POTASSIUM CHLORIDE FERTILIZATION AND COMMON ROOT ROT OF BARLEY

-- AN UPDATE --

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Common root rot (CRR, incited by Cochliobulus sativus) is one of the most widespread diseases of wheat and barley in the Great Plains and Prairie Provinces. Average yield losses, based on extensive surveys in the Prairie Provinces, average around 5% for wheat and 10% for barley, although in individual fields losses can be much higher. Potassium chloride fertilization has been effective in reducing CRR of barley in North Dakota, and I believe we are close to understanding why CRR is reduced by KCl fertilization. Much of our work in this area has been published (Goos, 1986; Goos et al. 1986; Timm et al. 1986). The purpose of this article is to summarize our findings with KCl fertilization and CRR and to suggest a possible theory as to why we are obtaining these responses.

A chloride or potassium effect?

There is little doubt that the effect of KCl fertilization on CRR is a chloride, not a potassium response. Table 1 compares the effect of KCl and K_2SO_4 fertilization on CRR of barley. Significant reductions in CRR were only observed with KCl fertilization. Yield increases at one site were only observed with KCl fertilization. Total potassium contents of plant tissues from plots not receiving KCl have always been in the "adequate" to "high" range in our research trials, and adding KCl fertilizer has had little influence on plant total K levels. Our

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research has been conducted on soils testing "very high" in exchangeable K. We are confident our KCl responses have been chloride, not potassium, responses.

Table 1. Effect of potassium source and rate on CRR severity of barley at the late milk or early dough stage of growth, and grain yield. Western North Dakota, 1983.

Potassium		Site			
Rate	Source	Minot	Williston	Powers Lake	Powers Lake
lb K_2O/A		----- Disease Severity Index[1] ----			--- bu/A --
0	-	2.3	3.6	3.2	58.8
25	KCl	2.0*	3.2*	3.0	63.6
100	KCl	2.1*	3.6	2.6*	65.8*
25	K_2SO_4	2.4	3.6	3.2	61.4
100	K_2SO_4	2.3	3.7	2.9	59.8

[1] 1 = none, 2 = slight, 3 = moderate, 4 = severe disease.
* Significantly different from the control.

Chloride responses - why?

There should be no doubt chloride responses are real. Agronomic responses have now been observed in western Oregon, North and South Dakota, as well as in Canada and other countries. Crops involved have included wheat, barley, corn, potatoes, and celery. The major hurdle, in my opinion, is to understand why chloride responses are occurring. When we understand why responses are occurring on a particular crop it will be easier to predict when chloride responses are likely and other management factors would be more self-evident.

Chloride response in North Dakota - why?

We are currently of the opinion that response to chloride fertilization in North Dakota is indirect. That is, we have no hard evidence of true chloride deficiencies. Rather, we feel our crop responses to chloride have been due to repression of crop disease. We have not

obtained a yield increase from chloride fertilization without first having measured repression of a plant disease. We have not been able to delineate a specific "critical level" of soil Cl. Table 2 indicates that we have had many sites with less than 50 lb of soil Cl/A with no yield response. Indeed, in winter wheat trials we have observed sites with essentially zero chloride in the 0-2 foot layer and have not obtained a yield response from KCl fertilization.

Table 2. Summary of effects of KCl fertilization on common root rot and grain yield. North Dakota, 1984-1986.

Site	Crop	Soil chloride level	CRR repression?	Yield response?
		lb Cl/A·2 ft		
1984				
Minot	Barley	36	Yes	No
Powers Lake	Barley	18	Yes	Yes
Williston	Barley	18	Yes	No
1985				
Minot	Durum	16	Yes†	No
Flaxton	Durum	15	No	No
Williston	Durum	22	No	No
Fortuna	Durum	160	No	-
1986				
Carrington	Barley	79	Maybe‡	No
Minot	Barley	20	No	No
Underwood++	Barley	4	Maybe	Yes
Stanley	Barley	2	Yes	Yes
Williston fallow	Barley	63	No	No
Williston recrop	Barley	12	Yes	Yes

† CRR repressed early in the season, not later.

‡ A trend for a response, but only marginally significant.

++Spot blotch was significant at this site and there could have been spot blotch repression.

A clue as to why chloride fertilization reduces CRR may be found in how chloride affects the nitrogen nutrition of the plant (and pathogen). We routinely measure dramatic effects of KCl fertilization on plant nitrate content (Table 3). We also have documented that CRR-resistant barley varieties accumulate less nitrate than susceptible varieties. Thus, CRR severity seems to be very closely related to the nitrate content of the plant (Figure 1). The role of chloride seems to be in reducing plant nitrate content, which in turn reduces plant predisposition to CRR. This finding is consistent with a recent study in Oregon (Christenson and Brett, 1985) which demonstrated that chloride fertilization reduced take-all root rot only when the chloride was effective as a nitrification inhibitor. Our future studies will attempt to confirm this theory.

Table 3. Effect of KCl fertilization on nitrate content of barley culms at heading. North Dakota, 1986.

KCl rate	Plant NO_3-N						
	Carrington	Underwood	Minot	Stanley	Williston fallow	Williston fallow	Average
kg/ha	---------- mg/kg ----------						
0	4437	3937	3212	4245	3772	1540	3523
200	3932	1804	2235	2516	2319	950	2292

Literature Cited

Christenson, N. W., and M. Brett. 1985. Chloride and liming effects on soil nitrogen form and take-all of wheat. Agron. J. 77:157-163.

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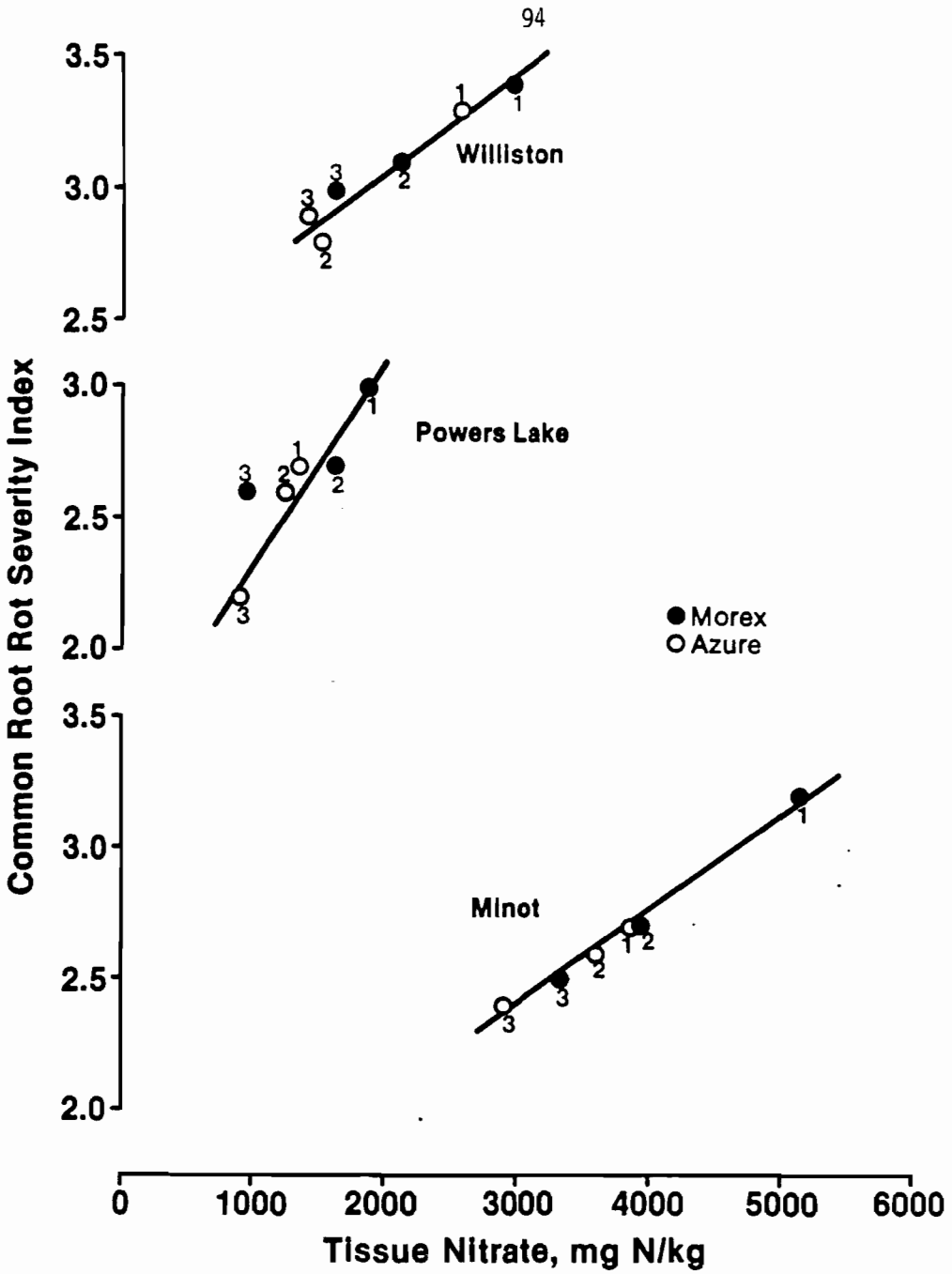

Figure 1. Relationship between the nitrate content of barley culms and common root rot of two barley varieties. Numbers by data points refer to KCl rate: 1 = 0, 2 = 42, and 3 = 167 lbs of KCl/Acre. Western North Dakota, 1984.

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