INTERPRETIVE SUMMARY - 1990

Project: MB-2 Leader: D. Flaten

Assessing the Chloride Fertilizer Requirements of Barley and Wheat Grown on Manitoba Soils

Chloride (Cl) responses in soils testing low in Cl have been demonstrated, but results have been inconsistent. Yield increases have been apparent at some sites without reductions in plant disease and in other sites reductions in plant disease were apparent without any effect on grain yield. These discrepancies may be due to varietal differences. This years results have indicated that some cultivars of wheat and barley are more responsive Cl fertilization than others. As the question of which variety responds best to Cl fertilization becomes unraveled, soil test recommendations can be made with greater confidence and less risk to farmers.

1990/91 Annual Report to the Potash and Phosphate Institute

Assessing the Chloride Fertilizer Requirements of Barley and Wheat Grown on Manitoba Soils

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Project leader: Dr. Don Flaten, Associate Dean, Faculty of Agriculture

Coinvestigators: Ramona Mohr, Graduate Student (M.Sc.)
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Locations of Research: Field trials were in south central Manitoba at Anola, Carman, Darlingford, Portage and Winnipeg.

Objectives: To determine the effects of chloride fertilizers on growth, disease severity and yield of barley and wheat

Results and Conclusions:

Field Trials

a) Effect of Chloride Fertilization on Bedford Barley and Katepwa Wheat

Chloride fertilization field trials were conducted at five sites in Southern Manitoba that tested low (<66 kg Cl^- ha^{-1} to 60 cm) to very low (<33 kg Cl^- ha^{-1}) in chloride. Experiments were conducted in 1989 and 1990 to evaluate the benefits of applying chloride fertilizer to Bedford barley and Katepwa wheat.

A randomized complete block experimental design was used at all sites. At Carman, Portage and Winnipeg (U of M campus), a factorial experiment consisting of three rates of broadcast chloride (0, 25 and 50 kg Cl^- ha^{-1}), two sources of chloride (KCl and NaCl) and two common root rot inoculation treatments (with and without) was used. Two additional treatments of 25 kg Cl^- ha^{-1} as KCl placed in the seedrow were included in the experiment. Treatments were replicated six times. The Carman and Portage sites included both Bedford barley and Katepwa wheat as test crops while the campus site included only Bedford barley. A second site on the campus also included Bedford barley but was used for a spot blotch inoculation study with similar fertilizer treatments as for the common root rot study.

At Anola and Darlingford, a factorial experiment consisting of three rates of broadcast chloride (0, 25 and 50 kg Cl^- ha^{-1}) and two sources of chloride (KCl and NaCl) was conducted. An additional treatment of 25 kg Cl^- ha^{-1} as KCl placed in the seedrow was included. Five replications were employed and Katepwa wheat was used.

At Carman, Portage and on-campus sites, plant counts at the one to three leaf stage, dry matter yields, plant tissue Cl, K, NO_3, NH_4, Cu, Mn and Zn levels, disease severity ratings, grain yield, thousand kernel weights, hectolitre weights, and barley plumpness were determined. Similar measurements were determined at Anola and Darlingford, except that plant tissue K, Cu, Mn and Zn levels and disease severity ratings were excluded.

In the spot blotch study on campus, there was no effect of chloride on the incidence or severity of the disease. There was, however, a significant (P=0.05) increase in yield as a result of chloride fertilization in 1989. At the Carman, Portage and campus sites where common root rot inoculum was applied, inoculum reduced plant counts but did not result in a consistent increase in the severity of common root rot. However, within the two year period during which this study has been conducted, the application of chloride to barley resulted in a significant (P=0.05 level) decrease in the severity of common root rot at Carman in 1990 and at the Point in 1989. Common root rot in Katepwa wheat was significantly (P=0.05 level) reduced at Carman in 1990. These significant decreases in common root rot did not result in significant increases in yield, however. A significant (P=0.05 level) increase in barley grain yield for the 50 kg Cl^- ha^{-1} treatment over the control treatment was observed in the common root rot study on the campus in 1990. However, in this plot, there was no significant decrease in common root rot as a result of chloride fertilization (Tables 1 to 3.) The application of chloride increased chloride content of plant tissue, however its effects on grain quality appear to be negligible. The effect of chloride application on nitrate concentration of plant tissue was inconsistent (Tables 4 and 5). Statistical and laboratory analyses are continuing at present.

b) Effect of Variety on Response to Chloride Fertilizer

As noted in last year's annual report, the low frequency of chloride response in the University of Manitoba trials may be a result of the cultivars of wheat and barley being used. Therefore, experiments comparing several wheat and barley varieties trials were conducted in 1990. A factorial experiment consisting of four cultivars, two rates (0 and 50 kg Cl^- ha^{-1}) and two sources (KCl and NaCl), with six replications was used. The barley variety trial was conducted at Portage using the cultivars Bedford, Heartland, Brier and Argyle. The wheat trial conducted at Anola included Katepwa, Marshall, Roblin and Biggar spring wheats. Measures taken included dry matter yield, Cl, NO_3^- and NH_4^+ concentrations in plant tissue, grain yield, thousand kernel weight, hectolitre weight, and barley plumpness.

Preliminary results indicate that certain cultivars may be more responsive than the Katepwa wheat and Bedford barley which have been used in studies to date. Chloride application increased yields of Roblin and Marshall wheat more than that of Katepwa and Biggar and increased yield of Heartland more than those of Bedford, Brier and Argyle (Table 6). The application of chloride increased chloride concentration of plant tissue, but did not affect nitrate in a consistent manner (Table 7). Of interest, however, is that the application of chloride tended to reduce the nitrate levels in both Marshall wheat and Heartland barley as has been noted in other cereal cultivars that respond to chloride fertilizer. Effects of chloride on grain quality appear negligible (Table 8).

Growth Chamber Studies

A growth chamber experiment was conducted from January to June of 1990 with the objective of determining the effect of chloride fertilization on yield, disease pressure and nutrient uptake of Bedford barley grown in a controlled environment on a soil testing very low in chloride (0.8 mg kg^{-1}).

A chloride nutrition study consisting of a completely randomized design of five replicates of five treatment (0, 5, 10, 20 and 40 ug g^{-1} Cl^-) was carried out. Concurrently, in the same growth chamber, a common root rot study consisting of a completely randomized design of five replicates of treatments of 0 and 40 mg Cl^- kg^{-1} soil with or without common root rot inoculum was conducted.

Plant counts were taken at the three leaf stage. At approximately boot stage, fresh weights, oven dry weights, tiller counts, plant height and plant stage (Feekes scale) were determined. Plant samples collected at boot stage were analyzed for Cl^-, NO_3, NH_4, total N, Cu, Mn, Zn and K. At the soft dough stage, fresh weights, oven dry weights, moisture content of the heads and common root rot ratings were conducted. At maturity, fresh weights, oven dry weights of straw and grain and head counts were taken.

During later stages of crop development, severe physiological leaf spotting occurred. This problem may well have affected the results obtained from this experiment, thus only trends apparent in the data will be commented on. The addition of chloride appeared to reduce both nitrate and total nitrogen (Kjeldahl) in plant tissue collected at boot stage. The addition of chloride did not appear to produce a consistent increase in grain yield but may have resulted in a slight decrease in common root rot severity. A complete set of data from these studies will be included in Ms. Mohr's thesis.

Planned Changes for 1991:

If finances are sufficient, a third year of field studies may be conducted. However, future investigations should focus on the differential responses of Canadian wheat and barley cultivars to chloride fertilizers. The yield response to chloride fertilizer applied to Katepwa wheat and Bedford barley trials was infrequent, but the yield response to chloride differed among cultivars observed in the 1990 variety trials. Cultivar has been cited as an important factor determining the probability of obtaining a yield response to chloride. Therefore, a characterization of Manitoba's popular cultivars in terms of their responsiveness to chloride may enhance our ability to predict the occurrence of a yield response to chloride. Field trials using four cultivars of wheat or barley, three rates (0, 25 and 50 kg ha^{-1} Cl^-) and two sources (KCl and NaCl) would be established at various sites testing low in chloride. Measures taken would be similar to those conducted to date.

Table 1: Effect of Chloride Fertilization and Common Root Rot (CRR) Inoculum on Yield of Katepwa Wheat

kg ha^{-1} Cl^- Applied	Cl^- Source*	CRR Inoculum Applied	Grain Yield (kg ha^{-1}) at 14% moisture			
			Carman	Portage	Anola	Darling-ford
0	KCl	-	4038	4203	2520	4034
25	KCl	-	3850	4356	2544	4257
50	KCl	-	4072	4363	2389	4306
0	NaCl	-	3979	4407	2476	4543
25	NaCl	-	4065	4381	2300	4351
50	NaCl	-	3749	4111	2267	4264
25	KCl (SR)	-	3882	4397	2459	4343
0	KCl	+	3695	4052		
25	KCl	+	3720	4176		
50	KCl	+	3495	3944		
0	NaCl	+	3448	3980		
25	NaCl	+	3482	4059		
50	NaCl	+	3394	3741		
25	KCl (SR)	+	3621	3936		

*SR indicates seedrow placed fertilizer treatments. All other treatments were broadcast.

Table 2: Effect of Chloride Fertilization and Common Root Rot (CRR) or Spot Blotch (SB) Inoculum on Yield of Bedford Barley

kg ha^{-1} Cl^- Applied	Cl^- Source*	CRR or SB Inoculum Applied	Grain Yield (kg ha^{-1}) at 14% moisture			
			Carman (CRR)	Portage (CRR)	U of M - Point	
					CRR	SB
0	KCl	-	4325	4949	5500	6269
25	KCl	-	4408	5197	5770	6271
50	KCl	-	3970	5110	6286	6507
0	NaCl	-	3975	5227	5713	6107
25	NaCl	-	3896	5180	5747	6429
50	NaCl	-	4639	5482	6217	6202
25	KCl (SR)	-	4246	5262	5745	
0	KCl	+	4300	5076	5181	5867
25	KCl	+	4768	5141	5728	6034
50	KCl	+	4376	4999	5668	6062
0	NaCl	+	4516	5004	5393	6169
25	NaCl	+	4234	4930	5274	6272
50	NaCl	+	4376	4786	5575	6327
25	KCl (SR)	+	3835	4855	5293	

*SR indicates seedrow placed fertilizer treatments. All other treatments were broadcast.

Table 3: Effect of Chloride Fertilization and Common Root Rot (CRR) Inoculum on Common Root Rot Severity of Katepwa Wheat and Bedford Barley

kg ha^{-1} Cl^- Applied	Cl^- Source*	CRR Inoculum Applied	Common Root Rot Severity (1 to 4 rating scale)**				
			Bedford Barley			Katepwa Wheat	
			Carman	Portage	U of M	Carman	Portage
0	KCl	-	2.48	3.16	3.44	2.42	3.17
25	KCl	-	2.49	3.09	3.54	2.57	3.20
50	KCl	-	2.20	3.21	3.46	2.4	2.99
0	NaCl	-	2.63	3.17	3.40	2.75	2.95
25	NaCl	-	2.29	3.14	3.36	2.53	2.93
50	NaCl	-	2.23	3.13	3.42	2.33	3.11
25	KCl (SR)	-	2.33	3.15	3.61	2.32	3.07
0	KCl	+	2.45	3.05	3.71	2.71	3.14
25	KCl	+	2.24	3.06	3.54	2.38	3.11
50	KCl	+	2.47	3.11	3.63	2.53	2.89
0	NaCl	+	2.62	3.09	3.70	2.60	3.03
25	NaCl	+	2.45	3.08	3.44	2.57	2.92
50	NaCl	+	2.37	3.13	3.62	2.34	3.07
25	KCl (SR)	+	2.53	2.92	3.53	2.67	2.93

* SR indicates seedrow placed fertilizer treatments. All other treatments were broadcast.

** Disease classes based on severity of lesions on subcrown internodes: 1=clean, 2=slight, 3=moderate, 4=severe (Ledingham et al., 1973)

Table 4: Effect of Chloride Fertilization and Common Root Rot (CRR) Inoculum on Chloride and Nitrate Concentration of Katepwa Wheat

kg ha^{-1} Cl^- Applied	Cl^- Source*	CRR Inoculum Applied	Midseason Plant Tissue Concentration ($\mu g\ g^{-1}$)					
			Carman		Portage		Anola	Darling-ford
			Cl^-	NO_3^-	Cl^-	NO_3^-	Cl^-	Cl^-
0	KCl	-	1104	2749	5701	2263	2750	2799
25	KCl	-	6734	2741	6955	2260	5080	4261
50	KCl	-	7869	2355	8542	1657	5045	5621
0	NaCl	-	2953	3338	5257	2459	2108	2951
25	NaCl	-	5766	2762	7372	2028	4312	4875
50	NaCl	-	6837	1890	7429	1881	6096	5925
25	KCl (SR)	-	5056	2803	7135	2080	4465	5320
0	KCl	+	1663	3437	5406	2238		
25	KCl	+	6223	2681	7088	2084		
50	KCl	+	7358	2268	7645	1819		
0	NaCl	+	1566	3675	5417	2204		
25	NaCl	+	6023	2797	6580	1996		
50	NaCl	+	8646	2364	7041	1991		
25	KCl (SR)	+	4748	2900	7042	2036		

*SR indicates seedrow placed fertilizer treatments. All other treatments were broadcast.

Table 5: Effect of Chloride Fertilization and Common Root Rot (CRR) or Spot Blotch (SB) Inoculum on Chloride and Nitrate Concentrations of Bedford Barley

kg ha^{-1} Cl^- Applied	Cl^- Source*	CRR or SB Inoculum Applied	Midseason Plant Tissue Concentrations ($\mu g\ g^{-1}$)							
			Carman		Portage		U of M - Point			
							Common Root Rot		Spot Blotch	
			Cl^-	NO_3^-	Cl^-	NO_3^-	Cl^-	NO_3^-	Cl^-	NO_3^-
0	KCl	-	1862	4450	7159	2824	981	2544	1170	2055
25	KCl	-	6418	4600	9495	2982	6327	2671	2351	2006
50	KCl	-	9905	4583	12408	1722	10465	2814	3437	1528
0	NaCl	-	2048	5400	6672	2676	1046	2948	980	1791
25	NaCl	-	6198	5430	9565	1940	6575	2792	2932	2198
50	NaCl	-	8782	4651	12103	3025	12876	2649	4103	1538
25	KCl (SB)	-	5896	5040	8287	1929	3796	2555		
0	KCl	+	1976	5267	6669	3056	977	2817	1123	2138
25	KCl	+	4099	4115	11335	2554	6159	1882	2263	1881
50	KCl	+	9421	3767	12254	2518	12271	2272	3453	1763
0	NaCl	+	2400	5635	7151	3522	971	2890	1099	1707
25	NaCl	+	5845	5464	10496	2872	6045	2612	2707	1750
50	NaCl	+	8463	4629	12020	1930	12308	2681	3916	1617
25	KCl (SR)	+	5395	5815	9836	3030	4338	3006		

*SR indicates seedrow placed fertilizer treatments. All other treatments were broadcast.

Table 6: Effect of Chloride Fertilization on Yield of Four Wheat and Four Barley Cultivars

kg ha^{-1} Cl^- Applied	Cl^- Source	Wheat Trial - Anola		Barley Trial - Portage	
		Cultivar	Grain Yield at 14% moisture (kg ha^{-1})	Cultivar	Grain Yield at 14% moisture (kg ha^{-1})
0		Katepwa	2684	Bedford	6036
50	KCl	Katepwa	2762	Bedford	5852
50	NaCl	Katepwa	2819	Bedford	5824
0		Roblin	2689	Brier	6100
50	KCl	Roblin	3070	Brier	6784
50	NaCl	Roblin	3294	Brier	6348
0		Biggar	2595	Argyle	5701
50	KCl	Biggar	2731	Argyle	6196
50	NaCl	Biggar	2514	Argyle	5741
0		Marshall	3195	Heartland	4966
50	KCl	Marshall	3552	Heartland	5666
50	NaCl	Marshall	3668	Heartland	6075

Table 7: Effect of Chloride Fertilization on Plant Tissue Chloride and Nitrate Concentration of Four Wheat and Four Barley Cultivars

kg ha^{-1} Cl^- Applied	Cl^- Source	Wheat Variety Trial - Anola			Barley Variety Trial - Portage		
		Cultivar	Plant Tissue Concentration ($\mu g\ g^{-1}$)		Cultivar	Plant Tissue Concentration ($\mu g\ g^{-1}$)	
			Cl^-	NO_3^-		Cl^-	NO_3^-
0		Katepwa	2378	1501	Bedford	6120	2514
50	KCl	Katepwa	8013	1016	Bedford	13788	2051
50	NaCl	Katepwa	6870	1295	Bedford	13457	2572
0		Roblin	2005	1155	Brier	6547	2534
50	KCl	Roblin	6015	897	Brier	15298	2532
50	NaCl	Roblin	6049	1204	Brier	15215	2620
0		Biggar	2645	2211	Argyle	7033	2634
50	KCl	Biggar	8945	1896	Argyle	15881	3148
50	NaCl	Biggar	9448	2437	Argyle	15436	2789
0		Marshall	2640	2236	Heartland	5523	3022
50	KCl	Marshall	9248	1812	Heartland	15778	2620
50	NaCl	Marshall	8850	1720	Heartland	14863	2562

Table 8: Effect of Chloride Fertilization on Grain Quality of Four Wheat and Four Barley Cultivars

kg ha^{-1} Cl^- Applied	Cl^- Source	Wheat Variety Trial - Anola			Barley Variety Trial - Portage				
		Cultivar	g/1000 kernels (14% moisture)	kg hL^{-1} (14% moisture)	Cultivar	g/1000 kernels (14% moisture)	kg hL^{-1} (14% moisture)	% thin kernels	% plump kernels
0		Katepwa	33.24	79.8	Bedford	36.06	68.8	34.8	59.9
50	KCl	Katepwa	32.80	79.7	Bedford	36.48	68.3	37.5	55.9
50	NaCl	Katepwa	32.52	79.3	Bedford	36.05	67.5	42.5	50.4
0		Roblin	33.52	77.7	Brier	39.21	63.7	37.2	55.2
50	KCl	Roblin	35.40	78.7	Brier	38.48	63.6	36.3	56.8
50	NaCl	Roblin	35.71	79.4	Brier	38.92	62.9	37.8	53.4
0		Biggar	32.92	75.3	Argyle	36.20	63.8	24.7	69.7
50	KCl	Biggar	33.43	75.2	Argyle	36.47	63.7	23.3	71.5
50	NaCl	Biggar	32.09	73.2	Argyle	36.19	62.7	25.5	67.5
0		Marshall	31.28	77.7	Heartland	37.52	63.6	34.2	55.8
50	KCl	Marshall	31.88	78.3	Heartland	38.16	63.7	33.1	56.7
50	NaCl	Marshall	32.29	78.4	Heartland	38.46	62.4	32.4	55.8

Effect of Chloride Fertilization on Growth and Yield of Bedford Barley and Katepwa Wheat

Preliminary Results
1989 and 1990 Field Trials

University of Manitoba

Measures included in this report are:

- grain yield
- emergence counts
- common root rot disease severity ratings
- plant tissue concentrations of Cl, NO_3^-, Mn and K
- thousand kernel weight
- hectolitre weight
- barley plumpness

Measures taken during the course of this study but not recorded in this report are:

- midseason dry matter yield (1990 only)
- foliar disease severity ratings (including spot blotch)
- plant tissue concentrations of Cu, Zn and NH_4^+; also Cl uptake (1990 only)
- total N in plant tissue and grain for select treatments (1990 only)
- total dry matter production
- stage of plant development (variety trials only)

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Grain Yield of Bedford Barley in 1989

Treatment			Grain Yield (kg ha^{-1})			
					University of Manitoba	
Cl$^-$ Source	kg ha^{-1} Cl$^-$ Applied	Disease Inoculum Applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	2907	4478	4799	4315
KCl	25	-	2970	4022	4760	4212
KCl	50	-	3348	4413	4295	4352
NaCl	0	-	3173	4242	4613	4465
NaCl	25	-	3096	4521	4880	3995
NaCl	50	-	2728	5136	4897	4845
KCl	0	+	2646	4252	4335	4408
KCl	25	+	3012	4314	4614	4533
KCl	50	+	3060	4608	4704	4829
NaCl	0	+	2706	4319	4624	4242
NaCl	25	+	2864	4280	4688	4240
NaCl	50	+	2935	4319	4451	4591
KCl (S)†	25	-	2857	4340	4166	-
KCl (S)	25	+	3183	3334	4471	-
Group Means						
KCl			2989	4348	4585	4441
NaCl			2910	4469	4692	4396
LSD (P=0.05)			ns	ns	ns	ns
	0		2858	4323	4593	4357
	25		2981	4284	4736	4245
	50		3014	4619	4587	4654
LSD (P=0.05)			ns	ns	ns	283
		-	3037	4469	4707	4364
		+	2861	4348	4569	4474
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.25	0.45	0.17	0.34
Source (S)	1	0.69	0.44	0.29	0.70
Rate (R)	2	0.51	0.18	0.39	0.02 *
S*R	2	0.34	0.65	0.88	0.39
I*R	2	0.47	0.67	0.68	0.47
S*I	1	0.84	0.19	0.48	0.11
I*S*R	2	0.30	0.24	0.03 *	0.51
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.34	0.23	0.27	0.65
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.75	0.40	0.02 *	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.56	0.01 **	0.56	-
all 0 vs 25 KCl	1	0.50	0.50	0.53	0.93
all 0 vs 50 KCl	1	0.09	0.41	0.53	0.18
all 0 vs 25 NaCl	1	0.54	0.73	0.20	0.17
all 0 vs 50 NaCl	1	0.86	0.08	0.58	0.04 *
C.V. (%)		17.1	14.9	9.1	11.1

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Grain Yield of Bedford Barley in 1990

Treatment			Grain Yield (kg ha⁻¹)			
					University of Manitoba	
Cl^- Source	kg ha⁻¹ Cl^- Applied	Disease Inoculum Applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	4325	4949	5500	6269
KCl	25	-	4408	5197	5770	6271
KCl	50	-	3971	5110	6286	6507
NaCl	0	-	3975	5227	5714	6107
NaCl	25	-	3896	5180	5747	6429
NaCl	50	-	4639	5482	6217	6202
KCl	0	+	4300	5076	5181	5867
KCl	25	+	4768	5142	5728	6034
KCl	50	+	4376	4999	5668	6062
NaCl	0	+	4516	5004	5393	6169
NaCl	25	+	4234	4930	5275	6272
NaCl	50	+	4376	4786	5575	6327
KCl (S)†	25	-	4246	5262	5745	-
KCl (S)	25	+	3835	4855	5293	-
Group Means						
KCl			4358	5079	5689	6168
NaCl			4273	5102	5653	6251
LSD (P=0.05)			ns	ns	ns	ns
	0		4279	5064	5447	6103
	25		4326	5112	5630	6251
	50		4340	5094	5936	6275
LSD (P=0.05)			ns	ns	252	ns
		-	4202	5191	5872	6297
		+	4428	4990	5470	6122
LSD (P=0.05)			ns	ns	206	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.18	0.11	0.002 **	0.07
Source (S)	1	0.61	0.86	0.73	0.39
Rate (R)	2	0.95	0.95	0.001 **	0.29
S*R	2	0.12	0.74	0.20	0.65
I*R	2	0.78	0.50	0.29	0.99
S*I	1	0.90	0.14	0.46	0.06
I*S*R	2	0.32	0.81	0.63	0.55
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.63	0.91	0.22	0.45
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.68	0.83	0.92	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.02 *	0.34	0.10	-
all 0 vs 25 KCl	1	0.20	0.57	0.06	0.73
all 0 vs 50 KCl	1	0.66	0.96	0.001 **	0.21
all 0 vs 25 NaCl	1	0.37	0.96	0.69	0.09
all 0 vs 50 NaCl	1	0.34	0.70	0.006 **	0.26
C.V. (%)		15.8	10.1	7.9	6.5

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Grain Yield of Katepwa Wheat in 1989 and 1990

Treatment			Grain Yield (kg ha^{-1})			
			1989		1990	
Cl$^-$ Source	kg ha^{-1} Cl$^-$ Applied	Disease Inoculum Applied	Carman	Portage	Carman	Portage
Treatment Means						
KCl	0	-	1944	3045	4038	4203
KCl	25	-	1954	3045	3850	4356
KCl	50	-	2224	3235	4072	4363
NaCl	0	-	1855	2718	3979	4407
NaCl	25	-	2234	2483	4065	4382
NaCl	50	-	1895	3122	3749	4111
KCl	0	+	1519	2645	3695	4052
KCl	25	+	1825	2892	3720	4176
KCl	50	+	1632	2640	3495	3944
NaCl	0	+	1991	2554	3448	3980
NaCl	25	+	1618	2991	3482	4059
NaCl	50	+	1625	2581	3395	3741
KCl (S)†	25	-	2004	2948	3882	4397
KCl (S)	25	+	1853	2865	3621	3936
Group Means						
KCl			1849	2917	3812	4183
NaCl			1870	2742	3686	4113
LSD (P=0.05)			ns	ns	ns	ns
	0		1827	2740	3790	4161
	25		1908	2853	3779	4243
	50		1844	2895	3678	4040
LSD (P=0.05)			ns	ns	ns	ns
		-	2018	2941	3959	4304
		+	1701	2717	3539	3992
LSD (P=0.05)			157	ns	163	157

ANOVA	df	Pr > F			
Inoculum (I)	1	0.0002 **	0.11	0.0001 **	0.0002 **
Source (S)	1	0.80	0.21	0.13	0.38
Rate (R)	2	0.68	0.65	0.47	0.11
S*R	2	0.18	0.90	0.59	0.31
I*R	2	0.30	0.10	0.85	0.74
S*I	1	0.40	0.26	0.39	0.43
I*S*R	2	0.02 *	0.66	0.24	0.70
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.49	0.35	0.25	0.14
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.79	0.78	0.87	0.83
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.88	0.94	0.61	0.19
all 0 vs 25 KCl	1	0.60	0.28	0.97	0.35
all 0 vs 50 KCl	1	0.39	0.35	0.95	0.95
all 0 vs 25 NaCl	1	0.40	0.99	0.89	0.59
all 0 vs 50 NaCl	1	0.57	0.59	0.07	0.04 *
C.V. (%)		17.6	20.7	8.9	7.6

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer on Grain Yield of Katepwa Wheat in 1989 and 1990

Treatment		Grain Yield (kg ha^{-1})			
		1989		1990	
Cl$^-$ Source	kg ha^{-1} Cl$^-$ applied	Anola	Darlingford	Anola	Darlingford
Treatment Means					
KCl	0	3095	1668	2520	4034
KCl	25	3123	1896	2544	4257
KCl	50	3308	1612	2389	4306
NaCl	0	3077	1783	2476	4543
NaCl	25	3197	1525	2300	4351
NaCl	50	3344	1821	2267	4264
KCl (S)†	25	3223	2069	2459	4343
Group Means					
KCl		3175	1725	2484	4199
NaCl		3206	1709	2348	4386
LSD (P=0.05)		ns	ns	ns	ns
	0	3086	1725	2498	4289
	25	3160	1716	2422	4304
	50	3326	1710	2328	4285
LSD (P=0.05)		ns	ns	ns	ns

ANOVA	df	Pr > F			
Source (S)	1	0.79	0.85	0.30	0.19
Rate (R)	1	0.24	0.99	0.57	0.99
S*R	2	0.95	0.02 *	0.82	0.25
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.69	0.42	0.23	0.89
broadcast vs seedrow (25Cl,KCl)	1	0.61	0.23	0.69	0.75
all 0 vs 25 KCl	1	0.83	0.17	0.80	0.89
all 0 vs 50 KCl	1	0.20	0.36	0.56	0.94
all 0 vs 25 NaCl	1	0.51	0.11	0.29	0.79
all 0 vs 50 NaCl	1	0.14	0.44	0.22	0.91
C.V. (%)		9.6	12.6	13.8	9.5

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Plant Counts of Bedford Barley in 1989

Treatment			Plant Counts (number of plants per 1m row) †		
Cl- Source	kg ha-1 Cl- applied	Disease Inoculum applied	Carman	Portage	University of Manitoba
Treatment Means					
KCl	0	-	39.0	40.5	48.5
KCl	25	-	36.8	38.0	53.0
KCl	50	-	40.0	45.7	53.2
NaCl	0	-	40.0	45.7	50.0
NaCl	25	-	41.8	45.3	57.3
NaCl	50	-	43.7	44.8	47.5
KCl	0	+	35.5	42.7	53.8
KCl	25	+	34.5	41.8	48.3
KCl	50	+	37.2	42.2	49.7
NaCl	0	+	33.7	40.2	51.8
NaCl	25	+	35.7	45.8	47.7
NaCl	50	+	35.6	41.3	50.3
KCl (S)‡	25	-	42.3	46.0	51.2
KCl (S)	25	+	38.5	43.7	45.0
Group Means					
KCl			37.2	41.8	51.1
NaCl			38.5	43.9	50.8
LSD (P=0.05)			ns	ns	ns
	0		37.0	42.3	51.0
	25		37.2	42.8	51.6
	50		39.1	43.5	50.2
LSD (P=0.05)			ns	ns	ns
		-	40.2	43.3	51.6
		+	35.3	42.3	50.3
LSD (P=0.05)			3.5	ns	ns

ANOVA	df	Pr > F		
Inoculum (I)	1	0.007 **	0.53	0.39
Source (S)	1	0.52	0.20	0.84
Rate (R)	2	0.57	0.81	0.74
S*R	2	0.70	0.24	0.51
I*R	2	0.96	0.33	0.02 *
S*I	1	0.24	0.25	0.81
I*S*R	2	0.94	0.61	0.26
Contrasts				
KCl vs NaCl at 25 and 50 Cl	1	0.34	0.24	0.86
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.18	0.05 *	0.63
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.32	0.65	0.38
all 0 vs 25 KCl	1	0.58	0.35	0.87
all 0 vs 50 KCl	1	0.52	0.50	0.87
all 0 vs 25 NaCl	1	0.49	0.18	0.53
all 0 vs 50 NaCl	1	0.32	0.74	0.36
C.V. (%)		18.3	16.2	12.8

† Plant counts conducted at the one to three leaf stage.
‡ (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Plant Counts of Bedford Barley in 1990

Treatment			Plant Counts (number of plants per 1m row) †		
Cl^- Source	kg ha^{-1} Cl^- Applied	Disease Inoculum Applied	Carman	Portage	University of Manitoba
Treatment Means					
KCl	0	-	41.3	32.5	39.5
KCl	25	-	40.0	38.3	37.5
KCl	50	-	42.5	32.8	46.0
NaCl	0	-	40.7	35.2	40.0
NaCl	25	-	38.5	33.2	42.0
NaCl	50	-	44.2	27.2	40.2
KCl	0	+	43.8	34.0	39.7
KCl	25	+	38.8	34.7	38.0
KCl	50	+	39.8	32.8	40.2
NaCl	0	+	36.8	34.2	38.8
NaCl	25	+	39.5	27.8	41.2
NaCl	50	+	35.0	25.8	38.5
KCl (S)‡	25	-	41.7	35.7	38.2
KCl (S)	25	+	41.3	34.0	38.8
Group Means					
KCl			41.1	34.2	40.1
NaCl			39.1	30.6	40.1
LSD (P=0.05)			ns	2.5	ns
	0		40.7	34.0	39.5
	25		39.2	33.5	39.7
	50		40.4	29.7	41.2
LSD (P=0.05)			ns	3.0	ns
		-	41.2	33.2	40.9
		+	39.0	31.6	39.4
LSD (P=0.05)			ns	ns	ns

ANOVA	df	Pr > F		
Inoculum (I)	1	0.10	0.19	0.23
Source (S)	1	0.15	0.005 **	0.98
Rate (R)	2	0.64	0.01 **	0.45
S*R	2	0.57	0.02 *	0.04 *
I*R	2	0.16	0.26	0.41
S*I	1	0.19	0.46	0.84
I*S*R	2	0.33	0.98	0.56
Contrasts				
KCl vs NaCl at 25 and 50 Cl	1	0.56	0.0001 **	0.98
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.63	0.37	0.82
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.46	0.82	0.78
all 0 vs 25 KCl	1	0.55	0.17	0.33
all 0 vs 50 KCl	1	0.81	0.54	0.05 *
all 0 vs 25 NaCl	1	0.43	0.06	0.25
all 0 vs 50 NaCl	1	0.60	0.0001 **	0.93
C.V. (%)		14.6	15.7	12.7

† Plant counts conducted at the one to three leaf stage.
‡ (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Plant Counts of Katepwa Wheat in 1989 and 1990

Treatment			Plant Counts (number of plants per 1m row) †			
			1989		1990	
Cl- Source	kg ha-1 Cl- applied	Disease Inoculum applied	Carman	Portage	Carman	Portage
Treatment Means						
KCl	0	-	42.5	48.3	43.8	48.3
KCl	25	-	43.2	52.5	37.5	43.7
KCl	50	-	42.3	52.8	46.5	42.0
NaCl	0	-	43.3	44.2	45.5	48.7
NaCl	25	-	41.2	50.5	41.8	45.3
NaCl	50	-	41.5	50.3	42.3	40.3
KCl	0	+	25.8	40.7	40.3	39.2
KCl	25	+	28.8	45.0	37.5	37.5
KCl	50	+	31.2	34.7	37.0	36.8
NaCl	0	+	27.3	34.5	40.3	38.0
NaCl	25	+	27.3	35.3	33.7	31.8
NaCl	50	+	27.5	39.2	34.2	33.8
KCl (S)‡	25	-	41.5	53.0	45.7	44.5
KCl (S)	25	+	26.7	34.5	38.7	41.5
Group Means						
KCl			35.6	45.7	40.4	41.3
NaCl			34.7	42.3	39.6	39.7
LSD (P=0.05)			ns	ns	ns	ns
	0		34.8	41.9	42.5	43.5
	25		35.1	45.8	37.6	39.6
	50		35.6	44.3	40.0	38.3
LSD (P=0.05)			ns	ns	3.4	2.6
		-	42.3	49.8	42.9	44.7
		+	28.0	38.2	37.2	36.2
LSD (P=0.05)			2.9	4.2	2.8	2.1

ANOVA	df	Pr > F			
Inoculum (I)	1	0.0001 **	0.0001 **	0.0001**	0.0001 **
Source (S)	1	0.51	0.12	0.56	0.14
Rate (R)	2	0.88	0.32	0.02 *	0.0003 **
S*R	2	0.58	0.35	0.39	0.73
I*R	2	0.57	0.51	0.30	0.20
S*I	1	0.85	0.83	0.31	0.11
I*S*R	2	0.85	0.37	0.37	0.42
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.27	0.34	0.34	0.14
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.64	0.92	0.02 *	0.77
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.55	0.04 *	0.73	0.17
all 0 vs 25 KCl	1	0.57	0.03 *	0.02 *	0.10
all 0 vs 50 KCl	1	0.36	0.56	0.72	0.02 *
all 0 vs 25 NaCl	1	0.82	0.75	0.02 *	0.007 **
all 0 vs 50 NaCl	1	0.91	0.36	0.04 *	0.0005 **
C.V. (%)		17.7	19.9	14.4	12.3

† Plant counts conducted at the one to three leaf stage.
‡ (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Common Root Rot Severity of Bedford Barley in 1989

Treatment			Common Root Rot Disease Rating †		
Cl- Source	kg ha⁻¹ Cl- applied	Disease Inoculum applied	Carman	Portage	University of Manitoba
Treatment Means					
KCl	0	-	2.46	2.27	2.65
KCl	25	-	2.48	2.15	2.51
KCl	50	-	2.55	2.05	2.65
NaCl	0	-	2.61	2.37	2.90
NaCl	25	-	2.45	1.95	2.63
NaCl	50	-	2.49	2.30	2.62
KCl	0	+	2.63	2.33	2.49
KCl	25	+	2.21	2.12	2.17
KCl	50	+	2.30	2.11	2.02
NaCl	0	+	2.41	2.05	2.15
NaCl	25	+	2.22	2.22	2.13
NaCl	50	+	2.25	2.04	2.08
KCl (S)‡	25	-	2.49	2.29	2.62
KCl (S)	25	+	2.41	2.13	2.07
Group Means					
KCl			2.44	2.17	2.42
NaCl			2.41	2.15	2.42
LSD (P=0.05)			ns	ns	ns
	0		2.53	2.25	2.55
	25		2.34	2.11	2.36
	50		2.40	2.13	2.34
LSD (P=0.05)			ns	ns	0.17
		-	2.51	2.18	2.66
		+	2.34	2.14	2.17
LSD (P=0.05)			0.14	ns	0.14

ANOVA	df	Pr > F		
Inoculum (I)	1	0.02 *	0.50	0.0001 **
Source (S)	1	0.55	0.77	0.96
Rate (R)	2	0.08	0.09	0.04 *
S*R	2	0.96	0.41	0.87
I*R	2	0.28	0.16	0.61
S*I	1	0.40	0.26	0.12
I*S*R	2	0.38	0.04 *	0.14
Contrasts				
KCl vs NaCl at 25 and 50 Cl	1	0.62	0.75	0.74
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.93	0.29	0.54
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.24	0.96	0.54
all 0 vs 25 KCl	1	0.10	0.16	0.06
all 0 vs 50 KCl	1	0.34	0.04 *	0.05 *
all 0 vs 25 NaCl	1	0.06	0.05 *	0.12
all 0 vs 50 NaCl	1	0.14	0.32	0.07
C.V. (%)		11.5	10.9	12.3

† Disease classes based on severity of lesions on subcrown internode: 1=clean 2=slight 3=moderate 4=severe (Ledingham et al., 1973)
‡ (S) indicates placement of chloride fertilizer in the seed row

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Common Root Rot Severity of Bedford Barley in 1990

Treatment			Common Root Rot Disease Rating †		
Cl- Source	kg ha⁻¹ Cl- applied	Disease Inoculum applied	Carman	Portage	University of Manitoba
Treatment Means					
KCl	0	-	2.48	3.16	3.44
KCl	25	-	2.49	3.09	3.55
KCl	50	-	2.20	3.21	3.46
NaCl	0	-	2.63	3.17	3.40
NaCl	25	-	2.29	3.14	3.36
NaCl	50	-	2.23	3.13	3.42
KCl	0	+	2.45	3.05	3.71
KCl	25	+	2.24	3.06	3.54
KCl	50	+	2.47	3.11	3.63
NaCl	0	+	2.62	3.09	3.70
NaCl	25	+	2.45	3.08	3.44
NaCl	50	+	2.37	3.13	3.62
KCl (S)‡	25	-	2.33	3.15	3.61
KCl (S)	25	+	2.53	2.92	3.53
Group Means					
KCl			2.39	3.11	3.55
NaCl			2.43	3.12	3.49
LSD (P=0.05)			ns	ns	ns
	0		2.55	3.12	3.56
	25		2.37	3.09	3.47
	50		2.32	3.15	3.53
LSD (P=0.05)			0.15	ns	ns
		-	2.39	3.15	3.44
		+	2.43	3.09	3.61
LSD (P=0.05)			ns	ns	0.08

ANOVA	df	Pr > F		
Inoculum (I)	1	0.43	0.15	0.0001 **
Source (S)	1	0.49	0.80	0.10
Rate (R)	2	0.009 **	0.60	0.15
S*R	2	0.41	0.82	0.35
I*R	2	0.21	0.88	0.03 *
S*I	1	0.42	0.68	0.51
I*S*R	2	0.17	0.85	0.95
Contrasts				
KCl vs NaCl at 25 and 50 Cl	1	0.84	0.95	0.09
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.28	0.62	0.53
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.05 *	0.20	0.89
all 0 vs 25 KCl	1	0.05 *	0.55	0.75
all 0 vs 50 KCl	1	0.02 *	0.52	0.79
all 0 vs 25 NaCl	1	0.06	0.92	0.008 **
all 0 vs 50 NaCl	1	0.008 **	0.80	0.48
C.V. (%)		10.5	6.0	4.7

† Disease classes based on severity of lesions on subcrown internode: 1=clean 2=slight 3=moderate 4=severe (Ledingham et al., 1973)
‡ (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Common Root Rot Severity of Katepwa Wheat in 1989 and 1990

Treatment			Common Root Rot Disease Rating †			
			1989		1990	
Cl- Source	kg ha-1 Cl- applied	Disease Inoculum applied	Carman	Portage	Carman	Portage
Treatment Means						
KCl	0	-	2.05	2.09	2.42	3.17
KCl	25	-	2.13	1.97	2.57	3.20
KCl	50	-	1.95	2.00	2.40	2.99
NaCl	0	-	2.01	1.95	2.75	2.95
NaCl	25	-	2.03	1.86	2.53	2.93
NaCl	50	-	2.11	1.71	2.33	3.11
KCl	0	+	2.15	1.87	2.71	3.14
KCl	25	+	2.19	1.91	2.38	3.11
KCl	50	+	1.92	1.76	2.53	2.89
NaCl	0	+	1.81	1.81	2.60	3.03
NaCl	25	+	2.01	2.09	2.57	2.92
NaCl	50	+	2.02	1.82	2.34	3.07
KCl (S)‡	25	-	2.11	2.21	2.32	3.07
KCl (S)	25	+	2.15	1.80	2.67	2.93
Group Means						
KCl			2.06	1.93	2.50	3.08
NaCl			2.00	1.87	2.52	3.00
LSD (P=0.05)			ns	ns	ns	ns
	0		2.01	1.93	2.62	3.07
	25		2.09	1.96	2.51	3.04
	50		2.00	1.82	2.40	3.01
LSD (P=0.05)			ns	ns	0.17	ns
		-	2.05	1.93	2.50	3.06
		+	2.02	1.88	2.52	3.03
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.62	0.57	0.77	0.55
Source (S)	1	0.29	0.51	0.78	0.14
Rate (R)	2	0.44	0.42	0.04 *	0.67
S*R	2	0.08	0.76	0.33	0.01 **
I*R	2	0.86	0.49	0.62	0.73
S*I	1	0.23	0.19	0.46	0.44
I*S*R	2	0.70	0.80	0.15	0.96
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.98	0.69	0.76	0.57
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.90	0.25	0.13	0.31
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.79	0.59	0.08	0.19
all 0 vs 25 KCl	1	0.11	0.93	0.16	0.32
all 0 vs 50 KCl	1	0.45	0.69	0.13	0.10
all 0 vs 25 NaCl	1	0.87	0.72	0.50	0.07
all 0 vs 50 NaCl	1	0.51	0.19	0.007 **	0.84
C.V. (%)		12.9	18.8	11.4	7.5

† Disease classes based on severity of lesions on subcrown internode: 1=clean 2=slight 3=moderate 4=severe (Ledingham et al., 1973)
‡ (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Midseason Plant Tissue Chloride Concentration of Bedford Barley in 1989

Treatment			Plant Tissue Cl^- Concentration ($\mu g\ g^{-1}$)			
					University of Manitoba	
Cl^- Source	kg ha^{-1} Cl^- applied	Disease Inoculum applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	6324	2567	1323	1079
KCl	25	-	11147	6677	6164	4032
KCl	50	-	12530	10173	9055	6558
NaCl	0	-	6188	2106	1397	1298
NaCl	25	-	9489	7015	5091	4414
NaCl	50	-	13157	9816	8643	7549
KCl	0	+	6789	2655	1306	1797
KCl	25	+	9700	6515	5670	4265
KCl	50	+	12713	9611	9057	7666
NaCl	0	+	4281	2791	1468	1113
NaCl	25	+	11483	7411	5397	4375
NaCl	50	+	13530	10739	7996	7404
KCl (S)†	25	-	9573	6482	4961	-
KCl (S)	25	+	8824	6859	5703	-
Group Means						
KCl			9746	6357	5429	4233
NaCl			9462	6687	4999	4359
LSD (P=0.05)			ns	ns	407	ns
	0		5895	2548	1373	1321
	25		10422	6914	5580	4272
	50		12960	10096	8688	7294
LSD (P=0.05)			~1200.‡	794	498	625
		-	9767	6410	5279	4155
		+	9430	6620	5149	4437
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.83	0.35	0.52	0.27
Source (S)	1	0.61	0.37	0.04 *	0.62
Rate (R)	2	0.0001 **	0.0001 **	0.0001 **	0.0001 **
S*R	2	0.26	0.40	0.17	0.60
I*R	2	0.66	0.88	0.78	0.83
S*I	1	0.69	0.19	0.85	0.12
I*S*R	2	0.04 *	0.78	0.35	0.73
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.60	0.12	0.004 **	0.33
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.17	0.84	0.02 *	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.47	0.93	0.95	-
all 0 vs 25 KCl	1	0.0001 **	0.0001 **	0.0001 **	0.0001 **
all 0 vs 50 KCl	1	0.0001 **	0.0001 **	0.0001 **	0.0001 **
all 0 vs 25 NaCl	1	0.0001 **	0.0001 **	0.0001 **	0.0001 **
all 0 vs 50 NaCl	1	0.0001 **	0.0001 **	0.0001 **	0.0001 **
C.V. (%)		21.8	19.5	15.8	25.1

† (S) indicates placement of chloride fertilizer in the seed row
‡ LSD for comparison between rates 0 and 25 is 1160, 0 and 50 is 1188 and 25 and 50 is 1200.
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Midseason Plant Tissue Chloride Concentration of Bedford Barley in 1990

Treatment			Plant Tissue Cl^- Concentration ($\mu g\ g^{-1}$)			
					University of Manitoba	
Cl^- Source	kg ha^{-1} Cl^- Applied	Disease Inoculum Applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	1862	7159	981	1170
KCl	25	-	6419	9495	6327	2351
KCl	50	-	9905	12408	10465	3437
NaCl	0	-	2048	6672	1046	980
NaCl	25	-	6198	9565	6575	2932
NaCl	50	-	8782	12103	12876	4103
KCl	0	+	1976	6669	977	1123
KCl	25	+	4099	11335	6159	2263
KCl	50	+	9422	12254	12271	3453
NaCl	0	+	2400	7151	971	1099
NaCl	25	+	5845	10496	6045	2707
NaCl	50	+	8463	12020	12308	3916
KCl (S)†	25	-	5896	8287	3796	-
KCl (S)	25	+	5395	9836	4338	-
Group Means						
KCl			5614	9886	6197	2299
NaCl			5623	9668	6637	2623
LSD (P=0.05)			ns	ns	ns	ns
	0		2017	6913	994	1093
	25		5640	10223	6277	2563
	50		9143	12196	11980	3727
LSD (P=0.05)			841	1043	612	519
		-	5869	9567	6378	2496
		+	5367	9987	6455	2427
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.15	0.33	0.76	0.75
Source (S)	1	0.98	0.61	0.08	0.13
Rate (R)	2	0.0001 **	0.0001 **	0.0001 **	0.0001 **
S*R	2	0.09	0.93	0.09	0.36
I*R	2	0.18	0.28	0.28	0.93
S*I	1	0.25	0.96	0.07	0.89
I*S*R	2	0.48	0.67	0.13	0.93
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.73	0.53	0.03 *	0.04 *
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.52	0.24	0.0001 **	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.12	0.15	0.003 **	-
all 0 vs 25 KCl	1	0.0001 **	0.0001 **	0.0001 **	0.0003 **
all 0 vs 50 KCl	1	0.0001 **	0.0001 **	0.0001 **	0.0001 **
all 0 vs 25 NaCl	1	0.0001 **	0.0001 **	0.0001 **	0.0001 **
all 0 vs 50 NaCl	1	0.0001 **	0.0001 **	0.0001 **	0.0001 **
C.V. (%)		25.1	18.3	17.0	36.4

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Midseason Plant Tissue Chloride Concentration of Katepwa Wheat in 1989 and 1990

Treatment			Plant Tissue Cl^- Concentration ($\mu g\ g^{-1}$)			
			1989		1990	
Cl^- Source	kg ha^{-1} Cl^- Applied	Disease Inoculum Applied	Carman	Portage	Carman	Portage
Treatment Means						
KCl	0	-	3147	2026	1105	5701
KCl	25	-	6943	6357	6734	6955
KCl	50	-	7929	7672	7869	8543
NaCl	0	-	4132	2249	2953	5257
NaCl	25	-	6166	6586	5766	7372
NaCl	50	-	8134	8198	6837	7429
KCl	0	+	2860	2381	1663	5406
KCl	25	+	5965	5639	6223	7088
KCl	50	+	7863	7048	7358	7645
NaCl	0	+	3638	2282	1566	5417
NaCl	25	+	6542	6648	6024	6580
NaCl	50	+	8130	8325	8646	7042
KCl (S)†	25	-	6386	5899	5056	7135
KCl (S)	25	+	6284	5652	4748	7043
Group Means						
KCl			5785	5187	5159	6890
NaCl			6124	5715	5299	6516
LSD (P=0.05)			ns	ns	ns	324
	0		3444	2235	1822	5445
	25		6404	6307	6187	6999
	50		8014	7811	7678	7665
LSD (P=0.05)			789	704	1016	397
		-	6075	5515	5211	6876
		+	5833	5387	5247	6530
LSD (P=0.05)			ns	ns	ns	324

ANOVA	df	Pr > F			
Inoculum (I)	1	0.45	0.66	0.93	0.04 *
Source (S)	1	0.30	0.07	0.74	0.02 *
Rate (R)	2	0.0001 **	0.0001 **	0.0001 **	0.0001 **
S*R	2	0.45	0.48	0.36	0.11
I*R	2	0.90	0.73	0.56	0.35
S*I	1	0.53	0.49	0.65	0.97
I*S*R	2	0.57	0.67	0.11	0.13
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.86	0.03 *	0.64	0.02 *
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.46	0.50	0.09	0.64
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.67	0.98	0.13	0.91
all 0 vs 25 KCl	1	0.0001 **	0.0001 **	0.0001 **	0.0001 **
all 0 vs 50 KCl	1	0.0001 **	0.0001 **	0.0001 **	0.0001 **
all 0 vs 25 NaCl	1	0.0001 **	0.0001 **	0.0001 **	0.0001 **
all 0 vs 50 NaCl	1	0.0001 **	0.0001 **	0.0001 **	0.0001 **
C.V. (%)		21.6	21.3	32.3	9.7

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer on Midseason Plant Tissue Chloride Concentration of Katepwa Wheat in 1990

Treatment		Plant Tissue Cl^- Concentration ($\mu g\ g^{-1}$)	
Cl^- Source	kg ha^{-1} Cl^- applied	Anola	Darlingford
Treatment Means			
KCl	0	2750	2799
KCl	25	5080	4260
KCl	50	5045	5621
NaCl	0	2107	2951
NaCl	25	4311	4876
NaCl	50	6096	5925
KCl (S)†	25	4465	5320
Group Means			
KCl		4292	4227
NaCl		4172	4584
LSD (P=0.05)		ns	ns
	0	2429	2875
	25	4696	4568
	50	5571	5773
LSD (P=0.05)		773	719

ANOVA	df	Pr > F	
Source (S)	1	0.70	0.22
Rate (R)	1	0.0001 **	0.0001 **
S*R	2	0.04 *	0.79
Contrasts			
KCl vs NaCl at 25 and 50 Cl	1	0.76	0.21
broadcast vs seedrow (25Cl,KCl)	1	0.35	0.05 *
all 0 vs 25 KCl	1	0.0001 **	0.004 *
all 0 vs 50 KCl	1	0.0001 **	0.0001 **
all 0 vs 25 NaCl	1	0.003 **	0.0001 **
all 0 vs 50 NaCl	1	0.0001 **	0.0001 **
C.V. (%)		23.9	17.6

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Midseason Plant Tissue Nitrate Concentration of Bedford Barley in 1989

Treatment			Plant Tissue NO_3^- Concentration ($\mu g\ g^{-1}$)			
					University of Manitoba	
Cl^- Source	kg ha^{-1} Cl^- applied	Disease Inoculum applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	5397	8988	6274	3644
KCl	25	-	4433	6843	6629	4467
KCl	50	-	3858	7475	6371	4032
NaCl	0	-	4467	7394	6833	3434
NaCl	25	-	4169	7571	6664	4332
NaCl	50	-	3361	7333	6650	4336
KCl	0	+	4460	8415	5643	4439
KCl	25	+	4144	6977	6139	3734
KCl	50	+	4147	7589	5969	3826
NaCl	0	+	4042	7650	6958	5142
NaCl	25	+	4142	7483	6733	4768
NaCl	50	+	3104	8205	5841	4163
KCl (S)†	25	-	4849	8209	6662	-
KCl (S)	25	+	3943	7351	7380	-
Group Means						
KCl			4414	7739	6171	4024
NaCl			3903	7612	6607	4362
LSD (P=0.05)			398	ns	ns	ns
	0		4591	8148	6430	4165
	25		4216	7235	6541	4325
	50		3618	7651	6208	4089
LSD (P=0.05)			-485 ‡	ns	ns	ns
		-	4277	7629	6563	4041
		+	4029	7720	6214	4345
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.11	0.81	0.24	0.23
Source (S)	1	0.02 *	0.74	0.15	0.18
Rate (R)	2	0.0002 **	0.09	0.66	0.74
S*R	2	0.28	0.09	0.48	0.95
I*R	2	0.42	0.65	0.86	0.03 *
S*I	1	0.97	0.49	0.66	0.16
I*S*R	2	0.56	0.83	0.73	0.63
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.11	0.30	0.60	0.21
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.22	0.12	0.90	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.67	0.62	0.05 *	-
all 0 vs 25 KCl	1	0.18	0.02 *	0.90	0.86
all 0 vs 50 KCl	1	0.02 *	0.20	0.55	0.53
all 0 vs 25 NaCl	1	0.14	0.20	0.58	0.31
all 0 vs 50 NaCl	1	0.0001 **	0.43	0.67	0.82
C.V. (%)		19.5	17.0	19.8	25.3

† (S) indicates placement of chloride fertilizer in the seed row
‡ LSD for the comparison between rates of 0 and 25 is 482, 0 and 50 is 487 and 25 and 50 is 492.
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Midseason Plant Tissue Nitrate Concentration of Bedford Barley in 1990

Treatment			Plant Tissue NO_3^- Concentration ($\mu g\ g^{-1}$)			
					University of Manitoba	
Cl^- Source	kg ha^{-1} Cl^- Applied	Disease Inoculum Applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	4450	2824	2544	2055
KCl	25	-	4600	2982	2671	2006
KCl	50	-	4583	1722	2814	1528
NaCl	0	-	5400	2676	2948	1791
NaCl	25	-	5430	1940	2792	2198
NaCl	50	-	4651	3025	2649	1539
KCl	0	+	5267	3056	2817	2138
KCl	25	+	4115	2553	1882	1881
KCl	50	+	3767	2518	2272	1763
NaCl	0	+	5635	3522	2890	1708
NaCl	25	+	4553	2872	2612	1750
NaCl	50	+	4629	1930	2681	1617
KCl (S)†	25	-	5040	2071	2555	-
KCl (S)	25	+	5815	3030	3006	-
Group Means						
KCl			4464	2609	2500	1895
NaCl			5050	2661	2762	1767
LSD (P=0.05)			ns	ns	ns	ns
	0		5188	3020	2800	1923
	25		4675	2587	2489	1959
	50		4408	2299	2604	1612
LSD (P=0.05)			ns	ns	ns	ns
		-	4852	2528	2736	1853
		+	4661	2742	2526	1810
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.53	0.38	0.35	0.74
Source (S)	1	0.06	0.83	0.24	0.34
Rate (R)	2	0.11	0.06	0.52	0.07
S*R	2	0.96	0.46	0.85	0.48
I*R	2	0.23	0.51	0.55	0.39
S*I	1	0.92	0.95	0.53	0.42
I*S*R	2	0.60	0.02 *	0.62	0.96
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.13	0.99	0.30	0.91
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.54	0.15	0.83	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.02 *	0.44	0.04 *	-
all 0 vs 25 KCl	1	0.06	0.51	0.11	0.92
all 0 vs 50 KCl	1	0.03 *	0.02 *	0.43	0.17
all 0 vs 25 NaCl	1	0.66	0.11	0.76	0.80
all 0 vs 50 NaCl	1	0.22	0.16	0.68	0.09
C.V. (%)		25.8	40.9	34.4	30.6

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Midseason Plant Tissue Nitrate Concentration of Katepwa Wheat in 1989 and 1990

Treatment			Plant Tissue NO_3^- Concentration ($\mu g\ g^{-1}$)			
			1989		1990	
Cl^- Source	kg ha^{-1} Cl^- applied	Disease Inoculum applied	Carman	Portage	Carman	Portage
Treatment Means						
KCl	0	-	3518	4292	2749	2263
KCl	25	-	2666	3793	2741	2260
KCl	50	-	2585	3516	2355	1657
NaCl	0	-	3841	4753	3338	2459
NaCl	25	-	2812	3724	2762	2028
NaCl	50	-	2829	4720	1890	1881
KCl	0	+	3523	5379	3437	2238
KCl	25	+	3112	4350	2681	2084
KCl	50	+	2648	3399	2268	1819
NaCl	0	+	2786	5154	3675	2204
NaCl	25	+	3034	3589	2797	1996
NaCl	50	+	3082	3752	2364	1991
KCl (S)†	25	-	3206	3280	2803	2080
KCl (S)	25	+	2914	4027	2900	2036
Group Means						
KCl			3009	4122	2705	2053
NaCl			3064	4282	2804	2093
LSD (P=0.05)			ns	ns	ns	ns
	0		3417	4895	3300	2291
	25		2906	3864	2745	2092
	50		2786	3847	2220	1837
LSD (P=0.05)			478	627	529	251
		-	3042	4133	2639	2091
		+	3031	4271	2870	2055
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.95	0.59	0.29	0.73
Source (S)	1	0.78	0.53	0.65	0.70
Rate (R)	2	0.02 *	0.002 **	0.0007 **	0.003 **
S*R	2	0.52	0.17	0.53	0.35
I*R	2	0.17	0.13	0.61	0.49
S*I	1	0.35	0.15	0.81	0.82
I*S*R	2	0.42	0.99	0.69	0.76
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.44	0.58	0.83	0.88
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.26	0.43	0.91	0.48
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.68	0.62	0.68	0.85
all 0 vs 25 KCl	1	0.07	0.04 *	0.07	0.45
all 0 vs 50 KCl	1	0.008 **	0.0006 **	0.003 **	0.0007 **
all 0 vs 25 NaCl	1	0.09	0.003 **	0.11	0.08
all 0 vs 50 NaCl	1	0.12	0.10	0.0005 **	0.03 *
C.V. (%)		27.1	27.3	32.9	21.2

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Midseason Plant Tissue Manganese Concentration of Bedford Barley in 1989

Treatment			Plant Tissue Mn Concentration ($\mu g\ g^{-1}$)			
					University of Manitoba	
Cl^- Source	kg ha^{-1} Cl^- applied	Disease Inoculum applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	38.5	41.8	16.9	16.7
KCl	25	-	40.7	30.8	15.7	19.2
KCl	50	-	34.9	31.7	15.1	18.1
NaCl	0	-	35.0	35.6	17.2	16.1
NaCl	25	-	36.1	34.4	15.6	19.9
NaCl	50	-	34.4	37.3	16.1	20.2
KCl	0	+	36.8	33.3	16.8	16.9
KCl	25	+	38.2	33.8	14.7	15.7
KCl	50	+	37.2	38.8	16.7	16.4
NaCl	0	+	36.3	35.5	16.7	18.1
NaCl	25	+	33.2	31.5	15.5	17.7
NaCl	50	+	32.6	40.1	17.7	18.0
KCl (S)†	25	-	39.6	38.4	14.6	-
KCl (S)	25	+	35.7	34.1	14.6	-
Group Means						
KCl			37.7	35.2	16.0	17.2
NaCl			34.7	35.9	16.5	18.3
LSD (P=0.05)			2.1	ns	ns	ns
	0		36.6	36.6	16.9	16.9
	25		37.0	32.7	15.4	18.1
	50		34.9	37.0	16.4	18.2
LSD (P=0.05)			ns	3.7	ns	ns
		-	36.5	35.4	16.1	18.4
		+	35.9	35.6	16.4	17.1
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.29	0.91	0.66	0.18
Source (S)	1	0.01 **	0.68	0.38	0.21
Rate (R)	2	0.12	0.04 *	0.09	0.48
S*R	2	0.44	0.37	0.77	0.79
I*R	2	0.58	0.03	0.25	0.19
S*I	1	0.99	0.80	0.92	0.64
I*S*R	2	0.56	0.17	0.90	0.86
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.04 *	0.37	0.29	0.16
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.77	0.08	0.46	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.39	0.94	0.94	-
all 0 vs 25 KCl	1	0.15	0.08	0.04 *	0.72
all 0 vs 50 KCl	1	0.50	0.47	0.21	0.84
all 0 vs 25 NaCl	1	0.29	0.07	0.10	0.18
all 0 vs 50 NaCl	1	0.11	0.38	0.96	0.13
C.V. (%)		14.2	17.1	14.1	22.1

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Midseason Plant Tissue Manganese Concentration of Bedford Barley in 1990

Treatment			Plant Tissue Mn Concentration ($\mu g\ g^{-1}$)			
					University of Manitoba	
Cl- Source	kg ha^{-1} Cl- Applied	Disease Inoculum Applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	42.0	20.6	12.7	13.4
KCl	25	-	42.4	22.7	12.0	13.6
KCl	50	-	38.8	19.1	11.6	12.7
NaCl	0	-	39.8	23.1	12.8	12.9
NaCl	25	-	38.9	19.3	12.1	13.2
NaCl	50	-	40.2	18.7	12.9	12.3
KCl	0	+	41.2	21.2	12.3	13.4
KCl	25	+	41.4	19.5	11.9	12.6
KCl	50	+	39.2	19.4	12.4	12.3
NaCl	0	+	41.7	21.0	12.8	14.0
NaCl	25	+	38.6	19.3	11.5	13.0
NaCl	50	+	40.8	18.0	13.0	13.3
KCl (S)†	25	-	39.0	19.2	12.0	-
KCl (S)	25	+	38.2	18.8	12.5	-
Group Means						
KCl			40.8	20.4	12.1	13.0
NaCl			40.0	19.9	12.5	13.1
LSD (P=0.05)			ns	ns	ns	ns
	0		41.2	21.5	12.6	13.4
	25		40.3	20.2	11.9	13.1
	50		39.8	18.8	12.4	12.6
LSD (P=0.05)			ns	1.3	0.6	ns
		-	40.4	20.6	12.3	13.0
		+	40.5	19.7	12.3	13.1
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.89	0.14	0.76	0.85
Source (S)	1	0.33	0.33	0.08	0.69
Rate (R)	2	0.38	0.0008 **	0.03 *	0.21
S*R	2	0.08	0.08	0.10	0.89
I*R	2	0.81	0.58	0.46	0.44
S*I	1	0.48	0.88	0.62	0.13
I*S*R	2	0.81	0.07	0.69	0.95
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.43	0.05 *	0.10	0.66
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.11	0.01 **	0.99	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.12	0.62	0.31	-
all 0 vs 25 KCl	1	0.57	0.69	0.05 *	0.53
all 0 vs 50 KCl	1	0.09	0.01 **	0.03 *	0.07
all 0 vs 25 NaCl	1	0.06	0.01 **	0.02 *	0.53
all 0 vs 50 NaCl	1	0.60	0.0005 **	0.36	0.27
C.V. (%)		9.0	12.0	7.7	11.5

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Midseason Plant Tissue Manganese Concentration of Katepwa Wheat in 1989 and 1990

Treatment			Plant Tissue Mn Concentration ($\mu g\ g^{-1}$)			
			1989		1990	
Cl^- Source	kg ha^{-1} Cl^- applied	Disease Inoculum applied	Carman	Portage	Carman	Portage
Treatment Means						
KCl	0	-	46.0	36.2	37.3	27.8
KCl	25	-	48.3	37.3	39.7	28.1
KCl	50	-	45.6	39.2	39.5	26.6
NaCl	0	-	58.0	36.9	40.4	28.8
NaCl	25	-	46.5	37.0	41.3	29.3
NaCl	50	-	51.2	44.9	34.3	27.4
KCl	0	+	47.1	40.3	43.2	27.8
KCl	25	+	45.4	40.9	38.6	27.2
KCl	50	+	50.7	38.3	42.9	26.4
NaCl	0	+	44.0	38.6	46.8	27.3
NaCl	25	+	48.2	37.4	45.4	25.8
NaCl	50	+	49.4	39.4	42.1	26.6
KCl (S)†	25	-	49.8	38.6	41.7	29.0
KCl (S)	25	+	44.9	36.5	46.1	29.0
Group Means						
KCl			47.1	38.7	40.2	27.3
NaCl			49.5	39.0	41.7	27.5
LSD (P=0.05)			ns	ns	ns	ns
	0		48.8	38.0	41.9	28.0
	25		47.1	38.1	41.2	27.6
	50		49.1	40.5	39.7	26.7
LSD (P=0.05)			ns	ns	ns	ns
		-	49.2	38.6	38.8	28.0
		+	47.4	39.1	43.2	26.8
LSD (P=0.05)			ns	ns	3.6	1.0

ANOVA	df	Pr > F			
Inoculum (I)	1	0.32	0.62	0.02 *	0.04 *
Source (S)	1	0.20	0.78	0.41	0.62
Rate (R)	2	0.63	0.15	0.60	0.11
S*R	2	0.69	0.15	0.21	0.88
I*R	2	0.20	0.07	0.53	0.33
S*I	1	0.13	0.15	0.36	0.16
I*S*R	2	0.10	0.93	0.86	0.70
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.51	0.58	0.79	0.76
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.72	0.64	0.65	0.48
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.92	0.11	0.09	0.17
all 0 vs 25 KCl	1	0.46	0.51	0.30	0.65
all 0 vs 50 KCl	1	0.74	0.64	0.80	0.05 *
all 0 vs 25 NaCl	1	0.59	0.63	0.60	0.57
all 0 vs 50 NaCl	1	0.58	0.01 **	0.17	0.19
C.V. (%)		15.7	12.0	18.4	8.0

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Midseason Plant Tissue Potassium Concentration of Bedford Barley in 1989

Treatment			Plant Tissue K Concentration (%)			
					University of Manitoba	
Cl- Source	kg ha-1 Cl- applied	Disease Inoculum applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	2.48	3.09	2.90	2.66
KCl	25	-	2.78	3.06	3.20	2.63
KCl	50	-	2.68	3.09	2.86	2.64
NaCl	0	-	2.59	2.75	3.07	2.70
NaCl	25	-	2.52	3.00	2.96	2.59
NaCl	50	-	2.52	2.93	3.03	2.62
KCl	0	+	3.03	3.89	3.01	2.65
KCl	25	+	2.70	3.44	2.99	2.53
KCl	50	+	2.78	3.01	2.84	2.64
NaCl	0	+	2.90	3.03	3.09	2.87
NaCl	25	+	2.68	2.99	2.99	2.63
NaCl	50	+	2.56	3.16	2.84	2.54
KCl (S)†	25	-	2.81	2.95	2.98	-
KCl (S)	25	+	2.65	2.98	3.06	-
Group Means						
KCl			2.74	3.28	2.96	2.62
NaCl			2.63	2.98	3.00	2.66
LSD (P=0.05)			ns	0.23	ns	ns
	0		2.75	3.20	3.02	2.72
	25		2.67	3.13	3.03	2.59
	50		2.63	3.05	2.89	2.61
LSD (P=0.05)			ns	ns	0.12	ns
		-	2.59	2.99	3.00	2.64
		+	2.79	3.27	2.96	2.64
LSD (P=0.05)			0.20	0.23	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.07	0.05 *	0.38	0.95
Source (S)	1	0.30	0.008 **	0.51	0.64
Rate (R)	2	0.60	0.60	0.05 *	0.26
S*R	2	0.76	0.26	0.11	0.56
I*R	2	0.20	0.33	0.31	0.74
S*I	1	0.98	0.26	0.96	0.55
I*S*R	2	0.59	0.35	0.24	0.72
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.18	0.13	0.81	0.87
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.89	0.41	0.06	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.85	0.08	0.53	-
all 0 vs 25 KCl	1	0.90	0.60	0.31	0.17
all 0 vs 50 KCl	1	0.83	0.50	0.02 *	0.42
all 0 vs 25 NaCl	1	0.26	0.12	0.54	0.28
all 0 vs 50 NaCl	1	0.16	0.28	0.27	0.18
C.V. (%)		14.1	14.4	6.8	11.1

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Midseason Plant Tissue Potassium Concentration of Bedford Barley in 1990

Treatment			Plant Tissue K Concentration (%)			
					University of Manitoba	
Cl- Source	kg ha-1 Cl- Applied	Disease Inoculum Applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	2.65	2.98	2.69	3.12
KCl	25	-	2.69	2.91	2.89	3.11
KCl	50	-	2.59	3.08	3.06	2.95
NaCl	0	-	2.62	3.14	3.01	3.20
NaCl	25	-	2.51	2.93	2.89	2.94
NaCl	50	-	2.54	2.88	2.96	3.12
KCl	0	+	2.62	3.13	2.90	3.13
KCl	25	+	2.74	2.99	2.84	3.28
KCl	50	+	2.61	3.05	3.02	3.02
NaCl	0	+	2.66	3.19	2.90	3.06
NaCl	25	+	2.44	3.38	3.11	3.18
NaCl	50	+	2.52	3.09	2.98	3.18
KCl (S)†	25	-	2.61	3.26	2.82	-
KCl (S)	25	+	2.65	3.19	2.95	-
Group Means						
KCl			2.65	3.02	2.90	3.10
NaCl			2.55	3.10	2.98	3.11
LSD (P=0.05)			0.10	ns	ns	ns
	0		2.64	3.11	2.88	3.13
	25		2.59	3.05	2.93	3.13
	50		2.56	3.03	3.00	3.07
LSD (P=0.05)			ns	ns	ns	ns
		-	2.60	2.99	2.92	3.07
		+	2.60	3.14	2.96	3.14
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.92	0.09	0.58	0.45
Source (S)	1	0.04 *	0.37	0.37	0.90
Rate (R)	2	0.48	0.75	0.41	0.82
S*R	2	0.12	0.42	0.42	0.40
I*R	2	0.99	0.67	0.92	0.49
S*I	1	0.81	0.35	0.98	0.85
I*S*R	2	0.73	0.56	0.32	0.88
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.01 **	0.57	0.74	0.89
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.46	0.13	0.71	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.44	0.38	0.54	-
all 0 vs 25 KCl	1	0.27	0.26	0.91	0.63
all 0 vs 50 KCl	1	0.62	0.76	0.18	0.29
all 0 vs 25 NaCl	1	0.03 *	0.72	0.29	0.60
all 0 vs 50 NaCl	1	0.14	0.39	0.43	0.87
C.V. (%)		7.8	12.9	11.3	12.4

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Midseason Plant Tissue Potassium Concentration of Katepwa Wheat in 1989 and 1990

Treatment			Plant Tissue K Concentration (%)			
			1989		1990	
Cl- Source	kg ha^{-1} Cl- applied	Disease Inoculum applied	Carman	Portage	Carman	Portage
Treatment Means						
KCl	0	-	3.05	3.10	2.47	3.28
KCl	25	-	2.84	3.11	2.39	3.44
KCl	50	-	2.87	3.15	2.55	3.15
NaCl	0	-	3.05	3.20	2.58	3.08
NaCl	25	-	2.90	3.28	2.40	3.36
NaCl	50	-	3.05	3.35	2.55	3.25
KCl	0	+	3.08	3.26	2.59	3.36
KCl	25	+	3.03	3.77	2.53	3.63
KCl	50	+	2.92	3.23	2.57	3.25
NaCl	0	+	2.99	3.44	2.43	3.51
NaCl	25	+	3.01	3.13	2.47	3.27
NaCl	50	+	3.06	3.29	2.49	3.47
KCl (S)†	25	-	3.05	3.35	2.45	3.51
KCl (S)	25	+	3.02	3.55	2.61	3.43
Group Means						
KCl			2.97	3.27	2.52	3.35
NaCl			3.01	3.28	2.49	3.32
LSD (P=0.05)			ns	ns	ns	ns
	0		3.04	3.25	2.52	3.31
	25		2.95	3.33	2.45	3.42
	50		2.98	3.26	2.54	3.28
LSD (P=0.05)			ns	ns	ns	ns
		-	2.96	3.20	2.49	3.26
		+	3.02	3.36	2.51	3.41
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.24	0.08	0.75	0.06
Source (S)	1	0.37	0.85	0.65	0.74
Rate (R)	2	0.22	0.74	0.51	0.31
S*R	2	0.19	0.21	1.00	0.17
I*R	2	0.31	0.47	0.69	0.56
S*I	1	0.41	0.15	0.30	0.69
I*S*R	2	0.97	0.18	0.78	0.28
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.15	0.69	0.68	0.80
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.08	0.28	0.71	0.73
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.91	0.33	0.62	0.36
all 0 vs 25 KCl	1	0.15	0.17	0.57	0.08
all 0 vs 50 KCl	1	0.06	0.66	0.68	0.41
all 0 vs 25 NaCl	1	0.22	0.84	0.40	0.94
all 0 vs 50 NaCl	1	0.86	0.62	0.99	0.66
C.V. (%)		6.8	11.4	11.2	10.8

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Thousand Kernel Weight of Bedford Barley in 1989

Treatment			Thousand Kernel Weight (g/1000 kernels)			
					University of Manitoba	
Cl^- Source	kg ha^{-1} Cl^- applied	Disease Inoculum applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	30.3	29.5	35.7	34.3
KCl	25	-	30.1	29.5	35.0	33.8
KCl	50	-	30.2	29.1	34.7	35.1
NaCl	0	-	29.8	29.1	34.9	34.7
NaCl	25	-	29.4	28.9	34.5	35.0
NaCl	50	-	29.1	30.7	35.4	34.2
KCl	0	+	29.6	28.2	34.5	33.4
KCl	25	+	30.1	30.6	33.6	35.3
KCl	50	+	30.4	29.8	36.6	35.0
NaCl	0	+	28.6	28.8	35.3	34.8
NaCl	25	+	28.9	29.2	34.9	33.5
NaCl	50	+	29.9	29.1	34.7	34.8
KCl (S)†	25	-	29.5	29.5	33.9	-
KCl (S)	25	+	30.4	28.9	34.9	-
Group Means						
KCl			30.1	29.5	35.0	34.5
NaCl			29.2	29.3	34.9	34.5
LSD (P=0.05)			ns	ns	ns	ns
	0		29.6	28.9	35.1	34.3
	25		29.6	29.6	34.5	34.4
	50		29.9	29.7	35.3	34.8
LSD (P=0.05)			ns	ns	ns	ns
		-	29.8	29.5	35.0	34.5
		+	29.5	29.3	34.9	34.5
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.63	0.56	0.76	0.91
Source (S)	1	0.15	0.74	0.83	0.93
Rate (R)	2	0.91	0.13	0.13	0.53
S*R	2	0.97	0.27	0.50	0.19
I*R	2	0.64	0.13	0.38	0.75
S*I	1	1.00	0.32	0.75	0.49
I*S*R	2	0.90	0.11	0.02 *	0.04 *
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.21	0.55	0.82	0.33
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.56	1.00	0.20	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.84	0.04 *	0.12	-
all 0 vs 25 KCl	1	0.43	0.02 *	0.11	0.64
all 0 vs 50 KCl	1	0.42	0.25	0.27	0.17
all 0 vs 25 NaCl	1	0.60	0.60	0.43	0.92
all 0 vs 50 NaCl	1	0.98	0.06	0.93	0.73
C.V. (%)		7.5	4.7	4.0	4.4

† (S) indicates placement of chloride fertilizer in the seed row

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Thousand Kernel Weight of Bedford Barley in 1990

Treatment			Thousand Kernel Weight (g/1000 kernels)			
					University of Manitoba	
Cl- Source	kg ha-1 Cl- applied	Disease Inoculum applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	33.0	34.9	38.7	38.4
KCl	25	-	34.1	35.7	40.1	40.2
KCl	50	-	31.8	36.2	39.4	40.0
NaCl	0	-	32.2	35.3	39.2	38.5
NaCl	25	-	32.2	36.5	40.1	40.0
NaCl	50	-	32.5	36.6	41.0	40.3
KCl	0	+	32.6	36.0	38.2	39.0
KCl	25	+	34.9	36.0	38.7	40.4
KCl	50	+	32.7	36.0	39.7	40.1
NaCl	0	+	34.0	36.1	38.9	38.0
NaCl	25	+	34.7	36.4	39.8	39.5
NaCl	50	+	33.2	36.3	40.0	40.2
KCl (S)†	25	-	34.7	37.2	39.6	-
KCl (S)	25	+	33.0	37.1	37.6	-
Group Means						
KCl			33.2	35.8	39.1	39.7
NaCl			33.1	36.2	39.8	39.4
LSD (P=0.05)			ns	ns	0.5	ns
	0		32.9	35.6	38.8	38.5
	25		33.9	36.2	39.7	40.0
	50		32.5	36.3	40.0	40.1
LSD (P=0.05)			ns	ns	0.6	0.6
		-	32.6	35.6	39.8	39.5
		+	33.7	36.2	39.2	39.5
LSD (P=0.05)			1.0	ns	0.5	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.05 *	0.37	0.02 *	0.99
Source (S)	1	0.90	0.20	0.005 **	0.26
Rate (R)	2	0.07	0.17	0.0002 **	0.0001 **
S*R	2	0.38	0.92	0.74	0.39
I*R	2	0.69	0.27	0.59	0.91
S*I	1	0.23	0.64	1.00	0.14
I*S*R	2	0.59	0.99	0.15	0.77
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.67	0.19	0.01 **	0.52
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.62	0.04 *	0.35	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.12	0.17	0.07	-
all 0 vs 25 KCl	1	0.04 *	0.50	0.09	0.0001 **
all 0 vs 50 KCl	1	0.37	0.27	0.04 *	0.0001 **
all 0 vs 25 NaCl	1	0.51	0.05 *	0.002 **	0.001 **
all 0 vs 50 NaCl	1	0.88	0.05 *	0.0001 **	0.0001 **
C.V. (%)		6.3	3.5	2.6	2.6

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Thousand Kernel Weight of Katepwa Wheat in 1989 and 1990

Treatment			Thousand Kernel Weight (g/1000 kernels)			
			1989		1990	
Cl- Source	kg ha-1 Cl- applied	Disease Inoculum applied	Carman	Portage	Carman	Portage
Treatment Means						
KCl	0	-	22.9	30.2	30.3	37.8
KCl	25	-	22.2	30.3	29.6	37.5
KCl	50	-	24.2	31.0	30.6	37.6
NaCl	0	-	22.6	30.0	31.5	37.2
NaCl	25	-	23.1	32.3	32.2	37.7
NaCl	50	-	23.0	32.3	34.7	37.5
KCl	0	+	23.3	31.8	33.6	38.0
KCl	25	+	24.1	31.3	32.8	38.0
KCl	50	+	23.6	31.9	33.4	37.6
NaCl	0	+	24.9	32.3	31.8	37.7
NaCl	25	+	24.4	32.9	33.8	38.4
NaCl	50	+	24.8	33.2	34.2	38.2
KCl (S)†	25	-	22.6	32.2	33.2	37.5
KCl (S)	25	+	25.2	33.2	33.3	37.4
Group Means						
KCl			23.4	31.1	31.7	37.7
NaCl			23.8	32.0	33.0	37.8
LSD (P=0.05)			ns	0.4	0.8	ns
	0		23.4	31.1	31.8	37.7
	25		23.4	31.7	32.1	37.9
	50		23.9	32.1	33.2	37.7
LSD (P=0.05)			ns	0.5	1.0	ns
		-	23.0	31.0	31.5	37.5
		+	24.2	32.2	33.3	38.0
LSD (P=0.05)			0.9	0.4	0.8	0.4

ANOVA	df	Pr > F			
Inoculum (I)	1	0.01 *	0.0001 **	0.0001 **	0.02 *
Source (S)	1	0.34	0.0001 **	0.003 **	0.90
Rate (R)	2	0.61	0.002 **	0.02 *	0.54
S*R	2	0.79	0.009 **	0.02 *	0.21
I*R	2	0.62	0.07	0.51	0.74
S*I	1	0.17	0.88	0.003 **	0.34
I*S*R	2	0.36	0.57	0.65	0.79
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.56	0.0001 **	0.0001 **	0.29
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.67	0.0006 **	0.001 **	0.97
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.28	0.0009 **	0.63	0.16
all 0 vs 25 KCl	1	0.65	0.38	0.34	0.76
all 0 vs 50 KCl	1	0.46	0.27	0.77	0.85
all 0 vs 25 NaCl	1	0.61	0.0001 **	0.06	0.19
all 0 vs 50 NaCl	1	0.47	0.0001 **	0.0001 **	0.58
C.V. (%)		7.8	2.9	5.4	2.1

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and Cochliobolus sativus Inoculum on Thousand Kernel Weight of Katepwa Wheat at Anola and Darlingford in 1989

Treatment		Thousand Kernel Weight (g/1000 kernels)			
		1989		1990	
Cl^- Source	kg ha^{-1} Cl^- applied	Anola	Darlingford	Anola	Darlingford
Treatment Means					
KCl	0	37.4	20.4	29.7	34.8
KCl	25	32.2	20.3	28.6	35.9
KCl	50	32.7	19.6	28.2	36.9
NaCl	0	32.0	19.9	29.1	36.0
NaCl	25	32.3	18.0	28.4	36.1
NaCl	50	32.5	20.2	28.4	36.4
KCl (S)†	25	32.9	21.1	29.4	35.7
Group Means					
KCl		34.1	20.1	28.8	35.9
NaCl		32.3	19.4	28.6	36.2
LSD (P=0.05)		1.7	ns	ns	ns
	0	34.7	20.1	29.4	35.4
	25	32.2	19.1	28.5	36.0
	50	32.6	19.9	28.3	36.7
LSD (P=0.05)		~2.0‡	ns	ns	0.8

ANOVA	df	Pr > F			
Source (S)	1	0.04 *	0.21	0.70	0.32
Rate (R)	1	0.04 *	0.35	0.19	0.01 *
S*R	2	0.03 *	0.14	0.85	0.12
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.96	0.28	0.97	0.75
broadcast vs seedrow (25Cl,KCl)	1	0.71	0.45	0.32	0.82
all 0 vs 25 KCl	1	0.03 *	0.88	0.26	0.34
all 0 vs 50 KCl	1	0.08	0.56	0.11	0.004 **
all 0 vs 25 NaCl	1	0.04 *	0.03 *	0.17	0.16
all 0 vs 50 NaCl	1	0.06	0.93	0.16	0.04 *
C.V. (%)		6.1	8.4	4.5	2.3

† (S) indicates placement of chloride fertilizer in the seed row
‡ LSD for comparison between rates 0 and 25 is 2.1, 0 and 50 is 2.1 and 25 and 50 is 2.0.
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Hectolitre Weights of Bedford Barley in 1989

Treatment			Hectolitre Weights (kg hL^{-1})			
					University of Manitoba	
Cl$^-$ Source	kg ha^{-1} Cl$^-$ applied	Disease Inoculum applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	61.5	59.9	65.3	63.8
KCl	25	-	60.8	59.4	63.7	62.7
KCl	50	-	63.1	58.8	63.2	64.5
NaCl	0	-	63.1	60.1	64.2	64.5
NaCl	25	-	61.8	59.4	63.5	62.3
NaCl	50	-	60.6	60.5	64.8	63.6
KCl	0	+	61.1	59.2	64.3	63.1
KCl	25	+	61.7	60.3	62.5	64.0
KCl	50	+	61.5	59.8	64.1	64.6
NaCl	0	+	60.4	58.8	64.4	64.4
NaCl	25	+	59.7	59.0	63.5	63.0
NaCl	50	+	61.2	59.1	62.7	63.3
KCl (S)†	25	-	60.5	59.8	61.6	-
KCl (S)	25	+	60.8	59.1	62.9	-
Group Means						
KCl			61.6	59.6	63.9	63.8
NaCl			61.1	59.5	63.8	63.5
LSD (P=0.05)			ns	ns	ns	ns
	0		61.5	59.5	64.5	63.9
	25		61.0	59.5	63.3	63.0
	50		61.6	59.5	63.7	64.0
LSD (P=0.05)			ns	ns	0.8	0.7
		-	61.8	59.7	64.1	63.6
		+	60.9	59.4	63.6	63.7
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.06	0.47	0.09	0.53
Source (S)	1	0.34	0.95	0.96	0.37
Rate (R)	2	0.83	0.97	0.008 **	0.01 **
S*R	2	0.62	0.61	0.54	0.01 **
I*R	2	0.59	0.44	0.95	0.11
S*I	1	0.32	0.13	0.79	0.84
I*S*R	2	0.11	0.66	0.01 **	0.68
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.22	0.94	0.56	0.01 **
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.60	0.64	0.007 **	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.52	0.24	0.66	-
all 0 vs 25 KCl	1	0.87	0.53	0.003 **	0.19
all 0 vs 50 KCl	1	0.27	0.83	0.06	0.18
all 0 vs 25 NaCl	1	0.67	0.78	0.03 *	0.004 **
all 0 vs 50 NaCl	1	0.73	0.56	0.09	0.27
C.V. (%)		3.7	2.9	2.1	1.9

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Hectolitre Weights of Bedford Barley in 1990

Treatment			Hectolitre Weights (kg hL^{-1})			
					University of Manitoba	
Cl- Source	kg ha^{-1} Cl- applied	Disease Inoculum applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	68.9	68.3	72.9	73.0
KCl	25	-	68.9	67.9	73.2	72.1
KCl	50	-	65.9	67.6	73.1	72.5
NaCl	0	-	67.6	67.7	73.7	73.6
NaCl	25	-	67.1	68.4	73.1	72.1
NaCl	50	-	67.2	68.2	73.7	72.4
KCl	0	+	68.2	68.3	73.2	73.0
KCl	25	+	69.7	68.5	72.4	72.5
KCl	50	+	67.5	67.3	72.7	72.7
NaCl	0	+	69.7	67.8	73.4	73.4
NaCl	25	+	68.9	68.2	72.7	72.5
NaCl	50	+	67.6	67.4	72.9	72.4
KCl (S)†	25	-	69.4	69.2	72.6	-
KCl (S)	25	+	68.1	68.6	71.6	-
Group Means						
KCl			68.2	68.0	72.9	72.6
NaCl			68.0	68.0	73.2	72.7
LSD (P=0.05)			ns	ns	0.3	ns
	0		68.6	68.0	73.3	73.2
	25		68.7	68.2	72.8	72.3
	50		67.1	67.6	73.1	72.5
LSD (P=0.05)			1.4	ns	0.3	0.3
		-	67.6	68.0	73.3	72.6
		+	68.6	67.9	72.9	72.7
LSD (P=0.05)			ns	ns	0.3	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.08	0.72	0.006 **	0.32
Source (S)	1	0.79	0.88	0.02 *	0.38
Rate (R)	2	0.03 *	0.09	0.03 *	0.0001 **
S*R	2	0.33	0.35	0.42	0.10
I*R	2	0.91	0.41	0.15	0.34
S*I	1	0.46	0.36	0.50	0.63
I*S*R	2	0.34	0.66	0.24	0.91
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.66	0.47	0.23	0.66
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.73	0.02 *	0.07	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.22	0.84	0.03 *	-
all 0 vs 25 KCl	1	0.38	0.61	0.03 *	0.0001 **
all 0 vs 50 KCl	1	0.02 *	0.10	0.08	0.004 **
all 0 vs 25 NaCl	1	0.47	0.41	0.06	0.0001 **
all 0 vs 50 NaCl	1	0.14	0.44	0.87	0.0002 **
C.V. (%)		3.3	1.4	0.87	0.81

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Hectolitre Weight of Katepwa Wheat in 1989 and 1990

Treatment			Hectolitre Weight (kg hL^{-1})			
			1989		1990	
Cl$^-$ Source	kg ha^{-1} Cl$^-$ applied	Disease Inoculum applied	Carman	Portage	Carman	Portage
Treatment Means						
KCl	0	-	75.2	78.9	82.7	83.4
KCl	25	-	73.6	80.0	81.4	83.2
KCl	50	-	76.8	79.8	81.2	82.5
NaCl	0	-	73.1	78.6	82.4	83.6
NaCl	25	-	74.9	79.7	81.9	83.2
NaCl	50	-	73.6	79.5	82.3	82.8
KCl	0	+	74.7	79.6	82.5	83.4
KCl	25	+	73.9	79.4	81.7	83.1
KCl	50	+	73.1	79.2	81.2	82.9
NaCl	0	+	76.3	79.1	81.3	83.2
NaCl	25	+	75.5	79.9	82.0	83.1
NaCl	50	+	76.3	79.0	81.6	82.8
KCl (S)†	25	-	72.8	79.0	81.6	83.3
KCl (S)	25	+	78.4	78.9	81.9	83.3
Group Means						
KCl			74.5	79.5	81.8	83.1
NaCl			74.9	79.3	81.9	83.1
LSD (P=0.05)			ns	ns	ns	ns
	0		74.8	79.0	82.2	83.4
	25		74.5	79.7	81.8	83.2
	50		74.9	79.5	81.6	82.7
LSD (P=0.05)			ns	0.5	ns	0.3
		-	74.5	79.4	82.0	83.1
		+	74.9	79.4	81.7	83.1
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.69	0.73	0.37	0.81
Source (S)	1	0.69	0.38	0.65	0.98
Rate (R)	2	0.92	0.05 *	0.18	0.0001 **
S*R	2	0.75	0.66	0.09	0.94
I*R	2	0.75	0.09	0.49	0.32
S*I	1	0.09	0.76	0.29	0.21
I*S*R	2	0.46	0.72	0.87	0.73
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.54	0.65	0.10	0.84
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.75	0.07	0.78	0.55
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.06	0.43	0.74	0.60
all 0 vs 25 KCl	1	0.47	0.07	0.13	0.16
all 0 vs 50 KCl	1	0.92	0.13	0.02 *	0.0001 **
all 0 vs 25 NaCl	1	0.79	0.06	0.55	0.16
all 0 vs 50 NaCl	1	0.93	0.52	0.54	0.0002 **
C.V. (%)		5.5	1.1	1.5	0.5

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Percent Thin Kernels of Bedford Barley in 1989

Treatment			Thin Kernels (%)			
					University of Manitoba	
Cl- Source	kg ha-1 Cl- applied	Disease Inoculum applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	22.7	22.3	5.1	6.8
KCl	25	-	26.3	23.9	6.5	7.3
KCl	50	-	21.8	24.2	7.3	6.3
NaCl	0	-	22.9	19.9	5.5	5.7
NaCl	25	-	25.3	21.8	6.7	8.5
NaCl	50	-	25.9	18.9	6.5	6.6
KCl	0	+	23.5	24.3	6.1	7.2
KCl	25	+	21.4	19.3	7.3	6.5
KCl	50	+	23.0	21.6	6.1	6.3
NaCl	0	+	26.6	22.4	5.7	5.6
NaCl	25	+	25.5	25.0	7.2	8.5
NaCl	50	+	21.2	25.7	8.4	7.5
KCl (S)†	25	-	23.8	21.4	8.8	-
KCl (S)	25	+	23.3	21.7	7.5	-
Group Means						
KCl			23.0	22.5	6.4	6.7
NaCl			24.7	22.2	6.7	7.1
LSD (P=0.05)			ns	ns	ns	ns
	0		23.8	22.2	5.6	6.3
	25		24.5	22.4	6.9	7.7
	50		23.2	22.6	7.1	6.7
LSD (P=0.05)			ns	ns	1.1	0.9
		-	24.1	21.8	6.3	6.9
		+	23.6	22.9	6.8	6.9
LSD (P=0.05)			ns	ns	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.94	0.43	0.25	0.86
Source (S)	1	0.49	0.77	0.53	0.37
Rate (R)	2	0.86	0.98	0.01 **	0.01 **
S*R	2	0.92	0.56	0.75	0.007 **
I*R	2	0.62	0.59	0.97	0.61
S*I	1	0.83	0.06	0.47	0.65
I*S*R	2	0.45	0.41	0.16	0.67
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.75	0.75	0.45	0.01 **
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.81	0.45	0.03 *	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.71	0.48	0.87	-
all 0 vs 25 KCl	1	0.70	0.73	0.04 *	0.30
all 0 vs 50 KCl	1	0.60	0.77	0.08	0.97
all 0 vs 25 NaCl	1	0.93	0.66	0.03 *	0.0003 **
all 0 vs 50 NaCl	1	0.66	0.99	0.005 **	0.19
C.V. (%)		36.9	25.8	26.4	23.4

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Percent Thin Kernels of Bedford Barley in 1990

Treatment			Thin Kernels (%)			
Cl- Source	kg ha-1 Cl- applied	Disease Inoculum applied	Carman	Portage	University of Manitoba	
					Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	52.2	41.6	23.5	26.7
KCl	25	-	51.3	37.3	21.9	26.8
KCl	50	-	54.3	38.9	24.2	26.7
NaCl	0	-	50.5	40.2	23.3	26.6
NaCl	25	-	56.0	34.8	22.8	25.7
NaCl	50	-	54.1	35.4	19.0	24.3
KCl	0	+	53.3	36.6	29.3	28.9
KCl	25	+	47.3	37.9	26.6	26.6
KCl	50	+	55.3	37.6	27.1	27.2
NaCl	0	+	50.4	37.3	27.3	29.2
NaCl	25	+	50.3	38.1	27.1	28.0
NaCl	50	+	55.9	38.3	24.8	26.1
KCl (S)†	25	-	50.8	31.3	26.0	-
KCl (S)	25	+	53.9	35.1	34.6	-
Group Means						
KCl			52.3	38.3	25.4	27.1
NaCl			52.8	37.4	24.0	26.7
LSD (P=0.05)			ns	ns	ns	ns
	0		51.6	38.9	25.9	27.9
	25		51.2	37.0	24.6	26.8
	50		54.9	37.6	23.8	26.1
LSD (P=0.05)			ns	ns	ns	ns
		-	53.1	38.0	22.4	26.1
		+	52.0	37.6	27.0	27.7
LSD (P=0.05)			ns	ns	1.8	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.54	0.76	0.0001 **	0.09
Source (S)	1	0.69	0.47	0.13	0.59
Rate (R)	2	0.11	0.48	0.18	0.27
S*R	2	0.26	0.94	0.14	0.62
I*R	2	0.21	0.17	0.97	0.79
S*I	1	0.84	0.25	0.93	0.45
I*S*R	2	0.93	0.95	0.55	0.89
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.28	0.40	0.22	0.48
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.90	0.05 *	0.10	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.08	0.37	0.002 **	-
all 0 vs 25 KCl	1	0.31	0.47	0.29	0.40
all 0 vs 50 KCl	1	0.16	0.72	0.90	0.50
all 0 vs 25 NaCl	1	0.50	0.19	0.55	0.47
all 0 vs 50 NaCl	1	0.15	0.26	0.01 **	0.05 *
C.V. (%)		12.3	14.1	16.8	14.2

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Kernel Plumpness of Bedford Barley in 1989

Treatment			Plump Kernels (%)			
Cl- Source	kg ha^{-1} Cl- applied	Disease Inoculum applied	Carman	Portage	University of Manitoba	
					Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	8.0	10.3	60.8	55.8
KCl	25	-	5.6	9.5	55.9	51.9
KCl	50	-	8.2	8.6	53.1	57.0
NaCl	0	-	5.9	10.8	59.6	58.6
NaCl	25	-	5.7	10.4	54.7	49.5
NaCl	50	-	5.5	11.6	57.9	51.8
KCl	0	+	4.9	6.6	56.8	49.8
KCl	25	+	7.2	12.4	50.9	56.8
KCl	50	+	5.2	8.9	58.1	55.2
NaCl	0	+	4.5	8.6	57.3	56.4
NaCl	25	+	4.4	7.6	53.3	48.5
NaCl	50	+	6.0	8.0	51.1	51.5
KCl (S)†	25	-	5.7	8.7	45.8	-
KCl (S)	25	+	6.1	10.7	51.4	-
Group Means						
KCl			6.6	9.4	55.9	54.4
NaCl			5.3	9.6	55.6	52.7
LSD (P=0.05)			ns	ns	ns	ns
	0		5.8	9.2	58.6	55.1
	25		5.7	10.0	53.7	51.7
	50		6.3	9.2	55.0	53.9
LSD (P=0.05)			ns	ns	3.9	ns
		-	6.5	10.2	57.0	54.1
		+	5.3	8.7	54.6	53.0
LSD (P=0.05)			ns	1.4	ns	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.08	0.04 *	0.14	0.49
Source (S)	1	0.14	0.81	0.85	0.27
Rate (R)	2	0.83	0.50	0.04 *	0.17
S*R	2	0.86	0.15	0.91	0.01 **
I*R	2	0.43	0.21	0.80	0.26
S*I	1	0.57	0.05 *	0.51	0.96
I*S*R	2	0.17	0.14	0.11	0.38
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.31	0.65	0.89	0.01 **
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.93	0.59	0.01 **	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.51	0.30	0.90	-
all 0 vs 25 KCl	1	0.42	0.07	0.03 *	0.73
all 0 vs 50 KCl	1	0.44	0.66	0.20	0.68
all 0 vs 25 NaCl	1	0.67	0.99	0.05 *	0.009 **
all 0 vs 50 NaCl	1	0.77	0.50	0.08	0.13
C.V. (%)		48.7	28.4	12.0	11.8

† (S) indicates placement of chloride fertilizer in the seed row
*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer and *Cochliobolus sativus* Inoculum on Kernel Plumpness of Bedford Barley in 1990

Treatment			Plump Kernels (%)			
					University of Manitoba	
Cl- Source	kg ha-1 Cl- applied	Disease Inoculum applied	Carman	Portage	Common root rot expt.	Spot blotch expt.
Treatment Means						
KCl	0	-	39.1	52.6	74.1	71.4
KCl	25	-	40.1	56.1	76.6	71.7
KCl	50	-	29.3	55.2	73.9	71.7
NaCl	0	-	36.8	54.1	74.7	71.9
NaCl	25	-	31.1	60.8	75.1	72.7
NaCl	50	-	31.9	60.1	79.9	74.5
KCl	0	+	35.9	58.3	67.8	69.2
KCl	25	+	46.3	56.7	70.9	71.7
KCl	50	+	33.5	56.2	70.3	71.4
NaCl	0	+	42.3	57.1	70.7	68.3
NaCl	25	+	41.9	56.6	70.8	70.1
NaCl	50	+	34.4	55.1	73.4	72.7
KCl (S)†	25	-	41.6	65.1	71.3	-
KCl (S)	25	+	35.1	60.3	61.5	-
Group Means						
KCl			37.4	55.8	72.3	71.2
NaCl			36.4	57.3	74.1	71.7
LSD (P=0.05)			ns	ns	ns	ns
	0		38.5	55.5	71.8	70.2
	25		39.8	57.6	73.4	71.6
	50		32.2	56.7	74.4	72.6
LSD (P=0.05)			ns	ns	ns	ns
		-	34.7	56.5	75.7	72.3
		+	39.2	56.7	70.6	70.6
LSD (P=0.05)			ns	ns	2.1	ns

ANOVA	df	Pr > F			
Inoculum (I)	1	0.12	0.91	0.0001 **	0.09
Source (S)	1	0.71	0.37	0.09	0.61
Rate (R)	2	0.06	0.60	0.16	0.17
S*R	2	0.34	0.85	0.13	0.57
I*R	2	0.52	0.20	1.00	0.72
S*I	1	0.49	0.18	0.89	0.36
I*S*R	2	0.72	0.92	0.57	0.97
Contrasts					
KCl vs NaCl at 25 and 50 Cl	1	0.45	0.26	0.19	0.49
b'cast vs seedrow (25Cl,KCl,-inoc)	1	0.82	0.02 *	0.07	-
b'cast vs seedrow (25Cl,KCl,+inoc)	1	0.09	0.33	0.002 **	-
all 0 vs 25 KCl	1	0.25	0.70	0.28	0.33
all 0 vs 50 KCl	1	0.08	0.94	0.89	0.39
all 0 vs 25 NaCl	1	0.62	0.17	0.51	0.44
all 0 vs 50 NaCl	1	0.19	0.36	0.008 **	0.03 *
C.V. (%)		30.5	11.1	6.9	6.0

† (S) indicates placement of chloride fertilizer in the seed row
, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Cultivar on the Response of Barley and Wheat to Chloride Fertilizers

Preliminary Results
1990 Field Trials

University of Manitoba

Effect of Chloride Fertilizer on Grain Yield of Several Barley and Wheat Cultivars in 1990

Treatment		Wheat Trial - Anola		Barley Trial - Portage	
kg ha^{-1} Cl$^-$ Applied	Cl$^-$ Source	Cultivar	Grain Yield (kg ha^{-1})	Cultivar	Grain Yield (kg ha^{-1})
Treatment Means					
0	-	Katepwa	2684	Bedford	6036
50	KCl	Katepwa	2762	Bedford	5852
50	NaCl	Katepwa	2819	Bedford	5824
0	-	Roblin	2690	Brier	6100
50	KCl	Roblin	3070	Brier	6784
50	NaCl	Roblin	3294	Brier	6348
0	-	Biggar	2595	Argyle	5701
50	KCl	Biggar	2732	Argyle	6196
50	NaCl	Biggar	2515	Argyle	5742
0	-	Marshall	3195	Heartland	4966
50	KCl	Marshall	3552	Heartland	5666
50	NaCl	Marshall	3668	Heartland	6075
Group Means					
0	-		2791		5701
50	KCl		3029		6124
50	NaCl		3074		5997
LSD (P=0.05)			243		ns
		Katepwa	2755	Bedford	5904
		Roblin	3018	Brier	6411
		Biggar	2614	Argyle	5879
		Marshall	3472	Heartland	5569
LSD (P=0.05)			281		443

ANOVA	df	Pr > F			
Cultivar (C)	3		0.0001 **		0.004 **
Treatment (T)	2		0.05 *		0.09
C*T	6		0.51		0.19
Contrasts					
KCl vs NaCl	1	Katepwa	0.81	Bedford	0.94
0 vs 50 Cl (both sources)	1	Katepwa	0.62	Bedford	0.55
KCl vs NaCl	1	Roblin	0.36	Brier	0.26
0 vs 50 Cl (both sources)	1	Roblin	0.02 *	Brier	0.17
KCl vs NaCl	1	Biggar	0.38	Argyle	0.24
0 vs 50 Cl (both sources)	1	Biggar	0.90	Argyle	0.42
KCl vs NaCl	1	Marshall	0.63	Heartland	0.29
0 vs 50 Cl (both sources)	1	Marshall	0.05 *	Heartland	0.009 **
C.V. (%)			14.2		11.2

*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer on Midseason Plant Tissue Chloride Concentration of Several Barley and Wheat Cultivars in 1990

Treatment		Wheat Trial - Anola		Barley Trial - Portage	
kg ha^{-1} Cl^- Applied	Cl^- Source	Cultivar	Cl^- Concentration ($\mu g\ g^{-1}$)	Cultivar	Cl^- Concentration ($\mu g\ g^{-1}$)
Treatment Means					
0	-	Katepwa	2378	Bedford	6121
50	KCl	Katepwa	8013	Bedford	13788
50	NaCl	Katepwa	6871	Bedford	13457
0	-	Roblin	2005	Brier	6547
50	KCl	Roblin	6016	Brier	15298
50	NaCl	Roblin	6050	Brier	15215
0	-	Biggar	2645	Argyle	7033
50	KCl	Biggar	8916	Argyle	15881
50	NaCl	Biggar	9448	Argyle	15436
0	-	Marshall	2640	Heartland	5523
50	KCl	Marshall	9248	Heartland	15778
50	NaCl	Marshall	8850	Heartland	14863
Group Means					
0	-		2417		6306
50	KCl		8048		15186
50	NaCl		7805		14743
LSD (P=0.05)			505		929
		Katepwa	5754	Bedford	11122
		Roblin	4690	Brier	12353
		Biggar	7003	Argyle	12783
		Marshall	6913	Heartland	12054
LSD (P=0.05)			583		1072

ANOVA	df	Pr > F			
Cultivar (C)	3		0.0001 **		0.02 *
Treatment (T)	2		0.0001 **		0.0001 **
C*T	6		0.0006 **		0.61
Contrasts					
KCl vs NaCl	1	Katepwa	0.03 *	Bedford	0.72
0 vs 50 Cl (both sources)	1	Katepwa	0.0001 **	Bedford	0.0001 **
KCl vs NaCl	1	Roblin	0.95	Brier	0.93
0 vs 50 Cl (both sources)	1	Roblin	0.0001 **	Brier	0.0001 **
KCl vs NaCl	1	Biggar	0.30	Argyle	0.63
0 vs 50 Cl (both sources)	1	Biggar	0.0001 **	Argyle	0.0001 **
KCl vs NaCl	1	Marshall	0.43	Heartland	0.33
0 vs 50 Cl (both sources)	1	Marshall	0.0001 **	Heartland	0.0001 **
C.V. (%)			14.3		13.3

*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer on Midseason Uptake of Chloride of Several Barley and Wheat Cultivars in 1990

Treatment		Wheat Trial - Anola		Barley Trial - Portage	
kg ha^{-1} Cl$^-$ Applied	Cl$^-$ Source	Cultivar	Cl$^-$ Uptake (kg ha^{-1})	Cultivar	Cl$^-$ Uptake (kg ha^{-1})
Treatment Means					
0	-	Katepwa	5.1	Bedford	22.3
50	KCl	Katepwa	18.2	Bedford	43.9
50	NaCl	Katepwa	15.2	Bedford	43.8
0	-	Roblin	4.0	Brier	21.2
50	KCl	Roblin	15.9	Brier	56.0
50	NaCl	Roblin	17.3	Brier	49.2
0	-	Biggar	6.0	Argyle	18.7
50	KCl	Biggar	19.4	Argyle	48.8
50	NaCl	Biggar	22.9	Argyle	34.4
0	-	Marshall	5.7	Heartland	12.9
50	KCl	Marshall	20.3	Heartland	43.5
50	NaCl	Marshall	21.2	Heartland	30.6
Group Means					
0	-		5.2		18.8
50	KCl		18.5		48.0
50	NaCl		19.2		39.5
LSD (P=0.05)			2.0		5.2
		Katepwa	12.8	Bedford	36.7
		Roblin	12.4	Brier	42.1
		Biggar	16.1	Argyle	34.0
		Marshall	15.8	Heartland	29.0
LSD (P=0.05)			2.3		6.0

ANOVA	df	Pr > F			
Cultivar (C)	3		0.002 **		0.0006 **
Treatment (T)	2		0.0001 **		0.0001 **
C*T	6		0.19		0.28
Contrasts					
KCl vs NaCl	1	Katepwa	0.14	Bedford	0.99
0 vs 50 Cl (both sources)	1	Katepwa	0.0001 **	Bedford	0.0001 **
KCl vs NaCl	1	Roblin	0.48	Brier	0.19
0 vs 50 Cl (both sources)	1	Roblin	0.0001 **	Brier	0.0001 **
KCl vs NaCl	1	Biggar	0.08	Argyle	0.007 **
0 vs 50 Cl (both sources)	1	Biggar	0.0001 **	Argyle	0.0001 **
KCl vs NaCl	1	Marshall	0.63	Heartland	0.02 *
0 vs 50 Cl (both sources)	1	Marshall	0.0001 **	Heartland	0.0001 **
C.V. (%)			23.7		25.3

*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer on Midseason Plant Tissue Nitrate Concentration of Several Barley and Wheat Cultivars in 1990

Treatment		Wheat Trial - Anola		Barley Trial - Portage	
kg ha^{-1} Cl^- Applied	Cl^- Source	Cultivar	NO_3^- Concentration ($\mu g\ g^{-1}$)	Cultivar	NO_3^- Concentration ($\mu g\ g^{-1}$)
Treatment Means					
0	-	Katepwa	1501	Bedford	2514
50	KCl	Katepwa	1016	Bedford	2051
50	NaCl	Katepwa	1295	Bedford	2572
0	-	Roblin	1155	Brier	2534
50	KCl	Roblin	897	Brier	2532
50	NaCl	Roblin	1204	Brier	2621
0	-	Biggar	2211	Argyle	2634
50	KCl	Biggar	1896	Argyle	3148
50	NaCl	Biggar	2437	Argyle	2789
0	-	Marshall	2236	Heartland	3023
50	KCl	Marshall	1812	Heartland	2620
50	NaCl	Marshall	1720	Heartland	2562
Group Means					
0	-		1776		2676
50	KCl		1405		2588
50	NaCl		1664		2636
LSD (P=0.05)			ns		ns
		Katepwa	1271	Bedford	2379
		Roblin	1085	Brier	2562
		Biggar	2181	Argyle	2857
		Marshall	1923	Heartland	2735
LSD (P=0.05)			456		ns

ANOVA	df		Pr > F		
Cultivar (C)	3		0.0001 **		0.27
Treatment (T)	2		0.17		0.92
C*T	6		0.88		0.64
Contrasts					
KCl vs NaCl	1	Katepwa	0.48	Bedford	0.24
0 vs 50 Cl (both sources)	1	Katepwa	0.32	Bedford	0.60
KCl vs NaCl	1	Roblin	0.44	Brier	0.84
0 vs 50 Cl (both sources)	1	Roblin	0.76	Brier	0.91
KCl vs NaCl	1	Biggar	0.18	Argyle	0.42
0 vs 50 Cl (both sources)	1	Biggar	0.90	Argyle	0.39
KCl vs NaCl	1	Marshall	0.82	Heartland	0.90
0 vs 50 Cl (both sources)	1	Marshall	0.17	Heartland	0.26
C.V. (%)			42.3		29.1

*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer on Midseason Plant Tissue Ammonium Concentration of Several Barley and Wheat Cultivars in 1990

Treatment		Wheat Trial - Anola		Barley Trial - Portage	
kg ha^{-1} Cl^- Applied	Cl^- Source	Cultivar	NH_4^+ Concentration ($\mu g\ g^{-1}$)	Cultivar	NH_4^+ Concentration ($\mu g\ g^{-1}$)
Treatment Means					
0	-	Katepwa	930	Bedford	807
50	KCl	Katepwa	836	Bedford	559
50	NaCl	Katepwa	830	Bedford	776
0	-	Roblin	464	Brier	873
50	KCl	Roblin	508	Brier	1070
50	NaCl	Roblin	657	Brier	934
0	-	Biggar	2207	Argyle	992
50	KCl	Biggar	2549	Argyle	1231
50	NaCl	Biggar	2504	Argyle	1019
0	-	Marshall	1579	Heartland	1210
50	KCl	Marshall	2067	Heartland	1253
50	NaCl	Marshall	1777	Heartland	1353
Group Means					
0	-		1295		971
50	KCl		1490		1028
50	NaCl		1442		1020
LSD (P=0.05)			ns		ns
		Katepwa	865	Bedford	714
		Roblin	543	Brier	959
		Biggar	2420	Argyle	1080
		Marshall	1808	Heartland	1272
LSD (P=0.05)			363		185

ANOVA	df	Pr > F			
Cultivar (C)	3		0.0001 **		0.0001 **
Treatment (T)	2		0.44		0.74
C*T	6		0.84		0.31
Contrasts					
KCl vs NaCl	1	Katepwa	0.99	Bedford	0.18
0 vs 50 Cl (both sources)	1	Katepwa	0.72	Bedford	0.32
KCl vs NaCl	1	Roblin	0.64	Brier	0.40
0 vs 50 Cl (both sources)	1	Roblin	0.66	Brier	0.36
KCl vs NaCl	1	Biggar	0.88	Argyle	0.19
0 vs 50 Cl (both sources)	1	Biggar	0.24	Argyle	0.34
KCl vs NaCl	1	Marshall	0.36	Heartland	0.54
0 vs 50 Cl (both sources)	1	Marshall	0.21	Heartland	0.50
C.V. (%)			38.6		27.5

*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer on Thousand Kernel Weight of Several Barley and Wheat Cultivars in 1990

Treatment		Wheat Trial - Anola		Barley Trial - Portage	
kg ha^{-1} Cl$^-$ Applied	Cl$^-$ Source	Cultivar	Thousand Kernel Weight (g/1000 kernels)	Cultivar	Thousand Kernel Weight (g/1000 kernels)
Treatment Means					
0	-	Katepwa	33.2	Bedford	36.1
50	KCl	Katepwa	32.8	Bedford	36.5
50	NaCl	Katepwa	32.5	Bedford	36.1
0	-	Roblin	33.6	Brier	39.2
50	KCl	Roblin	35.4	Brier	38.5
50	NaCl	Roblin	35.7	Brier	38.9
0	-	Biggar	32.9	Argyle	36.2
50	KCl	Biggar	33.4	Argyle	36.5
50	NaCl	Biggar	32.1	Argyle	36.2
0	-	Marshall	31.3	Heartland	37.6
50	KCl	Marshall	31.9	Heartland	38.2
50	NaCl	Marshall	32.3	Heartland	38.5
Group Means					
0	-		32.7		37.3
50	KCl		33.4		37.4
50	NaCl		33.2		37.4
LSD (P=0.05)			ns		ns
		Katepwa	32.8	Bedford	36.2
		Roblin	34.9	Brier	38.9
		Biggar	32.8	Argyle	36.3
		Marshall	31.8	Heartland	38.1
LSD (P=0.05)			0.8		1.0

ANOVA	df	Pr > F			
Cultivar (C)	3		0.0001 **		0.0001 **
Treatment (T)	2		0.22		0.94
C*T	6		0.05 *		0.92
Contrasts					
KCl vs NaCl	1	Katepwa	0.70	Bedford	0.62
0 vs 50 Cl (both sources)	1	Katepwa	0.35	Bedford	0.77
KCl vs NaCl	1	Roblin	0.68	Brier	0.62
0 vs 50 Cl (both sources)	1	Roblin	0.003 **	Brier	0.51
KCl vs NaCl	1	Biggar	0.08	Argyle	0.73
0 vs 50 Cl (both sources)	1	Biggar	0.82	Argyle	0.86
KCl vs NaCl	1	Marshall	0.59	Heartland	0.73
0 vs 50 Cl (both sources)	1	Marshall	0.19	Heartland	0.37
C.V. (%)			3.8		4.0

*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer on Hectolitre Weights of Several Barley and Wheat Cultivars in 1990

Treatment		Wheat Trial - Anola		Barley Trial - Portage	
kg ha^{-1} Cl^- Applied	Cl^- Source	Cultivar	Hectolitre Weight (kg hL^{-1})	Cultivar	Hectolitre Weight(kg hL^{-1})
Treatment Means					
0	-	Katepwa	79.8	Bedford	68.8
50	KCl	Katepwa	79.7	Bedford	68.3
50	NaCl	Katepwa	79.4	Bedford	67.6
0	-	Roblin	77.7	Brier	63.7
50	KCl	Roblin	78.7	Brier	63.6
50	NaCl	Roblin	79.4	Brier	62.9
0	-	Biggar	75.3	Argyle	63.8
50	KCl	Biggar	75.2	Argyle	63.7
50	NaCl	Biggar	73.2	Argyle	62.7
0	-	Marshall	77.7	Heartland	63.6
50	KCl	Marshall	78.3	Heartland	63.6
50	NaCl	Marshall	78.4	Heartland	62.4
Group Means					
0	-		77.6		65.0
50	KCl		78.0		64.8
50	NaCl		77.6		63.9
LSD (P=0.05)			ns		0.8
		Katepwa	79.6	Bedford	68.2
		Roblin	78.6	Brier	63.4
		Biggar	74.6	Argyle	63.4
		Marshall	78.2	Heartland	63.2
LSD (P=0.05)			0.9		0.9

ANOVA	df	Pr > F			
Cultivar (C)	3		0.0001 **		0.0001 **
Treatment (T)	2		0.58		0.02 *
C*T	6		0.04 *		1.00
Contrasts					
KCl vs NaCl	1	Katepwa	0.67	Bedford	0.33
0 vs 50 Cl (both sources)	1	Katepwa	0.69	Bedford	0.20
KCl vs NaCl	1	Roblin	0.34	Brier	0.40
0 vs 50 Cl (both sources)	1	Roblin	0.04 *	Brier	0.54
KCl vs NaCl	1	Biggar	0.01 *	Argyle	0.23
0 vs 50 Cl (both sources)	1	Biggar	0.10	Argyle	0.39
KCl vs NaCl	1	Marshall	0.88	Heartland	0.11
0 vs 50 Cl (both sources)	1	Marshall	0.34	Heartland	0.40
C.V.			1.7		2.1

*, ** Significant at the 0.05 and 0.01 levels respectively.

Effect of Chloride Fertilizer on Kernel Plumpness of Several Barley Cultivars in 1990

Treatment		Cultivar	Plump Kernels (%)	Thin Kernels (%)
kg ha^{-1} Cl$^-$ Applied	Cl$^-$ Source			
Treatment Means				
0	-	Bedford	60.0	34.8
50	KCl	Bedford	55.9	37.5
50	NaCl	Bedford	50.4	42.5
0	-	Brier	55.2	37.2
50	KCl	Brier	56.8	36.3
50	NaCl	Brier	53.4	37.8
0	-	Argyle	69.7	24.7
50	KCl	Argyle	71.5	23.3
50	NaCl	Argyle	67.5	25.5
0	-	Heartland	55.8	34.2
50	KCl	Heartland	56.7	33.1
50	NaCl	Heartland	55.8	32.4
Group Means				
0	-		60.1	32.7
50	KCl		60.2	32.6
50	NaCl		56.8	34.5
LSD (P=0.05)			ns	ns
		Bedford	55.4	38.2
		Brier	55.1	37.1
		Argyle	69.5	24.5
		Heartland	56.1	33.2
LSD (P=0.05)			5.3	4.0

ANOVA	df		Pr > F	
Cultivar (C)	3		0.0001 **	0.0001 **
Treatment (T)	2		0.24	0.46
C*T	6		0.84	0.64
Contrasts				
KCl vs NaCl	1	Bedford	0.24	0.16
0 vs 50 Cl (both sources)	1	Bedford	0.10	0.09
KCl vs NaCl	1	Brier	0.46	0.67
0 vs 50 Cl (both sources)	1	Brier	0.98	0.96
KCl vs NaCl	1	Argyle	0.39	0.54
0 vs 50 Cl (both sources)	1	Argyle	0.96	0.93
KCl vs NaCl	1	Heartland	0.85	0.83
0 vs 50 Cl (both sources)	1	Heartland	0.91	0.64
C.V. (%)			13.5	18.1

*, ** Significant at the 0.05 and 0.01 levels respectively.