

Spring Wheat Cultivar Response to Potassium Chloride Fertilization

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Chloride (Cl) is one of the 17 essential nutrients required for plant growth and development. Chloride plays a major role in plant function, including photosynthesis, enzyme activation, nutrient transport, water movement in cells, stomatal activity, accelerated plant development, reduced lodging, and improved disease suppression and tolerance.

Chloride is a mobile nutrient in the soil like nitrate (NO₃) and as such can move freely with the soil water. Consequently, soil Cl levels can increase or decrease from year-to-year, depending on the water table and landscape position used to collect soil samples. A soil Cl level less than 30 lb/A in the top 2 ft. of soil is generally used as an indication that insufficient Cl is available for optimizing grain yield of cereals. Levels of 30 to 60 lb/A may provide a crop response, while those above 60 lb/A are unlikely to be responsive.

Research across the Great Plains has identified that there is a strong varietal response of cereal crops to soil Cl levels. To evaluate the effect of soil and fertilizer Cl on annual spring wheat cultivars common to western Canada, a trial was conducted at the Agriculture and Agri-Food Canada Brandon Research Centre between 1996 and 1998. A selection of Canadian and adapted American hard red spring wheat varieties, along with Canada Prairie Spring, Canada Extra Strong, and Canada Western Amber Durum varieties, were grown on low to mod-

erate Cl testing soils. The wheat cultivars were grown with and without 40 lb Cl/A applied as KCl. The KCl was applied as a pre-plant spring band.

Two trial sites were used in each of the three years of the study, one a clay loam texture and the other a fine sandy loam texture. Soil Cl levels were low in all years at the fine sandy loam site and in 1996 and 1998 at the clay loam site (**Tables 1 and 2**). A moderate soil Cl level was recorded for the clay loam site in 1997. Soil

Increases in grain yield occurred frequently with potassium chloride (KCl) application, but response patterns for cultivars were not consistent from year to year or location to location.

potassium (K) levels were determined and found to be lower on the fine sandy loam soil (332 lb K/A in 1996, 288 in 1997, and 192 in 1998), relative to the clay loam (732 lb K/A in 1996, 510 in 1997, and 680 in 1998). Response of cultivars to Cl addition were evaluated for their statistical significance and the ability to return C\$1.50 for each C\$1.00 invested in fertilizer (fertilizer economics). Using a wheat price of C\$4.00/bu and C\$0.17/lb for Cl, this worked out to a 2.5 bu/A yield increase.

Few significant differences were observed in the Canadian and U.S. hard red spring wheat cultivars on the sandy loam soil site (**Table 1**). Where significant differences were recorded, addition of Cl did increase grain yields. From a fertilizer economics evaluation, 17 of the 30 cultivar-years (three years x 10 cultivars) showed a positive response to Cl addition, 11 showed no yield difference, and two showed a yield decline of more than 2.5 bu/A (**Table 3**).

The cultivar AC Barrie was the only hard red spring wheat to consistently give an economic response. Other cultivars like Guard showed a significant positive response in 1998, no difference in 1996, and an economic yield loss from Cl addition in 1997. On average, all of the Canadian hard wheat cultivars showed a yield response of more than 2.5 bu/A on this sandy loam soil, while only Pioneer 2375 was responsive amongst the U.S. hard wheat types (**Table 3**).

Significant positive responses were recorded with the Canada Prairie Spring wheat cultivar AC Karma and the Amber Durum cultivars Kyle and Plenty at this fine sandy loam soil site (**Table 1**). While Cl addition resulted in a large positive yield response for AC Karma and Kyle in two

years, both cultivars showed a negative economic response in 1997 (**Table 3**). Results were equally variable among years for Glenlea and AC Taber. These results confirm that crop response to Cl is not specific to low soil Cl levels alone, but is also influenced by the cultivar and the growing season. It is important to note that given the low to medium soil test K levels at the sandy loam site, some of the yield responses recorded could be due to the K applied with the Cl in the KCl fertilizer.

While Cl levels at the clay loam site were low to moderate in all years of the study, few significant grain yield responses were recorded (**Table 2**). Considering all classes of wheat in the study, only seven of the 45 cultivar-years (three years x 15 cultivars) showed a significant positive response,

TABLE 1. Effect of cultivar and KCl treatment on grain yield on a fine sandy loam soil in 1996, 1997 and 1998, Brandon, MB.

Cultivar	Grain yield, bu/A								
	1996			1997			1998		
	-Cl	p>f	+Cl	-Cl	p>f	+Cl	-Cl	p>f	+Cl
Canada Western Red Spring									
AC Barrie	27.1	ns	34.6	37.5	ns	44.5	36.3	*	42.0
CDC Teal	35.0	ns	34.3	32.4	ns	37.3	37.6	ns	41.4
AC Cora	28.8	+	33.8	38.8	ns	37.7	32.1	ns	38.6
AC Domain	28.1	ns	33.1	38.8	ns	37.8	35.9	*	44.3
AC Majestic	29.9	*	40.8	38.1	ns	41.6	38.7	ns	39.8
Roblin	27.1	**	32.0	27.3	ns	30.2	31.5	+	33.2
U.S. Hard Red Spring									
Grandin	37.1	ns	31.6	38.2	ns	37.8	32.7	ns	37.5
Pioneer 2375	32.7	ns	39.3	36.8	ns	39.0	41.4	ns	43.3
Marshall	41.8	ns	41.4	37.0	ns	40.0	44.4	ns	45.0
Guard	28.9	ns	28.9	32.2	ns	29.2	37.2	**	43.4
Canada Prairie Spring									
AC Karma	27.4	*	42.3	42.5	ns	37.7	38.3	+	45.0
AC Taber	35.9	ns	29.9	40.1	ns	46.2	44.2	ns	48.3
Canada Western Extra Strong									
Glenlea	29.3	ns	25.4	33.2	ns	38.0	37.4	ns	39.2
Canada Western Amber Durum									
Kyle	25.2	ns	32.6	39.0	ns	35.6	30.0	+	37.1
Plenty	22.5	+	31.5	30.1	**	37.6	36.4	ns	38.6
Soil test Cl (24 in.)	8 lb/A			10 lb/A			8 lb/A		
ns, +, *, ** represent not statistically significant, and significant at p = 0.10, 0.05, and 0.01, respectively, using orthogonal contrasts.									

TABLE 2. Effect of cultivar and KCl treatment on grain yield on a clay loam soil in 1996, 1997 and 1998, Brandon, MB.

Cultivar	Grain yield, bu/A								
	1996			1997			1998		
	-Cl	p>f	+Cl	-Cl	p>f	+Cl	-Cl	p>f	+Cl
Canada Western Red Spring									
AC Barrie	52.5	ns	51.5	54.7	ns	54.5	45.3	ns	45.8
CDC Teal	56.4	**	51.2	57.3	ns	56.1	51.8	ns	53.9
AC Cora	56.6	ns	56.5	52.6	ns	53.0	44.3	ns	45.9
AC Domain	51.6	ns	52.9	50.8	ns	53.2	53.4	+	52.1
AC Majestic	56.7	ns	59.5	50.2	ns	48.4	50.3	ns	51.9
Roblin	47.6	+	44.0	51.4	ns	48.1	43.2	ns	43.4
U.S. Hard Red Spring									
Grandin	52.6	ns	52.1	60.1	ns	60.5	52.3	ns	51.4
Pioneer 2375	60.3	ns	57.0	59.6	*	66.4	53.4	ns	53.8
Marshall	60.6	*	56.7	61.9	**	67.8	55.0	ns	52.0
Guard	54.4	ns	54.9	57.0	+	62.8	57.0	ns	56.4
Canada Prairie Spring									
AC Karma	57.9	*	66.4	53.8	**	64.0	56.6	+	62.9
AC Taber	60.7	ns	60.3	58.6	+	55.0	60.9	ns	58.7
Canada Western Extra Strong									
Glenlea	57.6	ns	58.8	54.6	ns	59.6	61.8	ns	60.1
Canada Western Amber Durum									
Kyle	61.2	ns	63.9	61.9	*	69.2	51.2	ns	50.1
Plenty	65.2	ns	67.1	68.6	ns	72.5	51.8	ns	57.3
Soil test Cl (24 in.)	8 lb/A			44 lb/A			18 lb/A		

ns, +, *, ** represent not statistically significant, and significant at p = 0.10, 0.05, and 0.01, respectively, using orthogonal contrasts.

while five showed a significant negative response to Cl addition. While AC Barrie showed a strong response to Cl addition at the fine sandy loam location, there was no response on the clay loam soil type. From a fertilizer economics point of view, yield responses were small, with only 12 of the 45 cultivar-years showing a positive response to Cl addition (Table 3). There were seven cultivar-years where Cl addition reduced grain yield by more than 2.5 bu/A, while the difference was less than this in the remaining 26 cultivar-years. On average across the study years, grain yield responses of greater than 2.5 bu/A were only recorded with AC Karma and the two durum cultivars. These results would indicate that while the soil Cl levels were low to moderate at this clay loam soil site, response to KCl addition was con-

siderably less than on the fine sandy loam soil location.

Increases in grain yield occurred frequently with KCl application, but the KCl response patterns for cultivars were not consistent from year to year or location to location. Decreases in crop yield with KCl application occurred in some site-year-cultivar combinations. The reason for the yield depression was uncertain. Consistent increases in grain yield with KCl application occurred in the cultivar Karma, which showed positive response to KCl application in five of the six site-years. Due to the inconsistency in the effects of KCl on grain yield, prediction of KCl response can be a challenge. However, it appears as if some cultivars, such as AC Karma, are more consistent in their response to KCl application than are

TABLE 3. Spring wheat grain yield response to Cl fertilizer (40 lb Cl/A) addition across the sites and years in Brandon, MB.

Cultivar	Fine sandy loam				Clay loam			
	1996	1997	1998	Mean	1996	1997	1998	Mean
Yield response, bu/A								
Canada Western Red Spring								
AC Barrie	7.5	7.0	5.7	6.7	-1.0	-0.2	0.5	-0.2
CDC Teal	-0.7	4.9	3.8	2.7	-5.2	-1.2	2.1	-1.4
AC Cora	5.0	-1.1	6.5	3.5	-0.1	0.4	1.6	0.6
AC Domain	5.0	-1.0	8.4	4.1	1.3	2.4	-1.3	0.8
AC Majestic	10.9	3.5	1.1	5.2	2.8	-1.8	1.6	0.9
Roblin	4.9	2.9	1.7	3.2	-3.6	-3.3	0.2	-2.2
U.S. Hard Red Spring								
Grandin	-5.5	-0.4	4.8	-0.4	-0.5	0.4	-0.9	-0.3
Pioneer 2375	6.6	2.2	1.9	3.6	-3.3	6.8	0.4	1.3
Marshall	0.4	3.0	0.6	1.3	-3.9	5.9	-3.0	-0.3
Guard	0.0	-3.0	6.2	1.1	0.5	5.8	-0.6	1.9
Canada Prairie Spring								
AC Karma	14.9	-4.8	6.7	5.6	8.5	10.2	6.3	8.3
AC Taber	-6.0	6.1	4.1	1.4	-0.4	-3.6	-2.2	-2.1
Canada Western Extra Strong								
Glenlea	-3.9	4.8	1.8	0.9	1.2	5.0	-1.7	1.5
Canada Western Amber Durum								
Kyle	7.4	-3.4	7.1	3.7	2.7	7.3	-1.1	3.0
Plenty	9.0	7.5	2.2	6.2	1.9	3.9	5.5	3.8

the majority of the cultivars evaluated in this study. **BC**

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Phosphorus Index... (continued from page 19)

is shown in **Figure 4**. Results show that the PI for pastures closely predicted annual P loads from pastures receiving natural rainfall and poultry litter applications ($r=0.91$). These results confirm that the PI for pastures predicts P loads well under field conditions with natural rainfall.

Summary

Since P runoff from perennial pastures is predominantly soluble P, the SRP concentration in the source and the amount applied are more important than

the total P content of the source. Validation studies showed the pasture PI predicts annual P losses very well from fields receiving natural rainfall. **BC**

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