# Suppression of Physiological Leaf Spot in Winter Wheat by Chloride Fertilization

By Richard Engel and Paul Fixen

*Physiological leaf spot in Redwin winter wheat and other susceptible varieties was found at low soil chloride (Cl) sites and was greatly suppressed by Cl fertilization.*

**GREAT PLAINS SOIL RESEARCH** has shown that foliar diseases in wheat are sometimes suppressed by Cl fertilization. The list includes leaf rust, tanspot, and Septoria leaf blotch. Recently, Montana studies indicate a "physiologic" leaf spot that appears in certain winter wheat varieties is greatly suppressed by Cl fertilization.

The term "physiologic" is used to describe leaf spots of unknown origin. Lesions typically appear at flag leaf emergence. Symptoms are first apparent on the lower or oldest leaves and progress to successively younger leaves over a 2 to 3 week period. Symptoms are often more severe towards the distal or tip half of the leaf blade. In severely affected plants, lesions coalesce, resulting in premature leaf senescence during the grain-ripening period. Symptoms are described as being similar to tanspot and Septoria leaf blotch diseases, but plant pathogens responsible for these diseases, i.e. *Septoria nodorum* and *Pyrenophora tritici f.* sp. *repentis*, cannot be isolated from affected tissue. Physiologic leaf spot occurrence and severity are dependent on variety selection and plant environment. Specific winter wheat varieties exhibit leaf spot symptoms while other varieties grown at the identical location do not. Also, among susceptible varieties there is great variability in symptoms from one season and locale to the next.

## Susceptible Varieties

Research over a three-year period (1991-1993) revealed three winter wheat varieties (Redwin, Manning, Kestrel) for which leaf spot severity was reduced by Cl fertilization. Other varieties susceptible to physiologic leaf spot and responsive to Cl fertilization probably exist, but have not been demonstrated in research trials. In Montana, Redwin winter wheat is probably the variety most commonly associated with this physiologic leaf spot phenomenon. The first experience with Cl suppression of physiological leaf spot occurred in 1991 at a site near Garryowen, MT, with only 4 lb/A soil Cl (0-24 in. depth). Chloride application as potassium chloride (KCl) had a dramatic and visually obvious effect on leaf spot severity in Redwin and Manning winter wheat. The Cl component in this fertilizer was responsible for the leaf spot suppression since potassium sulfate ($K_2SO_4$) had been

**CHLORIDE APPLICATION and variety affect physiological leaf spotting in winter wheat. Redwin variety is shown here. The plot at left received Cl application; the plot at right shows symptoms on leaves without Cl application.**

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Table 1. Physiological leaf spot severity in flag leaves of several winter wheat varieties as affected by Cl and propiconazole (Tilt).

| | Leaf spot, % | | | |
|---|---|---|---|---|
| | Control | | Propiconazole (Tilt) | |
| Cultivar | -Cl | +Cl | -Cl | +Cl |
| Kestrel | 23.7 | 3.7 | 26.5 | 2.3 |
| Redwin | 7.0 | 0.3 | 5.2 | 0.1 |
| Tiber | 0.2 | 0.1 | 0.0 | 0.0 |

South of Lodgegrass, MT (Bighorn Mtn. Foothills) 1993

applied to the control areas. Initially, these results came as a great surprise.

Because symptoms were similar to tanspot and since Cl had been shown to suppress this disease in South Dakota, we initially believed the response was an example of foliar disease suppression. However, results from more recent investigations now suggest the leaf spot phenomenon is probably not disease related, but a physiological disorder. There are three reasons for this conclusion: 1) application of propiconazole (Tilt) has no effect on leaf spot severity, 2) a causal organism cannot be isolated from affected areas of leaf blades, and 3) Tiber, a Redwin variety selection with leaf spot tolerance, does not exhibit lesion symptoms. See **Table 1**.

### Effect of Available Cl on Leaf Spot Severity

Relationship of physiological leaf spot severity and available Cl at a site south of Lodgegrass, MT (Bighorn Mountain foothills) indicated only small amounts of fertilizer Cl are required to dramatically reduce leaf spot severity. **Figure 1** shows that coincident with a reduction in leaf spot severity is a near linear increase in whole plant Cl concentration. Physiologic leaf spot in Redwin disappears at whole plant Cl concentrations greater than 0.30 percent. The results from this site and five other locations (data not shown) suggest that if physiological leaf spots occur in Redwin winter wheat, there is a high probability the Cl concentration in the plant and/or soil is extremely low.

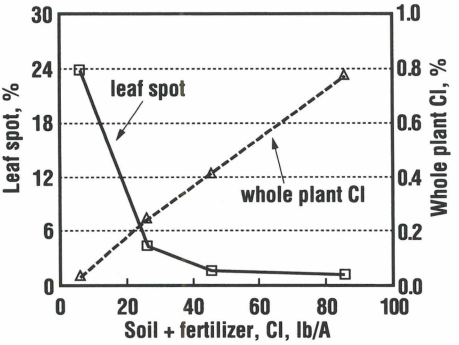
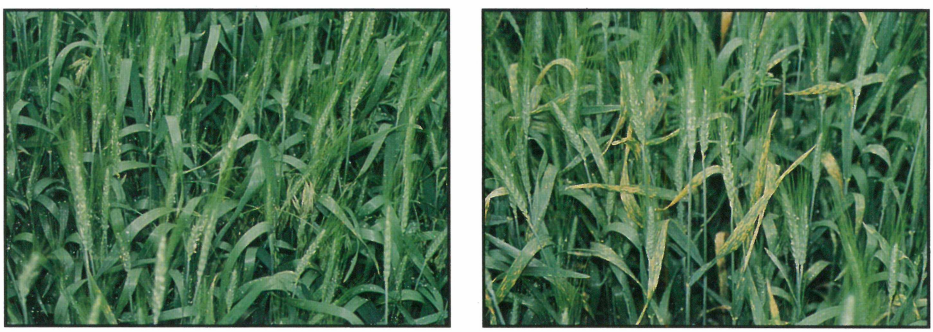



Figure 1. Physiological leaf spot severity and whole plant Cl in Redwin winter wheat as affected by available Cl in soil 0-48 in. plus fertilizer Cl.
South of Lodgegrass, MT. 1993

Low soil or plant Cl status is not a guarantee that physiologic leaf spot will occur in susceptible varieties. We have observed very little spotting even though soil and plant Cl levels were very low (less than 10 lb/A in 0-24 in. depth; less than 0.10 per-



EFFECTS of Cl are shown in these photos of Kestrel variety winter wheat. Plot at left received Cl application; plot at right shows leaf spotting symptoms without Cl.

Table 2. Chloride fertilizer increased grain yield and mature kernel weight in leaf spot susceptible winter wheat varieties.

| Site | Variety | Yield, bu/A | | Mature kernel wt., g/1,000 kernels | |
|---|---|---|---|---|---|
| | | -Cl[1] | +Cl[2] | -Cl | +Cl |
| 1 | Redwin | 47.0 | 49.5 | 28.6 | 31.7 |
| | Manning | 49.5 | 51.6 | 31.5 | 34.0 |
| 2 | Redwin | 82.0 | 94.2 | 33.7 | 36.7 |
| | Manning | 77.9 | 83.8 | 31.7 | 34.1 |
| 3 | Redwin | 56.9 | 62.8 | 33.5 | 36.6 |
| | Manning | 69.8 | 76.4 | 35.7 | 38.8 |
| 4 | Kestrel | 64.5 | 70.5 | 30.5 | 31.3 |
| | Tiber[3] | 64.8 | 66.8 | 33.0 | 34.3 |
| | Redwin | 71.1 | 78.8 | 32.4 | 33.8 |
| | Manning | 53.7 | 60.3 | 28.6 | 30.3 |
| 5 | Redwin | 60.3 | 65.7 | 34.0 | 35.8 |
| Mean | | 63.4 | 69.1 | 32.1 | 34.3 |

Site 1 = Garryowen (1991), 2 = Bighorn Mtn. foothills (1992), 3 = Lodgegrass (1992), 4 = Bighorn Mtn. foothills (1993), 5 = Bighorn Mtn. foothills (1993).

[1]Without applied Cl fertilizer.
[2]40 lb Cl/A at sites 1-3, 60 lb Cl/A at site 4, and mean of 20, 40, and 80 lb Cl/A at site 5, respectively.
[3]Tiber is a Redwin selection, not susceptible to leaf spotting.

cent Cl in whole plant). Other factors appear to play a role in the severity and development of these lesions. To date, our experience indicates that in susceptible varieties, leaf spotting is favored by a combination of low soil Cl, plus prolonged wet and cool weather.

## Grain Yield and Kernel Weight Response to Cl Fertilizer

Chloride fertilization has consistently increased winter wheat grain yield and mature kernel weights at sites with physiological leaf spot, detailed by data in **Table 2**. Yield responses to applied Cl averaged 5.7 bu/A or 9.0 percent, but varied considerably with location. Thousand kernel weight increases from applied Cl averaged 6.9 percent, hence kernel size was probably the most important yield component affected by Cl. Leaf spot suppression by Cl may explain a portion of the yield responses. A reduction in photosynthetic area due to lesion formation, particularly in the flag leaves, could affect yield by reducing kernel size at harvest. Tiber, a Redwin selection not affected by the leaf spotting phenomenon, exhibited a slightly smaller response to Cl at Site 4.

Although Cl rate comparisons have not been included at all locations, research on winter wheat in Montana generally suggests that 30 lb/A of available Cl, fertilizer plus soil (0-24 in. depth) Cl, are required for maximum production. The most common Cl fertilizer is 0-0-60 (KCl). At a price of approximately $145/ton, the nutrient would represent a cost of $0.15/lb Cl. Therefore, the material cost of applying 20-30 lb Cl/A is only $3.00-4.50 if the value of K in the fertilizer is ignored. A grower using this Cl application rate would suppress leaf spotting in susceptible varieties, and realize over a $4.00 return per dollar spent on Cl fertilizer in the first year. In addition, a large percentage of applied fertilizer Cl may be available to succeeding wheat crops under dryland conditions. Only small amounts of Cl absorbed by the wheat plant are translocated to the grain (less than 3 lb/A). Most Cl remains in the straw and is released to the soil as the residue decomposes. As rainfall is comparatively low in much of the wheat belt, leaching events are infrequent even though Cl is mobile in soils.

## Summary

In Montana, a leaf spot of nonpathogenic origin is frequently observed in selected winter wheat varieties. Lesion occurrence appears to be due to genetic background or physiological processes in affected varieties, rather than due to microbial infection. Leaf spot severity is closely associated with soil or plant Cl nutrition. Where leaf spots occur there is a high probability that both soil and plant are low in Cl. Other environmental factors such as high moisture and cool temperatures may contribute to the leaf spot problem. Small and comparatively inexpensive fertilizer Cl applications, perhaps $3.00 to $4.50/A can greatly suppress physiological leaf spot and result in increased yield and profits to the grower. Chloride yield responses can also occur when no leaf spotting is present. ■