NEWS & VIEWS

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Chloride…Can We Close the Book?

FIVE years ago the headlines in a popular western Canadian farm magazine read *'Grain crops don't need chloride fertilizer'*. The journalist based this title on one Manitoba study that indicated crops seldom respond to chloride (Cl) fertilizer. The researcher in that study was quoted, saying "Chloride occasionally produces modest yield increases in wheat and barley…but these responses are infrequent and difficult to predict".

How could this be? U.S. researchers were reporting applied Cl increases wheat yields about 50 percent of the time and increases were typically about 5 bu/A. Their reports were based on some 200 responsive and non-responsive Cl trials conducted in North and South Dakota, Montana, Kansas, and Texas.

Is the Canadian prairie situation that much different from the U.S. Great Plains? The answer to that question: No. New research in the prairies suggests there's really not much difference in how our crops respond to Cl. Knowledge about Cl fertility has increased greatly in the past few years…but we're not quite ready to close the book. There are still some unanswered questions, but we can safely say…*'Grain crops do need chloride fertilizer'*.

Let's review some of the things learned in recent years about soil and plant Cl.

Soil Cl—Cl behaves much like nitrate (NO_3) in the soil. Because both are negatively charged, they're not attracted to clay or organic matter and can move freely with the soil water. That means soil Cl levels can be highly variable and can increase or decrease from year to year, depending on the water table and the location in the landscape.

Saskatchewan research demonstrates how variable soil Cl levels can impact crop response in a gently rolling landscape (**Table 1**).

Table 1. Spring wheat yield response to Cl varies across landscape and from year to year in Saskatchewan.

Slope position	Spring soil Cl lb/A–2 ft	- Cl	+ Cl	Response
		bu/A		
1996				
Shoulder	48	30	35	5
Footslope	30	17	36	19
1997				
Shoulder	84	32	34	2
Footslope	78	34	32	-2

Cl application rate: 19 lb/A
Wheat variety: Columbus

Source: J. Schoenau
University of Saskatchewan

In 1996, Cl did not significantly increase yields in the upper slope positions, but Cl increased yields an amazing 19 bu/A in the lower slope soils. The more moist lower slope soils had greater leaching potential and as a result almost 20 lb less Cl than the upper slopes. However, in 1997 in an adjacent plot area, there was little difference between upper and lower slope soil Cl levels. In fact, soil Cl had doubled from the previous year, likely due to an upward movement of soil water and the result…no yield increase from Cl fertilizer.

Cereals have a high probability of responding to added Cl when soils test less than 30 lb/A in a 2 foot sample. Soils testing between 30 and 60 lb/A may be responsive, but soils with more than 60 lb/A are unlikely to be responsive.

Plant Cl—Cereal crops need 0.4 percent Cl in the whole plant at the boot to flowering stage to achieve their full yield potential. Great Plains research shows yield response occurs about half the time when plant Cl is between 0.12 and 0.4 percent, but it occurs 80 percent of the time when plant Cl concentrations are 0.12 percent or less.

Chloride plays many key roles in plants. It helps with photosynthesis, enzyme activation, and transportation of other plant nutrients, water movement and retention, plant development, lodging prevention and disease suppression. Chloride has also been found to control physiological leaf spotting in some winter and durum wheat varieties and barley.

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Physiological leaf spotting looks like tanspot or septoria, but it's not caused by plant pathogens. In susceptible varieties, its presence indicates Cl deficiency. CDC Kestrel, a high yielding semi-dwarf winter wheat recently released in the prairies, is particularly susceptible to physiological leaf spotting.

Dr. Brian Fowler, a researcher at the University of Saskatchewan Crop Development Centre, has been studying the effect of Cl on physiological leaf spot in winter wheat since 1996 at 3 locations in Saskatchewan. **Table 2** shows how Cl decreased leaf spot in several winter wheat cultivars in 1998.

Table 2. Chloride fertilization decreased physiological leafspot on winter wheat in Saskatchewan in 1998.

	% of flag and flag-1 leaf area damaged					
	Yorkton		Saskatoon		Clair	
Cultivar	-Cl	+Cl	-Cl	+Cl	-Cl	+Cl
CDC Clair	23	13	0	7	43	27
CDC Kestrel	33	17	10	0	67	30
CDC Osprey	20	7	17	7	20	20
Norstar	0	0	0	0	33	10
Norwin	27	30	27	7	33	23

Cl rate: 40 lb/A as KCl broadcast in early spring. (Fowler, unpublished data)

Chloride increased wheat yields an average of 4 percent (55.7 vs 58.1 bu/A) in the above trials in 1998, although yield increases have ranged from 1 to 13 percent during the course of the study.

Research in the U.S. and Canada has consistently shown that not all wheat varieties are sensitive to Cl deficiency. Some respond to Cl and others do not. In fact, a non-responsive variety (i.e. Ketepawa) helps explain the poor results of the Manitoba study mentioned at the beginning of this article.

Suppression of leaf spotting explains Cl response in some wheat varieties, but kernel size and weight appear to be a more constant yield component affected by Cl. For example, Dr. Fowler found, in the study reported in **Table 2**, that Cl fertilization increased grain test weight by 0.5 lb/bu (one percent) and kernel size by 0.35 g/1,000 kernels. Similar observations have been made in U.S. studies.

In an effort to better understand differences in varietal response to applied Cl a large North American study was instigated 3 years ago, with sites in Texas, Kansas, North and South Dakota, and Manitoba. Dr. Cindy Grant, at the Brandon Research Station, has been studying Cl response of 15 spring wheat cultivars in Manitoba on two contrasting soil types; a clay loam and fine sandy loam. Her results show Cl fertilization increased grain yields on both soils, but response was highly variable (**Table 3**). On average, the clay loam was less responsive to applied Cl, but it had moderate levels of soil test Cl in 1997 and 1998, where the fine sandy loam had low levels in each year of the study.

Figure 1 shows how individual cultivars responded to applied Cl. Response patterns were generally not consistent from year to year. Both positive and negative trends were observed. However, results were not always statistically significant due to variability in the data.

Table 3. Average yield increase of 15 spring wheat cultivars in response to Cl fertilization in two Manitoba soils.

	Clay loam		Fine sandy loam	
	Mean	Range	Mean	Range
	- - - - - - - - - - - - - - - bu/A - - - - - - - - - - - - - - -			
1996	0.1	-5.2 to 8.5	3.6	-6.0 to 14.9
1997	2.5	-3.6 to 10.2	1.9	-4.8 to 7.5
1998	0.5	-3.0 to 6.3	4.1	0.6 to 8.3

(Grant, unpublished data)

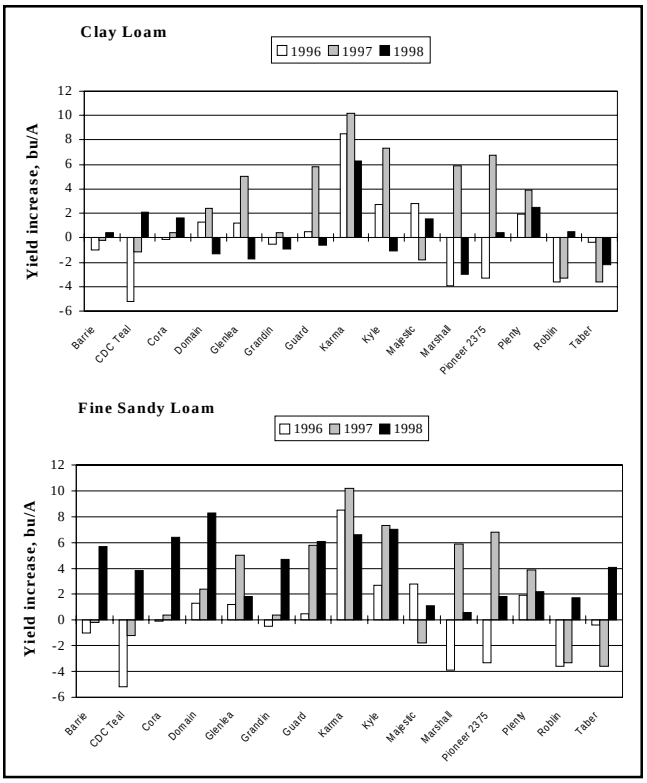

Figure 1. Spring wheat varieties respond differently to Cl fertilization in two Manitoba soils. (Grant, unpublished data)

The above data illustrate the importance of considering fertilizer response data from a long-term perspective. Crops may not respond to fertilization every year, but over time and when conditions are right, the deficient nutrient must be present to optimize production.

Summary

Research in the Canadian prairies shows our cereal crops do respond to Cl fertilization. However, response may vary from one cultivar to another and within the same cultivar from one year to the next. We don't know why response is so variable, but Cl movement in the soil due to changes in the water table, differing disease pressures or other crop stresses may help explain it.

So we're not ready to close the book on Cl…there are still unanswered questions. But, our knowledge is increasing. We can't afford to ignore Cl fertilization. When soil Cl levels are less than 30 lb/A and tissue Cl levels are less than 0.4 percent, the chances of response increase—the lower the Cl levels the greater the probability of response. ■

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