THE EFFECTS OF POTASSIUM AND CHLORIDE NUTRITION ON SEED YIELD OF CANARYSEED

William E. May, Sukhdev S. Malhi, Christopher B. Holzapfel, and Guy P. Lafond Agriculture and Agri-Food Canada, Indian Head, SK,
william.may@agr.gc.ca, 306-695-5225

ABSTRACT

The year to year variability of grain yield in canaryseed has been a major concern among canaryseed growers. An experiment was conducted to determine the responsiveness of canaryseed seed yield to potassium (K) and chloride (Cl) and to provide better recommendations to producers on the use of KCl in Canaryseed from soil test results. Current research has shown that chloride has a large impact on canaryseed yield in specific fields. Growers should measure the residual level of chloride in fields they intend to seed to canaryseed. More research is required to properly identify the level of chloride required in a field before canaryseed will not respond to the addition of chloride. At this time growers are advised to test the responsiveness of canaryseed to chloride on their own individual fields using strips of KCL.

INTRODUCTION

Historically, canaryseed or annual canarygrass (*phalaris canariensis* L.) has been fed to caged birds. North Africa, western Mediterranean region or Canary Island have been suggested as the centre of origin for canaryseed as a harvested crop (Nagy 1996; Putnam et al.1996). Canada produces approx 69 to 79% of the world's canaryseed production. Production of Canaryseed in North America is centred in the province of Saskatchewan (FOASTAT, 2008).

Canaryseed was first tested as a grain crop in 1906 at Indian Head, SK (MacKay 1907). In Canada, the recording of canaryseed acres began in 1981 with 23,000 ha being seeded and seeded acreage has ranged from 95,000 to 350,000 over the last 20 years, with 89 to 98% of this production occurring in Saskatchewan (Saskatchewan Ministry of Agriculture 2008).

Canaryseed growers identified spatial and temporal variability in seed yield as their greatest concern in an informal survey in 1997. A limited amount of research has been conducted on the effect of various agronomic practices including, seeding date, seeding rate, insect, disease and weed control, and fertility on canaryseed yield. Initially, fertility recommendations for canaryseed in Saskatchewan were based on the recommendations for spring wheat (Slinkard et al. 1991). Holt (1988) found that over a six year period at Indian Head, grain yield response was maximized between 50 and 75 kg Nitrogen ha^{-1}. Very little information has been published on the requirements of Canaryseed for potassium (K) and chloride (Cl). Putnam et al.(1996) published K recommendations for canaryseed in North Dakota. Canaryseed growers observed increased seed yield of with the application of KCl. An experiment was conducted to determine the responsiveness of canaryseed seed yield to K and Cl and to provide better recommendations to producers on the use of KCl in Canaryseed based on soil test results.

MATERIALS AND METHODS

One field experiment was conducted at the following sites in Saskatchewan, Indian Head, Carry The Kettle (2 sites), Regina plain, and Stewart Valley from 2007 to 2009. The soil series were Indian Head heavy clay at Indian Head, Oxbow loam and alluvium at Carry The Kettle, Regina heavy clay at Regina, and Sceptre heavy clay at Stewart Valley.

The experiment was a randomized complete block design involving ten treatments and four replications. The treatments consisted of three rates of K, 10, 20 and 30 kg K ha^{-1} and three rates of Cl, 9.1, 18.2 and 27.3 kg Cl ha^{-1} (Table 1). The forms of fertilizer used were, KCl, K_2SO_4, and $CaCl_2$. A treatment with no K or Cl was also included. A Blanket application of fertilizers was applied to all plots at a rate of 100 kg of 46-0-0 (urea), 50 kg of 11-51-0 (mono ammonium phosphate) and 50 kg of 21-0-0-24 (ammonium sulphate) ha^{-1}.

The cultivar CDC Togo with a seeding rate was 35 kg $ha^{-1}$was used at all locations. The row width was 30.5 cm (12 inches) at Indian Head, Carry The Kettle and Regina; and 25.4 cm (10 inches) at Stewart Valley. The plot size was 10.7 x 4.0 m (35 x 13 feet) at Indian Head, Carry The Kettle and Regina; and 9.1 x 4.3 m (30 x 14 feet) at Stewart Valley. The plots were managed using a no-till production system. Glyphosate was applied before seeding and all in-crop broadleaf herbicide applications were determined separately for each location according to weed species and density.

Table 1. The form and rate of potassium and chloride used for each treatment

Treatment	Form	Potassium	Chloride	KCL	K_2SO_4 rate	$CaCl_2$ rate
				0-0-60-0 (K_2O)	0-0-51-17 (K_2O)	(94%)
		kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}
1	none	0	0.0			
2	KCl	10	9.1	20.0		
3	KCl	20	18.2	40.0		
4	KCl	30	27.3	60.0		
5	K_2SO_4	10			23.5	
6	K_2SO_4	20			47.1	
7	K_2SO_4	30			70.6	
8	$CaCl_2$		9.1			15.1
9	$CaCl_2$		18.2			30.2
10	$CaCl_2$		27.3			45.3

Data Collection

Soil test were carried out at each site for N, P, K S and Cl. Plant density was determined 3 to 5 wk after seeding and canaryseed heads were counted after head emergence. Both plants and heads were measured in two 1-m sections of crop row within each plot. Physiological maturity was reached when kernel moisture was approximately 30 to 35%. Lodging was rated in each plot at physiological maturity using a 1 to 10 scale (1 = standing, 10 = completely lodged). Grain yield was expressed on a clean grain basis using 13% kernel moisture. Kernel weight, expressed per 1000 seeds (g), was calculated by weighing 200 kernels in 1998 and 1999, and between 700 and 1000 kernels in 2000 and 2001. Kernel head^{-1} was calculated using heads m^{-2}, grain yield and kernel weight. Kernel m^{-2} was calculated using grain yield and kernel weight. Test weight was measured as specified by the Canadian Grain Commission's Official Grain Grading Guide (2006).

Statistical Analysis

Individual sites were analyzed using the GLM procedure in SAS (1999).

RESULTS AND DISCUSSION

In 2007 the yields were on the low side due to temperature and moisture stress during seed development (Table 2). At 3 of the 5 locations, which included both Carry The Kettle and Regina a strong yield response occurred when chloride was applied. The yield components most affected were seeds m^{-2} and seeds head^{-1} (Table 3). This means that the addition of chloride prevented seed abortion from occurring or facilitated grain filling. Grain yield was not affected by chloride or potassium applications at Stewart Valley in 2007. In 2008, both locations near

Carry The Kettle showed a chloride response which followed a similar pattern seen in 2007. One important difference is that the yield response at the one of Carry The Kettle sites occurred when yield conditions were quite good, 1300 to 2100 lb acre^{-1} (Table 2). There was no response at the other locations to K or Cl in 2008. In 2009, again both sites at Carry The Kettle showed a chloride response while at Stewart Valley a weak responses were observed (Table 2).

The response to chloride occurred when canaryseed was under stress and under high yielding conditions. No response has been observed to K even in fields that were low to moderate in K. These results indicate that Canaryseed growers need to measure chloride when doing soil tests. At this time we do not know what level of chloride is required before a response will occur. Therefore, growers are advised to test the responsiveness of canaryseed to chloride on their own individual fields using strips of KCL.

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Table 2. The effect of Potassium (K) and Chloride (Cl) nutrition on Canaryseed Yield

Form	K	Cl	Grain Yield													
			2007				2008					2009				
			Stewart Valley	Carry The Kettle	Carry The Kettle	Regina	Indian Head	Carry The Kettle	Carry The Kettle	Regina	Stewart Valley	Indian Head	Stewart Valley	Carry The Kettle	Carry The Kettle	Regina
	kg ha^{-1}	kg ha^{-1}	lb $acre^{-1}$													
none	0	0.0	750	8	183	715	1576	23	1365	1308	1055	2182	637	206	1577	1184
KCl	10	9.1	820	110	578	848	1537	375	2086	1296	1018	2117	844	965	1611	1242
KCl	20	18.2	774	57	655	707	1587	345	1678	1238	936	2253	833	1028	1677	1174
KCl	30	27.3	819	78	645	926	1579	418	1598	1256	1010	2200	972	1005	1661	1328
K_2SO_4	10		725	14	203	651	1533	25	1396	1163	834	2127	628	143	1520	1210
K_2SO_4	20		812	16	176	670	1593	47	1517	1167	602	2270	669	196	1612	1260
K_2SO_4	30		699	6	152	661	1522	45	1171	1153	982	2200	797	283	1469	1213
$CaCl_2$		9.1	832	64	599	709	1505	414	2089	1279	939	2220	888	965	1642	1228
$CaCl_2$		18.2	775	87	652	740	1445	460	1712	1233	1005	2321	919	945	1658	1217
$CaCl_2$		27.3	822	73	655	786	1475	396	2068	1109	987	2185	850	1011	1787	1316
		LSD	NS	63	155	120	NS	85	481	NS	NS	NS	244	168	142	NS
		CV	10	71	24	11.1	7.6	23	20	7.3	20	4.3	21	17	6	11

Table 3. The effect of Potassium (K) and Chloride (Cl) nutrition on seed density of Canaryseed

Form	K	Cl	Seed Density													
			2007				2008					2009				
			Stewart Valley	Carry The Kettle	Carry The Kettle	Regina	Indian Head	Carry The Kettle	Carry The Kettle	Regina	Stewart Valley	Indian Head	Stewart Valley	Carry The Kettle	Carry The Kettle	Regina
	kg ha^{-1}	Kg ha^{-1}	seeds m^{-2}													
none	0	0.0	10720	114	2492	10059	25248	365	18785	19753	14107	26870	8655	2998	20857	17485
KCl	10	9.1	11548	1580	7688	11866	23180	5737	29325	19777	14087	25512	11284	13001	21474	18541
KCl	20	18.2	11069	831	8629	10053	24626	5430	25341	18701	13446	27386	11112	13593	21911	16508
KCl	30	27.3	11631	1097	8386	12714	25654	5825	22643	19503	13201	27223	12953	13120	22300	19147
K_2SO_4	10		10400	209	2690	9782	23670	444	19700	17532	11194	26287	8672	2165	20288	17428
K_2SO_4	20		11691	232	2356	9523	25365	882	21628	17440	8557	26492	9136	2862	21493	18192
K_2SO_4	30		10369	78	2063	9389	24092	680	17889	17279	13241	27722	10821	3861	19447	17338
$CaCl_2$		9.1	11893	945	7960	10449	23920	6089	27186	19849	12470	26674	11996	13319	21618	18070
$CaCl_2$		18.2	11022	1255	8677	10837	22169	6539	24760	18068	13447	28414	12360	12719	22996	17930
$CaCl_2$		27.3	11656	1065	8688	11290	24416	5912	27473	16553	13518	28782	11387	13770	23699	20052
		LSD	NS	860	2022	1693	NS	1296	5520	NS	NS	NS	NS	2170	1966	NS
		CV	11	68	23	11	9.7	24	16	9.1	19	10	20	16	6.3	11