55.0	56.8	3708	3767	3738	0.52	0.50	0.51

Grain yield of Guard, Karma, Kyle, Marshall and Pioneer 2357 were all increased by the application of KCl (Tables 10 and 11). In contrast, Taber showed a decrease in grain yield with KCl application. In 1996, the only cultivar showing an increase in grain yield with KCl application on the clay loam soil was Karma, while three other cultivars showed decreases in grain yield with KCl. Kyle and Majestic both showed decreases in straw yield with KCl application, while Kyle, Karma and Pioneer 2375 all showed increases in harvest index with application of KCl. The effect of KCl on responsive cultivars appears to be primarily through improvements in grain filling.

Disease incidence at the first sampling in early July was very light and there was no effect of KCl addition in any cultivar (Tables 10 and 12). However, at the second sampling, later in July, disease incidence was somewhat higher and KCl suppressed leaf diseases in Grandin, Marshall and Taber. It is interesting that Taber showed a decrease in leaf disease combined with a decrease in grain yield. It also should be noted that the cultivars showing a decrease in leaf disease were not the cultivars that showed an increase in grain yield. Therefore, leaf disease suppression did not appear to be the major mechanism of yield increase from KCl application at this site. In 1996, on the clay loam site, reduction in disease incidence occurred more frequently with KCl application than did increases in grain yield, however disease incidence was substantially higher in 1996 as compared to 1997.

Table 12: Effect of cultivar and KCl treatment on leaf diseases at two dates on 15 cultivars of wheat grown on a clay loam soil in 1997.

Cultivar	Disease 1			Disease 2		
	Control	KCl	Mean	Control	KCl	Mean
Barrie	0.88	0.82	0.85	2.43	2.40	2.42
CDC Teal	0.87	1.07	0.97	2.37	2.38	2.38
Cora	0.97	0.95	0.96	2.37	2.07	2.22
Domain	1.23	1.02	1.13	2.38	2.78	2.58
Glenlea	0.92	1.04	0.98	2.44	2.06	2.25
Grandin	1.03	1.02	1.03	3.82	2.50	3.16
Guard	0.98	1.05	1.02	2.97	3.15	3.06
Karma	0.73	0.93	0.83	2.87	2.53	2.70
Kyle	0.76	0.80	0.78	2.83	2.78	2.80
Majestic	1.13	1.02	1.08	2.57	2.63	2.60
Marshall	0.65	0.88	0.77	2.55	2.38	2.47
Pioneer 2375	0.98	0.88	0.93	2.65	3.05	2.85
Plenty	0.70	0.72	0.71	2.25	2.52	2.38
Roblin	1.10	0.98	1.04	2.60	2.47	2.53
Taber	0.78	0.78	0.78	2.30	2.05	2.18

Fine Sandy Loam

The fine sandy loam soil contained less than 15 kg Cl per hectare to 60 cm, yet wheat showed less response to KCl application on the fine sandy loam than on the higher-Cl clay loam soil (Tables 13 and 15). When all cultivars were combined, there was an increase in grain yield and harvest index with application of KCl. There was no influence of KCl on disease incidence at either date. Cultivar affected grain yield, straw yield and harvest index, but the only treatment by cultivar interaction occurred with straw yield.

Table 13: P-values from ANOVA table for effect of cultivar and KCl applications on grain yield, disease incidence and harvest index on a fine sandy loam soil (1997)

Source	Grain Yield	Straw Yield	Harvest Index	Disease 1	Disease 2
Treatment	0.0406	ns	0.0328	ns	ns
Cultivar	0.0001	0.0001	0.0127	ns	0.0015
Treat*Cultivar	ns	0.0959	ns	ns	ns
MSE	115981	172083	0.0019	0.7187	0.3575
CV	17.1	14.2	10.7	39.5	28.4

When cultivars were examined individually, the only significant increase in grain yield occurred with Plenty (Tables 14 and 15). Two cultivars, Pioneer 2375 and Plenty, showed an increase in straw yield with KCl application, while three cultivars, Cora, Guard and Majestic, showed decreases in straw yield. Harvest index was only affected in CDC Teal, increasing with

KCl application. Disease incidence was only affected in Kyle, where the early disease was decreased with KCl application (Tables 14 and 16).

Table 14: P-values from analysis of variance for effect of KCl treatment on grain yield, leaf diseases and harvest index of wheat grown on a fine sandy loam soil in 1997.

<u>Cultivar</u>	<u>Grain Yield</u>	<u>Straw Yield</u>	<u>Harvest Index</u>	<u>Disease 1</u>	<u>Disease 2</u>
Barrie	ns	ns	ns	ns	ns
CDC Teal	ns	ns	0.0616	ns	ns
Cora	ns	0.0736	ns	ns	ns
Domain	ns	ns	ns	ns	ns
Glenlea	ns	ns	ns	ns	ns
Grandin	ns	ns	ns	ns	ns
Guard	ns	0.0038	ns	ns	ns
Karma	ns	ns	ns	ns	ns
Kyle	ns	ns	ns	0.0158	ns
Majestic	ns	0.0748	ns	ns	ns
Marshall	ns	ns	ns	ns	ns
Pioneer 2375	ns	0.0135	ns	ns	ns
Plenty	0.0072	0.0772	ns	ns	ns
Roblin	ns	ns	ns	ns	ns
Taber	ns	ns	ns	ns	ns

Table 15: Effect of cultivar and KCl treatment on grain yield, leaf diseases and harvest index of wheat grown on a fine sandy loam soil in 1997.

<u>Cultivar</u>	<u>Grain Yield</u> (Bu/acre)			<u>Straw Yield</u> (Kg/ha)			<u>Harvest Index</u>		
	<u>Control</u>	<u>KCl</u>	<u>Mean</u>	<u>Control</u>	<u>KCl</u>	<u>Mean</u>	<u>Control</u>	<u>KCl</u>	<u>Mean</u>
Barrie	37.5	44.5	41.0	3679	3896	3788	0.41	0.43	0.42
CDC Teal	32.4	37.3	34.9	3463	3550	3506	0.39	0.41	0.40
Cora	38.8	37.7	38.3	4063	3359	3711	0.39	0.43	0.41
Domain	38.8	37.8	38.3	3425	3213	3319	0.43	0.44	0.44
Glenlea	33.2	38.0	35.6	3755	4086	3921	0.37	0.38	0.38
Grandin	38.2	37.8	38.0	3829	3409	3619	0.40	0.43	0.41
Guard	32.2	29.2	30.7	3279	2963	3121	0.40	0.40	0.40
Karma	42.5	37.7	40.1	3538	3609	3573	0.45	0.41	0.43
Kyle	39.0	35.6	37.3	4250	3745	3998	0.38	0.39	0.39
Majestic	38.1	41.6	39.9	3525	3954	3739	0.42	0.41	0.42
Marshall	37.0	40.0	38.5	3975	3850	3913	0.39	0.41	0.40
Pioneer 2375	36.8	39.0	37.9	3171	3788	3479	0.44	0.41	0.42
Plenty	30.1	37.6	33.8	3146	3663	3404	0.39	0.41	0.40
Roblin	27.3	30.2	28.8	3291	3300	3296	0.36	0.38	0.37

Taber	40.1	46.2	43.1	4196	4163	4179	0.39	0.43	0.41
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Table 16: Effect of cultivar and KCl treatment on leaf diseases at two dates on 15 cultivars of wheat grown on a fine sandy loam soil in 1997.

Cultivar	Disease1			Disease 2		
	Control	KCl	Mean	Control	KCl	Mean
Barrie	2.16	1.83	2.00	2.13	1.87	2.00
CDC Teal	2.50	2.67	2.59	2.10	2.50	2.30
Cora	1.17	2.00	1.59	2.03	1.87	1.95
Domain	2.33	2.33	2.33	2.60	2.73	2.67
Glenlea	2.20	1.71	1.96	1.76	1.69	1.73
Grandin	1.83	2.83	2.33	2.37	2.00	2.19
Guard	2.67	2.17	2.42	2.60	2.33	2.47
Karma	2.67	2.33	2.50	2.47	2.00	2.24
Kyle	2.86	1.60	2.23	2.51	1.96	2.24
Majestic	1.83	2.17	2.00	2.10	2.30	2.20
Marshall	1.83	2.00	1.92	1.63	1.70	1.67
Pioneer 2375	2.17	1.67	1.92	1.93	1.97	1.95
Plenty	2.33	2.17	2.25	2.57	1.80	2.19
Roblin	1.67	1.83	1.75	2.10	2.10	2.10
Taber	2.50	2.17	2.34	1.53	1.80	1.67

1998 Growing Season

Clay Loam Soil

Conditions in 1998 differed from the previous years. Very dry conditions occurred early in the season, leading to concerns of drought. Near the middle of June, rainy conditions began and the season became extremely wet. Flooded conditions occurred in the low spots in the field and disease incidence was high.

Table 17: P-values from ANOVA for effect of cultivar and KCl applications on grain yield, straw yield, harvest index and disease incidence on a clay loam soil (1998)

Source	Grain Yield	Straw Yield	Harvest Index	Disease 1	Disease 2
Treatment	ns	0.0001	0.0001		
Cultivar	0.0001	0.0001	0.0001		
Treat*Cultivar	ns	0.0249	0.0109		
MSE	69108	599394	0.0004		
CV	7.5	11.5	5.9		

Straw yield was reduced and harvest index increased on the clay loam soil by application of KCl when averaged over all cultivars, while grain yield was not affected (Tables 17-19). All three yield parameters varied with cultivar. At the second assessment, disease incidence varied with cultivar but not with treatment. A treatment by cultivar interaction occurred for straw yield and harvest index at the second sampling, indicating that response to KCl application differed among cultivars. Therefore, analysis was conducted for each cultivar separately (Table 18).

Table 18: P-values for analysis of variance for effect of KCl treatment on grain yield, leaf diseases and harvest index of wheat grown on a clay loam soil in 1998.

Cultivar	Grain Yield	Straw Yield	Harvest Index	Disease 1	Disease 2
Barrie	ns	0.0157	0.0130		
CDC Teal	ns	ns	0.0198		
Cora	ns	0.0134	0.0099		
Domain	0.0583	ns	ns		
Glenlea	ns	ns	0.0595		
Grandin	ns	0.0184	ns		
Guard	ns	ns	ns		
Karma	0.0719	0.0306	ns		
Kyle	ns	ns	ns		
Majestic	ns	0.0085	0.0050		
Marshall	ns	ns	ns		
Pioneer 2375	ns	ns	ns		
Plenty	ns	ns	ns		
Roblin	ns	0.0922	0.0563		
Taber	ns	0.0006	0.0052		

Table 19: Effect of cultivar and KCl treatment on grain yield, straw yield and harvest index of wheat grown on a clay loam soil in 1998.

Cultivar	Grain Yield (Kg/ha)			Straw Yield (Kg/ha)			Harvest Index		
	Control	KCl	Mean	Control	KCl	Mean	Control	KCl	Mean
AC Barrie	3021	3050	3036	6260	5113	5687	0.33	0.37	0.35
CDC Teal	3451	3592	3522	5347	4877	5112	0.40	0.43	0.41
Cora	2954	3061	3008	6660	5417	6039	0.31	0.36	0.34
Domain	3560	3474	3517	5657	5320	5489	0.39	0.40	0.40
Glenlea	4121	4006	4064	7790	7093	7442	0.35	0.36	0.36
Grandin	3485	3425	3455	6610	5793	6202	0.35	0.37	0.36
Guard	3802	3761	3782	7837	7067	7452	0.33	0.35	0.34
Karma	3770	4194	3982	5880	7020	6450	0.39	0.37	0.38
Kyle	3411	3337	3374	11917	10867	11392	0.22	0.24	0.23
Majestic	3354	3457	3406	7260	5953	6607	0.32	0.37	0.35

Marshall	3669	3468	3569	5853	5153	5503	0.39	0.40	0.40
Pioneer 2375	3560	3584	3572	5650	5230	5440	0.39	0.41	0.40
Plenty	3454	3820	3637	10417	10580	10499	0.25	0.27	0.26
Roblin	2883	2896	2890	5017	4650	4834	0.37	0.38	0.38
Taber	4060	3910	3985	7157	6027	6592	0.36	0.39	0.38

Grain yield of Karma was increased ($p < 0.0719$) by the application of KCl (Tables 18 and 19). In contrast, Domain showed a decrease in grain yield with KCl application ($p < 0.0583$). In 1996, the only cultivar showing an increase in grain yield with KCl application on the clay loam soil was Karma, while three other cultivars showed decreases in grain yield with KCl. In 1997, a number of cultivars, including Karma showed an increase in grain yield with KCl application on the clay loam soil while Taber showed a decrease. In 1998, straw yield of AC Barrie, Cora, Grandin, Majestic, Roblin and Taber all decreased with application of KCl, while straw yield of Karma increased. AC Barrie, CDC Teal, Cora, Glenlea, Majestic, Roblin and Taber all showed a greater harvest index with application of KCl on the clay loam site.

Table 20: Effect of cultivar and KCl treatment on leaf diseases at two dates on 15 cultivars of wheat grown on a clay loam soil in 1997.

<u>Cultivar</u>	<u>Disease 1</u>			<u>Disease 2</u>		
	<u>Control</u>	<u>KCl</u>	<u>Mean</u>	<u>Control</u>	<u>KCl</u>	<u>Mean</u>
Barrie						
CDC Teal						
Cora						
Domain						
Glenlea						
Grandin						
Guard						
Karma						
Kyle						
Majestic						
Marshall						
Pioneer 2375						
Plenty						
Roblin						
Taber						

Fine Sandy Loam

Growing conditions on the fine sandy loam soil were initially dry, but heavy and frequent rainfall towards the end of June and through July led to high to excess midsummer moisture conditions.

Table 21: P-values from ANOVA table for effect of cultivar and KCl applications on grain yield, disease incidence and harvest index on a fine sandy loam soil (1997)

<u>Source</u>	<u>Grain Yield</u>	<u>Straw Yield</u>	<u>Harvest Index</u>	<u>Disease 1</u>	<u>Disease 2</u>
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Treatment	0.0001	0.0001	ns
Cultivar	0.0001	0.0129	0.0001
Treat*Cultivar	ns	ns	ns
MSE	94493	254145	0.0012
CV	11.8	14.9	7.9

When all cultivars were combined, there was an increase in both grain yield and straw yield with application of KCl (Table 21). This soil tends to be barely adequate in K levels. Therefore, it is possible that under the high moisture conditions occurring in 1998, some of the response on this site could be due to K response. There was no influence of KCl on disease incidence at either date. Cultivar affected grain yield, straw yield and harvest index, but there were no cultivar by treatment interactions. However, information was broken out by cultivar in tables 22 and 23 to provide additional information on the degree of response of the various cultivars.

Table 22: P-values from analysis of variance for effect of KCl treatment on grain and straw yield, harvest index and leaf diseases of wheat grown on a fine sandy loam soil in 1998

<u>Cultivar</u>	<u>Grain Yield</u>	<u>Straw Yield</u>	<u>Harvest Index</u>	<u>Disease 1</u>	<u>Disease 2</u>
Barrie	0.0240	ns	ns		
CDC Teal	ns	0.0028	ns		
Cora	ns	0.0148	ns		
Domain	0.0188	0.0155	ns		
Glenlea	ns	ns	ns		
Grandin	ns	0.0160	ns		
Guard	0.0097	0.0540	ns		
Karma	0.0863	0.0044	0.0777		
Kyle	0.0726	0.0968	ns		
Majestic	ns	0.0893	ns		
Marshall	ns	ns	ns		
Pioneer 2375	ns	ns	ns		
Plenty	ns	0.0468	ns		
Roblin	0.0502	ns	0.0770		
Taber	ns	ns	ns		

Table 23: Effect of cultivar and KCl treatment on grain yield, leaf diseases and harvest index of wheat grown on a fine sandy loam soil in 1998.

<u>Cultivar</u>	<u>Grain Yield</u> (Kg/ha)			<u>Straw Yield</u> (Kg/ha)			<u>Harvest Index</u>		
	<u>Control</u>	<u>KCl</u>	<u>Mean</u>	<u>Control</u>	<u>KCl</u>	<u>Mean</u>	<u>Control</u>	<u>KCl</u>	<u>Mean</u>
Barrie	2417	2798	2608	3200	3513	3357	0.43	0.45	0.44
CDC Teal	2504	2759	2632	3121	3996	3559	0.45	0.41	0.43

Cora	2139	2572	2356	3088	3975	3532	0.41	0.39	0.40
Domain	2396	2955	2676	2804	3454	3129	0.46	0.46	0.46
Glenlea	2496	2616	2556	3412	3833	3623	0.43	0.41	0.42
Grandin	2180	2497	2339	3042	3767	3405	0.42	0.40	0.41
Guard	2481	2890	2686	3025	3471	3248	0.45	0.46	0.45
Karma	2556	3002	2779	2908	3650	3279	0.47	0.45	0.46
Kyle	2002	2472	2237	3029	3683	3356	0.41	0.41	0.41
Majestic	2580	2656	2618	3525	3204	3365	0.45	0.43	0.44
Marshall	2961	2999	2980	3250	3254	3252	0.48	0.48	0.48
Pioneer 2375	2762	2885	2824	3233	3346	3290	0.46	0.46	0.46
Plenty	2428	2576	2502	3592	3933	3763	0.41	0.40	0.40
Roblin	2098	2212	2155	2975	2896	2936	0.42	0.44	0.43
Taber	2948	3221	3085	3704	3542	3623	0.45	0.48	0.46

When cultivars were examined individually, grain yield was increased in AC Barrie, Domain, Guard, Karma, Kyle and Roblin (Table 22-23). Eight cultivars, Teal, Cora, Domain, Grandin, Guard, Karma, Kyle and Plenty showed an increase in straw yield with KCl application, while Majestic showed a decrease in straw yield. In 1997, Majestic also showed a decrease in straw yield with KCl application. Harvest index was decreased by KCl application in Karma and increased with KCl application in Roblin.

Table 24: Effect of cultivar and KCl treatment on leaf diseases at two dates on 15 cultivars of wheat grown on a fine sandy loam soil in 1998.

Cultivar	Disease 1			Disease 2		
	Control	KCl	Mean	Control	KCl	Mean
Barrie						
CDC Teal						
Cora						
Domain						
Glenlea						
Grandin						
Guard						
Karma						
Kyle						
Majestic						
Marshall						
Pioneer 2375						
Plenty						
Roblin						
Taber						

Effect of Rate of Chloride Fertilizer on Biggar Wheat

Rate of KCl fertilizer did not influence any parameter measure when sites were combined (Tables 25 and 26). However there were significant site effects on all parameters except straw yield and a rate by site interaction occurred with grain yield and harvest index, so the two sites were

examined separately (Tables 26 and 27).

Table 25: P-values from ANOVA for effect of KCl rate and soil type on grain yield, straw yield, harvest index and disease incidence (1997)

Source	DF	Heading	Straw Yield	Grain Yield	Harvest Index	Disease 1	Disease 2
Rate	1	ns	ns	ns	ns	ns	ns
Site	1	0.0001	ns	0.0001	0.0001	0.0001	0.0397
Rate*Site	1	ns	ns	0.0365	0.0791	ns	ns
Rep	5	0.0179	ns	0.0810	ns	ns	ns
MSE		344.3	161557	42131	0.000946	0.302	0.2929
CV		11.3	11.72	7.34	6.88	35.33	20.87

Clay Loam soil

On the clay loam soil, grain yield decreased slightly with KCl applications. The highest grain yield was with no applied KCl and the lowest was with the highest level of fertilization (Tables 26 and 27). Dry matter yield at heading, straw yield, harvest index and early disease incidence were not influenced by KCl rate. However, disease late in July was reduced by increasing KCl application.

Table 26: P-values from ANOVA for effect of KCl rate on grain yield, straw yield, harvest index and disease incidence on two soils (1997)

<u>Clay Loam</u>							
Source	D F	Heading	Straw Yield	Grain Yield	Harvest Index	Disease 1	Disease 2
Rate	1	ns	ns	0.0594	ns	ns	0.0528
Rep	5	ns	ns	0.0037	ns	ns	0.0001
MSE		446.3	77858	24085	0.000679	0.0607	0.0409
CV		10.93	8.1	4.76	5.34	28	7.24
<u>Fine Sandy Loam</u>							
Rate	1	ns	ns	ns	ns	ns	ns
Rep	5	0.0004	ns	ns	ns	ns	0.0423
MSE		204	185199	45556	0.0011	0.44696	0.3922
CV		10.6	12.6	9.17	8.08	30.68	26.17

Fine Sandy Loam

None of the parameters measured were influenced by KCl application on the fine sandy loam soil.

Grain yield was substantially lower on the fine sandy loam soil than on the clay loam soil and the low yield potential due to drought may have restricted response to fertilizer additions, in spite of the low soil Cl concentration.

Table 27: Effect of cultivar and KCl treatment on dry matter yield at heading, grain yield, straw yield, harvest index and leaf diseases of wheat grown on a clay loam and fine sandy loam soil in 1997.

Clay Loam

	<u>Rate</u>	<u>Heading</u> (g m ⁻¹)	<u>Straw Yield</u> (kg ha ⁻¹)	<u>Grain Yield</u> (bu acre ⁻¹)	<u>Harvest Index</u>	<u>Disease1</u>	<u>Disease2</u>
	0	191	3242	50.7	0.51	0.77	2.92
	10	205	3379	48.5	0.49	0.92	2.87
	20	188	3654	47.6	0.47	0.93	2.75
	40	191	3442	48.4	0.49	1.00	2.75
	80	191	3488	47.3	0.48	0.78	2.68
<u>Fine Sandy Loam</u>							
	0	134	3330	34.7	0.41	1.83	2.20
	10	132	3480	34.5	0.40	2.50	2.17
	20	136	3217	31.9	0.40	2.50	2.93
	40	142	3757	35.6	0.39	2.17	2.53
	80	131	3300	36.3	0.43	2.17	2.13

Effect of Rate of Chloride Fertilizer on Biggar Wheat (1998)

Rate of KCl fertilizer and site both influenced grain yield, straw yield, and heading yield (Table 28) and a rate by site interaction occurred with harvest index.

Table 28: P-values from ANOVA for effect of KCl rate and soil type on grain yield, straw yield, harvest index and disease incidence (1998)

<u>Source</u>	<u>DF</u>	<u>Heading</u>	<u>Straw Yield</u>	<u>Grain Yield</u>	<u>Harvest Index</u>	<u>Disease 1</u>	<u>Disease 2</u>
Rate	1	0.0022	0.0070	0.0049	ns		
Site	1	0.0001	0.0001	0.0001	0.0001		
Rate*Site	1	ns	ns	ns	0.0401		
Rep	5	0.0362	0.0001	0.0003	0.0140		
MSE		1764	431077	212121	0.0005		
CV		15.7	15.0	12.8	4.8		

Clay Loam soil

On the clay loam soil, heading yield of Biggar was not influenced by rate of KCl fertilization but grain yield ($P < 0.0814$) and straw yield ($p < 0.0154$) both increased with KCl applications. The highest grain and straw yields occurred with the two highest rates of KCl fertilization (Tables 29 and 30) on the clay loam soil, but harvest index also decreased at the two highest levels of KCl application, indicating that increase in straw yield was greater than the increase in grain yield.

Fine Sandy Loam Soil

On the fine sandy loam soil, heading yield, grain yield and harvest index were all influenced by rate of KCl application (Tables 29 and 30). Heading yield increased with 10 kg ha⁻¹ KCl, with a further increase occurring at the 40 kg ha⁻¹ rate. Grain yield increased linearly to 40 kg ha⁻¹ and levelled off between 40 and 80 kg ha⁻¹. Harvest index on this site increased with increasing KCl rate, in contrast to the effect on the clay loam site.

Table 29: P-values from ANOVA for effect of KCl rate on grain yield, straw yield, harvest index and disease incidence on two soils (1998)

<u>Clay Loam</u>							
<u>Source</u>	<u>DF</u>	<u>Heading</u>	<u>Straw Yield</u>	<u>Grain Yield</u>	<u>Harvest Index</u>	<u>Disease 1</u>	<u>Disease 2</u>
Rate	1	ns	0.0154	0.0814	0.0691		
Rep	5	ns	0.0100	ns	0.0001		
MSE		3058	622604	249299	0.000263		
CV		17.2	13.5	12.1	3.9		
<u>Fine Sandy Loam</u>							
Rate	1	0.0005	ns	0.0023	0.0522		
Rep	5	0.0052	0.0001	0.0001	0.0172		
MSE		638	121250	86341	0.00031		
CV		11.9	12.0	9.6	3.43		

Table 30: Effect of cultivar and KCl treatment on dry matter yield at heading, grain yield, straw yield, harvest index and leaf diseases of wheat grown on a clay loam and fine sandy loam soil in 1998.

<u>Clay Loam</u>							
	<u>Rate</u>	<u>Heading</u> (g m ⁻¹)	<u>Straw Yield</u> (kg ha ⁻¹)	<u>Grain Yield</u> (kg ha ⁻¹)	<u>Harvest Index</u>	<u>Disease1</u>	<u>Disease2</u>
	0	305	5730	4068	0.42		
	10	286	5240	3816	0.42		
	20	322	5623	4007	0.42		
	40	335	6177	4354	0.41		
	80	364	6490	4368	0.40		
<u>Fine Sandy Loam</u>							
	0	181	2662	2666	0.50		
	10	209	2888	2925	0.50		
	20	211	2883	3173	0.51		
	40	217	3117	3250	0.52		
	80	244	2988	3273	0.53		

Summary

When all cultivars were combined, grain yield and harvest index were increased by KCl application on both soils, with the greatest effect occurring on the clay loam soil, which contained higher levels of Cl. When cultivars were examined individually, Guard, Karma, Kyle, Marshall and Pioneer 2375 showed an increase in grain yield on the clay loam soil and only Plenty showed an increase on the fine sand loam soil. The grain yield was not associated with increased straw yield or consistently with reduced disease incidence. Only in 1998 was there an increase in grain yield with increasing KCl rate in Biggar on both locations.

The KCl response patterns for cultivars were not consistent from year to year or location to location, although the cultivar Karma showed increased grain yield with KCl addition in five of the six site-years. Due to the inconsistency, prediction of KCl response appears to be a challenge.

Information on crop disease incidence and on grain and tissue nutrient concentrations will be forwarded as the analysis is completed.