Fertilizer Facts: February 1993 Number 3

Winter Wheat Response to Chloride Fertilizers

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Chloride (CI) has been recognized as an essential nutrient for plant growth since 1954. Chloride is classified as a micronutrient, since plants require only trace amounts for their physiological functions. As soil Cl levels and inputs from rain were considered adequate to meet this requirement, until recently, comparatively little attention was given to CI fertilization. During the mid1980's agronomic researchers in the Great Plains became interested in Cl. Interest developed based on Pacific Northwest studies which showed CI in potassium chloride (KCI) fertilizers increased yield and reduced take-all root rot in winter wheat. In addition, previous investigations in the region, some dating back to the early 1970's, documented small, but significant yield and quality improvements in wheat and barley to KCI additions. This occurred at sites where soil test results indicated seemingly abundant supplies of available K 2O.

Potassium chloride accounts for >95% of all K 2O fertilizer sold in Montana. When a grower applies K fertilizer, either alone or in a blend, Cl is typically applied (1 lbs K 2O/acre = 0.76 lbs Cl/acre from 0-0-62). Spring wheat studies in South Dakota have shown a response frequency to Cl applications of 69, 3 1, and 0% where soil Cl levels (0-24 inch depth) are 0-30, 31-60, and >60 lbs Cl/acre, respectively. In Montana, studies were initiated in 1988 to determine if winter wheat would respond to Cl, and if so, to develop a soil CI test and fertilizer recommendation program. This report provides an update and interpretation of research results to date.

Field experiments were established at nine sites in southcenatal Montana between 1988-1992. Sites 1-2 consisted of two varieties ('Redwin' and 'Cree'), five Cl levels (0, 20, 40, 80 and 120 lbs/acre), and six replications. Sites 3-9 consisted of six varieties ('Redwin', 'Cree', 'Neeley', 'QT-542', 'Weston', and 'Manning'), CI levels (0 and 40 lbs/acre), and four replications. Chloride was applied as KCI in a band approximately 4 inches to the side and 2 inches below the seed row at seeding. Appropriate controls were used at all sites to ensure that reported responses were a result of Cl and not IC Nitrogen and phosphorus were applied at all sites to ensure adequate nutrition of these nutrients.

Chloride significantly increased winter wheat grain yield at seven of nine sites (Table 1). Yield response at these seven sites was frequently small and averaged 4 bu/ acre, or 7% over the control. At six of the seven responsive sites, yield improvement was great enough to increase economic return to the grower, assuming Cl costs $0.16-0.17/lb and a wheat price of $3.00 per bushel. Largest yield responses to 0 occurred at sites 2 and 6. Yield potential and growing season environment differed greatly at these sites. Site 2 was characterized by severe drought (< 2.0 inches growing season precipitation) and high heat stress during grainfill. In contrast, site 6 was characterized by high rainfall (15.7 inches growing season precipitation), and seasonably cool temperatures during grainfill. It appears that Cl responses can occur over a wide range of environments and crop yield potentials (high versus low).

Table 1. Winter wheat yield and mature kernel weights as affected by chloride fertilization in Montana.

Site	Year	County	Varieties#	Yield			1000 Kernel Weight		
				Control	Chloride	Response	Control	Chloride	Response
				bu/a			grams		
1	1988	Rosebud	R,C	27.3	28.1	0.9 *	20.6	23.0	2.4 *
2	1988	Rosebud	R,C	14.3	20.4	6.1 *	15.0	16.8	1.8 *
3	1991	Bighorn	R,C,W,M,Q,N	48.5	50.3	1.7 *	30.6	33.2	2.6 *
4	1991	Bighorn	R,C,W,M,Q,N	77.6	80.6	3.0 *	36.6	38.1	1.5 *
5	1991	Yellowstone	R,C,W,M,Q,N	58.7	60.2	1.6	34.2	34.2	0.0
6	1992	Bighorn	R,C,W,M,Q,N	77.3	86.4	9.1 *	34.2	36.6	2.4 *
7	1992	Bighorn	R,C,W,M,Q,N	64.2	67.8	3.6 *	36.2	38.9	2.6 *
8	1992	Yellowstone	R,C,W,M,Q,N	90.3	91.6	1.3	35.3	36.5	1.2 *
9	1992	Yellowstone	R,C,W,M,Q,N	86.7	90.2	3.4 *	39.3	40.8	1.5 *
		Mean over responsive sites =		56.6	60.5	**4.0**	31.0	33.0	**2.0**

R='Redwin'; C='Cree'; W='Weston'; M='Manning; Q='QT542; N='Neeley'
* Significant response due to Cl application.

Mature kernel weights were increased by Cl at eight of nine sites (Table 1). This occurred most probably because C1 accelerated kernel growth rates. At these eight responsive sites, CI increased mature 1000 kernel weights by an average of 2.0g (454g = 1 lb), or 6.5%. Analysis of spike density, kernels per spike, and kernel weight at several sites suggests that kernel size may be the yield component most frequently affected by Cl. Overall, most of the yield improvement by Cl can be accounted for by Larger kernels at harvest.

Plant Cl levels at the boot stage appear to be useful in diagnosing potentially yield responsive from nonresponsive sites of wheat and barley to Cl fertilizer. Data from the present stud is included with a recent four state Great Plains survey (Figure 1). In this Figure, 'control' treatments refer to wheat or barley not receiving supplemental fertilizer Cl. Three zones of differing CI status can be distinguished: a low range <0.12% Cl, where Cl yield responses observed approximately 80% of the time; a transition range (>0.12 -0.40% CI), containing an approximately equal mix of responsive and non-responsive combinations; and an adequate range (>0.40% Cl) where few significant responses to Cl were observed.

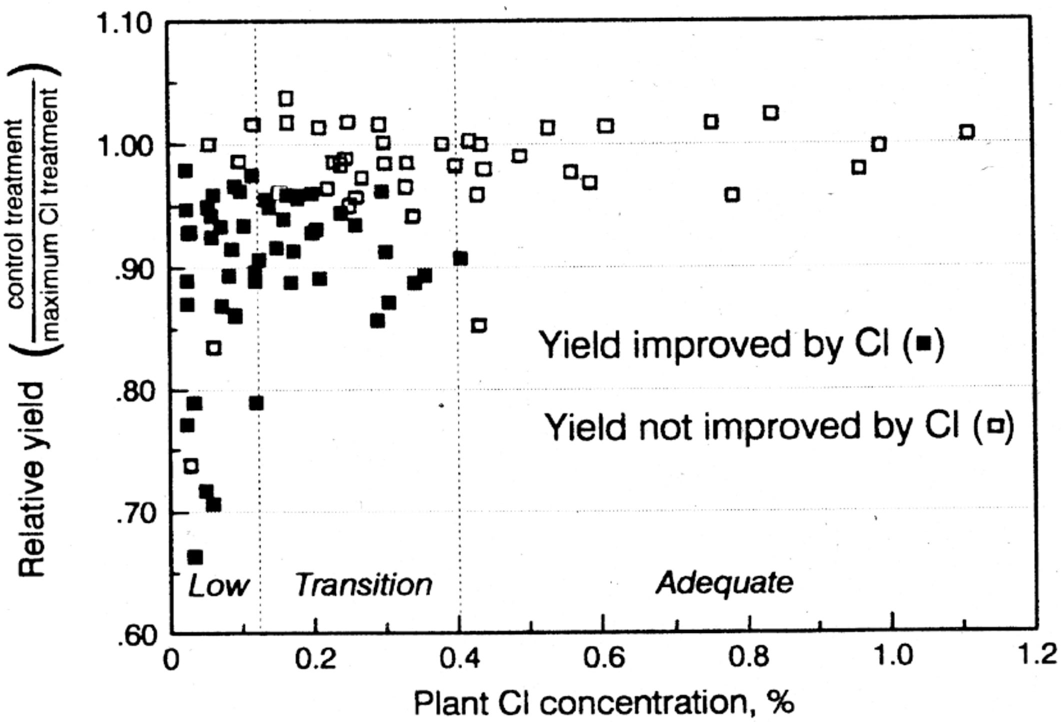

Figure 1. Plant Cl concentration in unfertilizedconrol treatments vs. relative yield in wheat and barley (96 variety x size combinations over four Great Plains states).

Winter wheat Cl uptake and concentration were sensitive to the amount of soil test Cl and fertilizer Cl applied. Plant Cl concentration increas with soil Cl (0-24 inch depth) in this study (Figure 2). Assuming a plant Cl level of 0.40% will ensure adequate Cl nutrition, a critical soil Cl level of 30 lbs/acre Cl (0-24 inch depth) can be defined from the curve. Application of Cl fertilizer should be made according to the following guideline: Fertilizer Cl Requirement (lbs/acre) 30 lbstacre - soil Cl in 0-24 inch depth. The above guideline provides an estimate of Cl requirements by winter wheat based on interpretation of current information. Plant CI concentrations are affected by other by factors including soil CI below 24 inches in the profile, available water-plant relations, plant development stage, and soil nitrate-nitrogen levels. These factors may need to be considered in future updates.

Although, plant Cl and/or soil Cl levels were not reliable predictors of the actual magnitude of the yield response, in most instances (seven of eight sites, or 88% of test locations) use of the fertilizer guideline above would have improved economic return to the grower. Chloride fertilizer sold as 0-0-62, is currently priced at \$0.16 - \$0.17/lb. The material cost of application using the above guideline is comparatively small. In addition, a large percentage of applied fertilizer Cl may be available to succeeding wheat crops under dryland conditions. Only small amounts of Cl are removed in the grain, i.e., < 3 lbs/acre. Chloride in the wheat straw will be recycled and released to the soil as the residue decomposes. Also, as rainfall is comparatively low in Montana, leaching events are infrequent, even though Cl is mobile in soils.

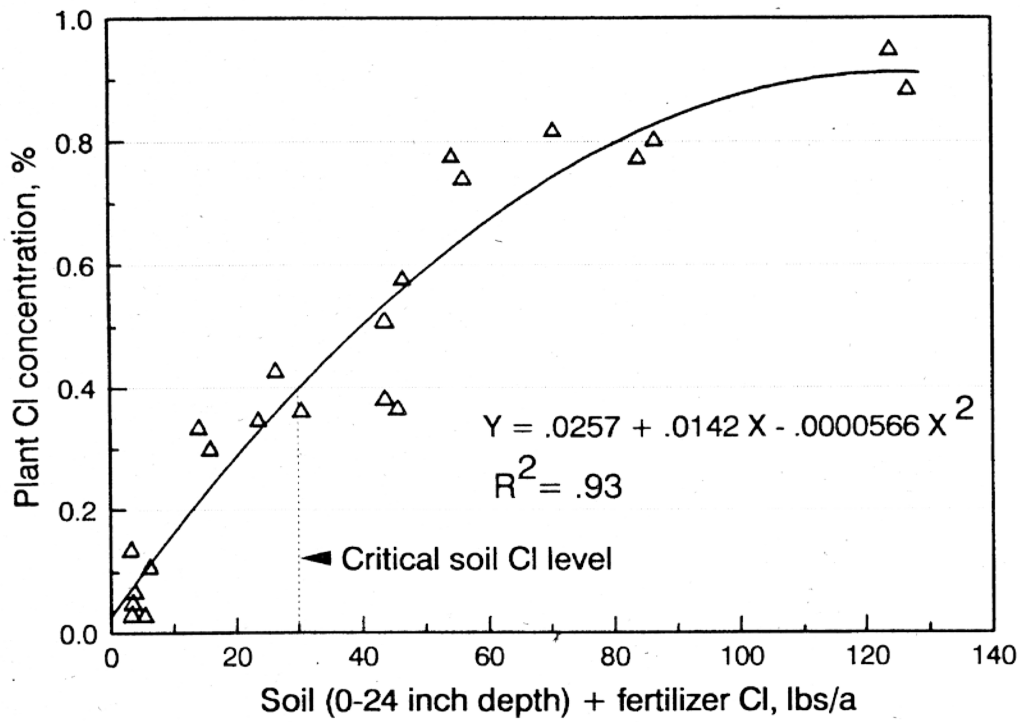

Figure 2. Effect of soil + fertilizer Cl on plant concentration.

Fertilizer Facts

- Chloride is an essential nutrient.
- Chloride fertilizer applications increased yield when soil test levels were <30 lbs/acre in the 0-24 inch depth.
- Chloride increased mature kernel weights.
- Plant Cl levels at the boot stage can be used to diagnosis Cl responsive from non-responsive sites.

(Edited by Jeff Jacobsen, Extension Soil Scientist)