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More Profits With Chloride

University research has demonstrated the benefits of chloride fertilization for crop yields and profitability.

Chloride (Cl) is a recognized essential element for plants but is one that has had a relatively small amount of emphasis compared to other essential nutrients. Since the late '70s, however, a better appreciation has been gained of the role of this nutrient in plant nutrition and plant health, which ultimately translates into improved crop yields and profits. University research has led the way in establishing the importance of Cl in crop production.

Chloride is usually listed as a micronutrient but in reality its essential concentrations in plants are nearly the same as sulfur (S). We would suggest that it should be more correctly classified as a secondary nutrient along with S, magnesium (Mg), and calcium (Ca). Critical levels of Cl in plants are in the 0.20 to 0.25 percent range.

Chloride roles in plant nutrition include 1) acting as a counter-ion for transport of potassium (K), Ca, Mg, and ammonium (NH_4^+) ions, 2) maintenance of cell hydration, and 3) a key role in photosynthesis. Furthermore, research has shown some important positive effects on the suppression of root, stalk, and leaf fungal diseases. Those diseases include suppression of take-all root rot, tan spot, stripe rust, leaf rust, and Septoria in wheat, and stalk rot in corn and grain sorghum. Disease interaction mechanisms are not well understood, but the effects are positive on crop yields and the effects of Cl and crop protection chemicals are additive.

Chloride deficiency symptoms have been observed in wheat (Figure 1), but the intensity changes with varieties. Severe Cl deficiency shows up as chlorotic spotting of the flag leaf, which significantly reduces effective photosynthetic area. Plants may also exhibit leaf tip wilting and bronzing.

In the soil, chloride exists as the negatively charged Cl anion and is readily mobile in the soil, similar to the mobility of nitrate-nitrogen. It moves with the soil water, can be leached like nitrate, and should be managed like nitrate for highest plant availability. Soil tests for Cl are offered upon request by many commercial and university soil test labs. Samples deeper than the

conventional surface soil samples provide a better indication of Cl availability. A 2-foot sample is frequently recommended.

Fine textured soils that have a history of K fertilization with potassium chloride (0-0-60) will likely be high in Cl. Similarly, soils irrigated with high chloride water content will likely show high Cl concentrations. Responses to additional Cl fertilization would not be likely.

For those areas of the North American continent where soils are high in K and K fertilization is not practiced, Cl fertilization may be a very profitable management addition for wheat, corn, grain sorghum, and forage grasses. Some indication of responses in sunflowers has been recorded but little research has been conducted on other broad leaf crops, including soybeans.

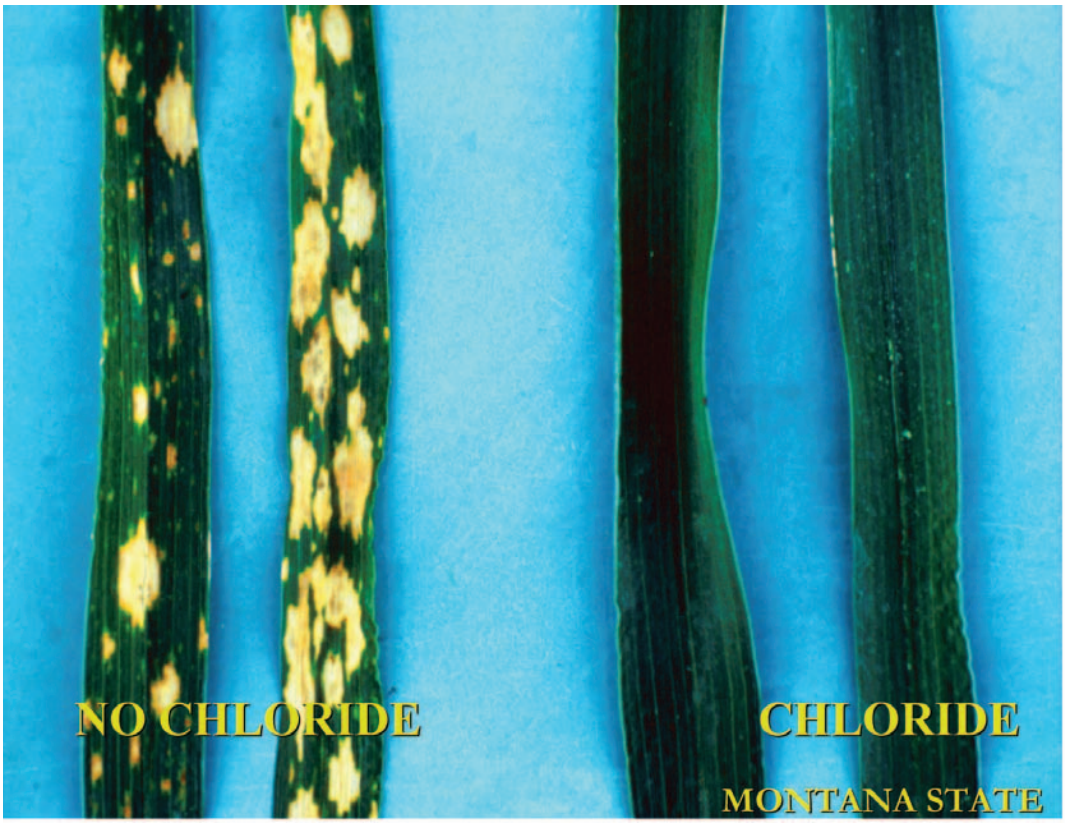

Figure 1. Chloride deficiency symptoms in wheat. Dr. Rich Engel, Montana State University.

Chloride fertilization

Chloride fertilizers include ammonium chloride solution (6% nitrogen (N), 16.5% Cl), potassium chloride solid (45-47% Cl), magnesium chloride solid (75% Cl), and calcium chloride solid (65% Cl). Potassium, magnesium, and calcium chloride can be made available as solutions but with substantially lower Cl concentrations. Limitations of these materials in fluid mixes include potassium nitrate salt out in combination with UAN, and Mg and Ca incompatibility with any traces of P in fluid systems.

Because of soil mobility of Cl, application close to the time of plant need is probably a better management choice. This would include:

- Topdressing of winter wheat along with N and S
- At seeding or preplant applications for spring grains
- Spring preplant, at planting (sidebanded starter), or sidedress applications (along with N and S) for corn, grain sorghum, and sunflowers
- Winter or early spring topdressing with N and S for cool season grasses
- Spring and split applications with N and S for perennial warm season grasses.

Remember that with any application involving fluid P, Mg and Ca, chlorides are not compatible.

Chloride rates in the 20- to 30-lb/A range have been adequate under most conditions. Relatively high salt indices of these materials preclude applications in direct seed contact for small grains or row crops. Starter placement (2x2 or 2x0) for row crops or spring grains has worked well. Closer placements on finer-textured soils, relative to the row, may be possible with precision applicators.

As far as plant availability goes, all of these Cl sources are effective. Once in the soil, Cl is Cl. University research has confirmed that point. Decisions on selection of a material to sell or use have to be based on availability in the market, compatibility with other fluid nutrients with which the material will be mixed, and, of course, price.

Profit maker

Wheat. An earlier Fluid Journal article by Lamond et al. (FJ, Fall 1999) discussed wheat responses to Cl. Recent data continue to substantiate the opportunities for increased yield and profit. For instance, Texas A&M data show how Cl fertilization relates to leaf rust intensity reduction as well as increased yields.

Chloride fertilization of wheat has typically increased yields from 5 to 7 bu/A (Figure 2), which would increase net return around $9 to $16/A at today's prices. Occasionally, yield increases have been as high as 20+ bu/A, but some varieties have produced little response. Soil testing is the best means of estimating where this investment can pay off best. Spring topdressing has proven to be most effective for winter wheat in Kansas and Texas.

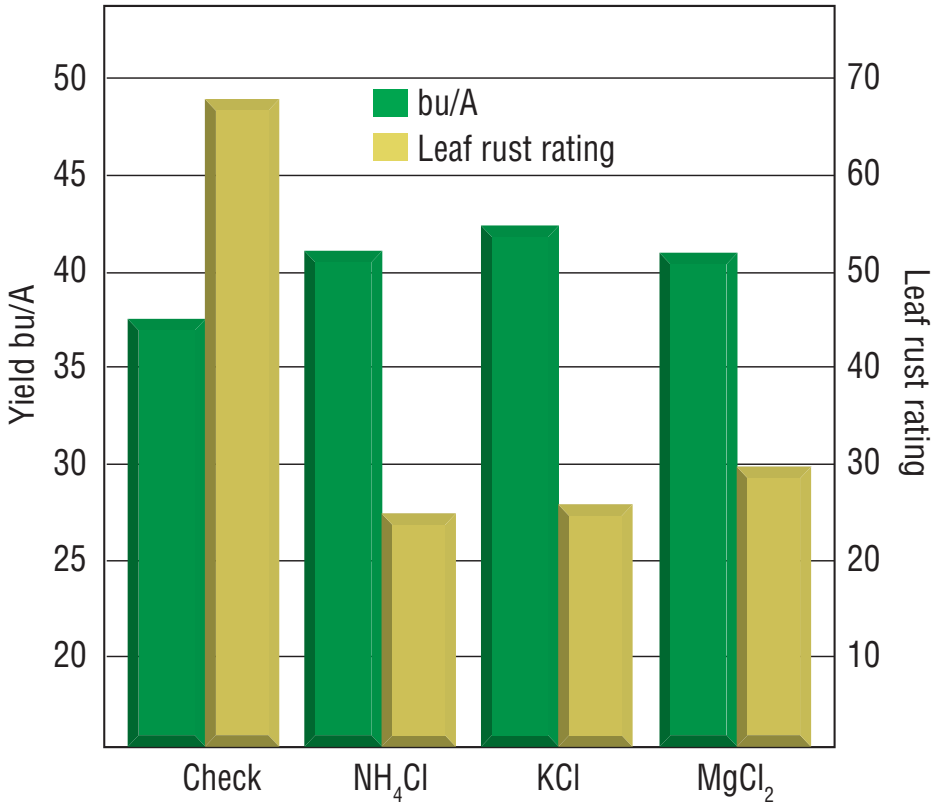

Figure 2. Effect of topdressed chloride on leaf rust and yield in wheat, chloride rate at 40 lbs/A, Hill County, Texas; Miller, Texas A&M.

Table 1. Dryland grain sorghum yield and net return increases from fertilization, Kansas.

	Locations															
Cl rate lbs/A	1		2		3		4		5		6		7		8	
	per acre															
	bu	$	bu	$	bu	$	bu	$	bu	$	bu	$	bu	$	bu	$
20	8	16	6	10	14	34	4	4	10	22	18	46	9	19	16	40
40	12	20	6	2	-3	-25	8	8	13	23	22	50	11	17	17	35

KSU Soil test Cl: low
Sorghum: $3/bu Cl: $0.38/lb

Table 2. Dryland corn yield and net return increases from chloride fertilization, Kansas.

	Locations									
Cl rate lbs/A	1		2		3		4		5	
	per acre									
	bu	$	bu	$	bu	$	bu	$	bu	$
20	19	58	2	-1	12	34	8	20	7	16
40	16	40	10	19	14	33	9	16	4	0

KSU Soil test Cl: low-medium
Corn: $3.50/bu Cl: $0.38/lb

The first ten years of Cl field research were focused on small grains, especially winter and spring wheat, while more recent studies have emphasized the profitability of Cl fertilization for both dryland grain sorghum and corn. Fewer studies have been conducted with irrigated crops because of appreciable quantities of Cl in irrigation water. For both of these row crops, soil test Cl has been the best predictor of Cl fertilization responses. Yield responses have frequently been larger than those recorded for wheat with correspondingly higher net returns per acre.

Most of the studies have been conducted with broadcast

applications of Cl immediately after planting, usually in combination with N solution. However, recent studies have also shown that placement of the same rates beside the row at planting is effective and occasionally more effective than broadcast applications. The compatibility of ammonium chloride solutions with N, P, S and other fluid starter nutrients makes this an attractive means of Cl application when no other nutrient applications are planned.

Grain sorghum. Grain sorghum yield responses to 20 lbs Cl/A on low Cl soils ranged from 4-18 bu/A over 8 locations for an average of 11 bu/A and an average increased return of $25/A. Increasing the Cl rate to 40 lbs/A produced small additional increases in some cases in Kansas State University studies (Table 1).

Corn. Corn yield responses to 20 lbs/A Cl applications on low Cl soils ranged from 4-19 bu/A (average 10 bu/A) with a few additional increases to an additional 20 lbs/A Cl. Returns to the initial 20 lbs Cl on the average were $27/A in these Kansas studies (Table 2).

Summary

In the final analysis, Cl fertilization based on soil testing is an inexpensive way of boosting crop yields, lowering production costs per bushel and increasing grower profitability. Application rates around 20 lbs Cl/A seem to be optimal in most cases. Returns vary with crop, yield level, and prices but are in the $9-$27/A range for wheat, grain sorghum, and corn.

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