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Spring Wheat Response to Potassium and Chloride

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Very limited soil fertility research with potassium (K) fertilizers was conducted by the Montana Agricultural Experiment Station or Cooperative Extension Service prior to 1960. Dryland winter wheat research during the 1960s indicated that potash (potassium chloride, KCl) responses could be expected frequently, even though soil K levels were considered very high. About half of the irrigated spring wheat trials during this period had two to eight bu/a potash responses. Again, the soil K levels were very high, and the responses were not predictable by the soil analysis. Cool, wet soil conditions limited potassium availability and explained the poor correlation with K soil analysis.

During the early 1970s with funding from the MSU fertilizer research and education program, predicting potash response became a major focus of field and laboratory research. Eventually, potash response data were collected from 23 spring wheat locations. Of these locations, *only six* had statistically significant potash responses. The average response was 1.6 bu/a. Potash rates varied from 20 to 40 lbs K_2O/a. The responses occurred at yield levels ranging from 16 to 60 bu/a without any predictable response from the K soil analysis.

Research emphasis shifted to no-till cropping systems and the other component of potash fertilizer, chloride (Cl), during the 1980s. Chloride fertilization suppressed some plant diseases and eliminated a physiological leaf spot complex associated with certain winter wheat varieties (*Fertilizer Facts Nos. 3 and 16*). Potash variables were included in no-till nutrient management research with results similar to previous studies. Eight spring wheat locations were studied with *only one* being statistically significant (average response of 2.9 bu/a).

During the early 1990s, the effect of K on spring wheat sawfly infestation and damage was investigated with inconclusive results. However, these trials did indicate that potash yield response could be due to K, Cl or both, with optimum response occurring with 20 to 30 lbs K_2O or Cl per acre. As a result of this preliminary research, K and Cl variables were included in subsequent spring wheat research with the objective of surveying response to K and Cl additions.

Thirty research locations were selected with the following criteria: representative soils, sufficient soil water for crop production (as determined by the Brown probe), and good cooperators with optimum agronomic management. Potassium and Cl treatments of 20 or 30 lbs/a applied separately and together were applied with adequate nitrogen (N) and phosphorus (P). Treatments included KNO_3, NH_4Cl and KCl. The 30 lbs/a rate was used on high yield potential sites (> than 40 bu/a). Nitrogen, K, and Cl were broadcast while planting and P was applied with the seed. The spring wheat variety was 'Amidon.' Fertilizer sources were urea, treble superphosphate, monoammonium phosphate, potassium chloride, potassium nitrate, and ammonium chloride. Plot size was six rows wide and 20 feet long. Locations were characterized by standard soil analyses. Ammonium acetate extractable K was determined from 0-6 inch soil samples. Calcium nitrate extractable Cl was measured from 0-1 foot and 1-2 foot depth soil samples.

Grain yield responses to K and Cl fertilization and associated K and Cl soil analyses are shown in Table 1. Response refers to the difference between appropriate treatment means. For example, K or Cl response was determined by contrasting the optimum N-P-K-Cl treatment and a similar treatment without K or Cl. Most of the experiments were conducted on a conventional alternate crop-fallow cropping system. However, some experiments (footnote) were on chemical fallow, no-till recrop, and conventionally tilled recrop. Grain yields averaged 46 bu/a and ranged from 16 bu/a at Ledger in 1994 to 82 bu/a at Benchland in 1993. Yield responses were averaged by location and analyzed by a t-test. The average response to K was 1.9 bu/a, and the average response to Cl was 1.0 bu/a. Both response averages were significant at the 5% level across all locations. The greatest K response was 13.2 bu/a at Ethridge in 1995, and the greatest Cl response was 5.3 bu/a at Cut Bank (east) in 1993.

As indicated in Table 1, K or Cl response in these studies was not predictable by soil analyses. Plant analysis may be a better indicator of spring wheat Cl status. Research from other locations in Montana and other states had found soil and plant analysis as useful indicators of K and Cl response. Extractable K levels were generally very high, averaging 388 ppm. Only three locations had K levels below 250 ppm, however, four locations had K levels that exceeded 500 ppm. Soil Cl levels averaged 36 lbs/a with a range of 4-139 lbs/a. The literature suggests that spring wheat will respond to Cl when soil extractable Cl is less than 60 lbs/a in a two foot soil sample. In this database, only three locations had Cl levels that exceeded 60 lbs/a. Montana winter wheat Cl research suggests an optimum of 30 lbs Cl/a in the top two feet of the profile. Residual Cl levels below this initial level increase the likelihood of a Cl response for winter wheat.

Fertilizer Facts:

- Spring wheat growers may observe a 1-2 bu/a response by adding 20 to 30 lbs K_2O/a as potash (0-0-60) to an optimum N and P fertilizer program.
- Spring wheat response to potash was not predictable with K or Cl soil analyses in these studies.
- Potash did not affect grain protein levels.
- Potash usually enhances the onset of crop maturity.

Edited by Jeff Jacobsen, Extension Soil Scientist

Table 1. Summary of Spring Wheat Response to Potassium (K) and Chloride (Cl).

	Average	**K**		**Cl**	
Location[†]	**Site Yield**	**Response**	**Soil Analysis**[#]	**Response**	**Soil Analysis**[§]
	----bu/a----	*----bu/a----*	*----ppm----*	*----bu/a----*	*----lbs/a----*
	1993				
Benchland[1]	82	4.6	356	0.2	47
Cut Bank (east)	35	-4.5	284	5.3	30
Cut Bank (north)	68	1.6	354	-0.8	32
Dodson	29	-0.5	462	-1.6	38
Ethridge	33	-1.8	455	3.1	34
Havre[6]	30	1.6	417	1.4	139
Hogeland	50	3.7	372	-1.1	46
Inverness	57	3.1	295	-2.4	34
Joplin[2]	66	1.6	409	-0.6	59
Shonkin[1]	40	-0.4	350	-0.9	55
Loma[3]	47	2.7	407	1.5	34
Loring	51	5.1	481	1.4	29
Lothair	68	4.4*	603	-1.0	71
	1994				
Cut Bank (east)	33	1.1	192	1.2	4

Cut Bank (north)	38	2.4	346	2.9	20
Ethridge	28	2.2	401	0.8	79
Inverness[4]	49	2.2	512	2.0	18
Joplin[2,5]	38	4.5*	225	4.8*	5
Ledger[3]	16	-0.6	318	1.0	44
Loma	32	0.9	301	3.6	107
Lothair	34	-0.6	646	-2.2	22
Shonkin[3]	27	2.7	425	1.9	18
	1995				
Cut Bank (north)	62	1.4	292	3.0	8
Ethridge	56	13.2*	412	3.0	8
Havre	58	1.4	374	0.7	8
Inverness[2]	54	-0.9	300	0.0	8
Joplin[2]	64	1.3	354	-0.3	8
Ledger[3]	32	4.2	212	1.8	8
Loma[3]	58	1.4	490	0.1	21
Lothair[2]	57	0.0	592	2.3	36
	1993-1995				
Overall Mean	46.3	1.9*	388	1.0*	36

*Significant according to LSD or t-test at p = 0.05.

[†]1 = Conventional till recrop, 2 = Chemical fallow, 3 = No-till recrop, 4 = Wheat streak mosaic virus symptoms, 5 = Fargo damage, 6 = Hail damage.

[#]K soil analyses from 0-6 inch samples.

[§]Cl soil analyses from 0-2 foot samples.