EFFECT OF WATER QUALITY ON POSTEMERGENCE GRASS HERBICIDE EFFICACY

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Postemergence grass herbicides are often applied using a water carrier to ensure distribution onto plant surfaces. The water used as a carrier may contain various ions and/or salts. The type of salts present in the water may cause the water to be either "hard" (due to calcium and/or magnesium salts) or "alkali" (due to bicarbonate ions in the water). The salts present in the spray water may impact herbicide efficacy. Research was conducted at Brandon, Manitoba and Saskatoon, Saskatchewan to determine the effect of either alkali water (water that contained sodium bicarbonate) or hard water (water that contained calcium and magnesium sulphate) on the efficacy of four postemergence grass herbicides, clethodim (Select), sethoxydim (Poast), fenoxaprop-p (Excel Super), and quizalofop (Assure). Calcium/magnesium sulphate in the water did not reduce oats control by any of the four postemergence grass herbicides. In addition, sodium bicarbonate in the spray solution did not reduce oats control by fenoxaprop-p and quizalofop. However, sodium bicarbonate reduced the efficacy of both sethoxydim and clethodim on oats. These results tend to indicate that hard water should not affect any of the herbicides tested. However, the efficacy of sethoxydim and clethodim but not fenoxaprop-p or quizalofop can be reduced if alkali water is used as the carrier.

SUMMARY

Research was conducted at Brandon, Manitoba and Saskatoon, Saskatchewan to determine the effect of either alkali water or hard water on the efficacy of four postemergence grass herbicides, clethodim (Select), sethoxydim (Poast), fenoxaprop-p (Excel Super), and quizalofop (Assure). Fenoxaprop-p and quizalofop were not antagonized by either sodium bicarbonate or calcium/magnesium sulphate in the water used for herbicide application. However, sodium bicarbonate reduced the efficacy of sethoxydim and clethodim. There appeared to be a relationship between herbicide rate and the sodium bicarbonate concentration in the water. Calcium/magnesium sulphate did not reduce the efficacy of these two herbicides; in fact, at Saskatoon, clethodim efficacy appeared to improve with increasing calcium/magnesium sulphate concentration.

INTRODUCTION

Wild oats and green foxtail are two of the most troublesome annual weeds encountered by canola producers in western Canada. Several postemergence herbicides are available that will control these two weeds. These herbicides range in cost from approximately $11.00/acre to over $37.00/acre. Factors which limit the efficacy of these herbicides will limit the return on the cost of the herbicide application.

Postemergence grass herbicides must be applied in a carrier to ensure distribution onto plant surfaces. Frequently, water is used as the carrier. This can come from either surface water or groundwater. Groundwater can contain various ions and the type of ions contained in the water determine the characteristics of the water. Water that is high in sodium and bicarbonates is termed "alkali" water while water which contains calcium and magnesium salts is considered 'hard" water.

The salts present in the water may impact herbicide efficacy. For example, sodium bicarbonate in the water reduced the efficacy of sethoxydim and the amine salts of MCPA and 2,4-D. Glyphosate activity was reduced by water containing calcium and/or magnesium salts. However, the effect of alkali water on other postemergence grass herbicides has not been reported. Further, there has been no report on the effect of hard water on the efficacy of these herbicides.

Therefore, the objective of this research was to determine the effect of:
(1) alkali water (sodium bicarbonate) on the efficacy of clethodim, sethoxydim, fenoxaprop-p-ethyl (referred to as fenoxaprop), and quizalofop-ethyl (referred to as quizalofop), and
(2) hard water (calcium/magnesium sulphate) on the efficacy of clethodim, sethoxydim, fenoxaprop-p, and quizalofop.

MATERIALS AND METHODS

Research was conducted in the summer of 1993 at two sites, one at the Brandon Research Station and the other at the Kernen Farm of the University of Saskatchewan. Two experiments were conducted at each site, both randomized complete block designs in a split-plot arrangement. Experiment 1 evaluated the effect of alkali water (i.e., water that contains sodium bicarbonate) on postemergence grass herbicide efficacy while Experiment 2 evaluated the effect of hard water (i.e. water that contains calcium and/or magnesium water) on the efficacy of clethodim, sethoxydim, fenoxaprop-p, and quizalofop.

Tame oats was seeded at right angles to the crop to simulate wild oats. Main plots for each experiment consisted of the individual herbicides while subplots were a factorial arrangement of herbicide rates (one-half and the recommended rate for each herbicide) and three concentrations of the salt used in the particular experiment (0, 500, and 1000 ppm of sodium bicarbonate or 0, 250, and 500 ppm of calcium/magnesium sulphate). An untreated check was included for each herbicide.

Plots were visually evaluated approximately three weeks after herbicide application. Rating was conducted using a 0 to 100 scale, where 0 equals no control and 100 equals complete control. Typically, commercially acceptable control is 80. Tame oat fresh weight per m^2 was determined by clipping two 0.25 m^2 quadrants at the soil surface. Other weed and crop species were removed and oat fresh weight determined and data converted to a m^2 basis. Plots were harvested for grain yield using a small-plot combine. Canola seed yield was determined after cleaning samples and was expressed as kg seed/ha.

RESULTS AND DISCUSSION

Herbicides and herbicide rates

In general, weed control was better at Saskatoon than at Brandon when no salts were present in the spray solution. This was most likely due to differences in prevailing environmental conditions at the time of herbicide application. Weed control from fenoxaprop-p or quizalofop at Brandon was not commercially acceptable when the herbicides were applied at one-half the label rate (Tables 1, 2, 4, and 5).

Experiment 1 - Effect of sodium bicarbonate on herbicide efficacy

Sodium bicarbonate reduced the activity of clethodim at both Brandon and Saskatoon when visually evaluated (Table 1). Antagonism of clethodim or sethoxydim control of oats was greater at Saskatoon than at Brandon. This indicates that sodium bicarbonate antagonism is partly dependent upon the prevailing environmental conditions. Under conditions of stress, such as heat, drought, or later growth stages of weeds at the time of herbicide application, antagonism of weed control will be greater. A similar trend was also noted for oats control based upon tame oat fresh weight (Table 2). Antagonism was more readily apparent for fresh weight data compared to visual data. This may be due to regrowth of oats after the visual evaluation. This is not unexpected, as the sodium bicarbonate may be reducing clethodim or sethoxydim uptake enough so that enough herbicide is absorbed by the weeds to suppress them initially but not enough for complete control.

Antagonism of clethodim or sethoxydim control of oats by sodium bicarbonate was more evident at herbicide rates equal to one-half the label rate. There is some evidence in the literature that the antagonistic effect of sodium bicarbonate on the efficacy of these two herbicides may be related to spray solution pH. In tests conducted in the laboratory, there is little difference in spray solution pH between a 500 and 1000 ppm sodium bicarbonate solution. Differences then between herbicides would be related to the actual amount of chemical required to control the specific weed encountered.

Neither fenoxaprop-p nor quizalofop activity were consistently reduced by the presence of sodium bicarbonate in the spray solution, based upon either visual data or fresh weight data (Tables 1 and 2). This indicates that the efficacy of fenoxaprop-p or quizalofop will not be reduced if high sodium bicarbonate water is used as the carrier.

Canola yields at Brandon were variable due to severely lodging and subsequent harvest difficulties (Table 3). However, at Saskatoon, canola yield data was consistent with tame oats efficacy data. Canola yields were lower for clethodim when sodium bicarbonate was present in the spray solution compared to distilled water.

Experiment 2 - Effect of calcium/magnesium sulphate on herbicide efficacy

Similar to the sodium bicarbonate experiment, the efficacy of either fenoxaprop-p or quizalofop was not affected by calcium/magnesium sulphate in the spray solution at either Brandon or Saskatoon (Tables 4 and 5). In contrast to results when sodium bicarbonate was present in the spray solution, the efficacy of clethodim or sethoxydim was also not affected by calcium/magnesium sulphate.

In 1992, results from Saskatoon indicated that clethodim control of oats increased when calcium salts were added to the spray solution. However, at either location (Brandon or Saskatoon), this trend did not occur in 1993, based on either visual or fresh weight data (Tables 4 and 5).

Yield data at Brandon was somewhat variable due to lodging and subsequent harvest difficulties (Table 6). However, yield data generally related to weed control between herbicides and herbicide rates. At Saskatoon, yield data generally reflected tame oats control, whereby yields were highest where tame oats control was highest.

Research currently being conducted in the laboratory indicates that the antagonistic effect of sodium bicarbonate on tralkoxydim (a member of the same herbicide family as clethodim and sethoxydim) is based upon spray solution pH. The high solution pH caused by sodium bicarbonate causes a molecular change in the herbicide, which makes it less likely to be taken up by weeds. These changes would also occur with clethodim and sethoxydim. However, most calcium/magnesium salts found in water producers use for spraying would not cause any change in the spray solution pH and no changes in the molecular structure of the herbicide.

In summary, fenoxaprop-p and quizalofop were not antagonized by either sodium bicarbonate or calcium/magnesium sulphate salts in the spray solution. However, sodium bicarbonate salts in the spray solution reduced the efficacy of both sethoxydim and clethodim on oats. Antagonism was more apparent when one-half the recommended rate was used, most likely due to the good control by these two herbicides at the label rate. Calcium/magnesium sulphate salts in the herbicide mixture did not reduce the efficacy of these two herbicides.

Table 1. Effect of sodium bicarbonate and herbicide on tame oat control.

		Brandon				Saskatoon			
Herbicide rate	Sodium bicarbonate	Clethodim	Sethoxydim	Fenoxaprop	Quizalofop	Clethodim	Sethoxydim	Fenoxaprop	Quizalofop
	ppm	%				%			
0.5X	0	71	77	44	38	65	93	80	96
	500	69	38	30	46	5	20	86	95
	1000	48	21	44	53	4	6	60	100
1X	0	87	88	76	80	93	68	96	100
	500	87	76	77	61	16	61	99	100
	1000	64	76	68	71	45	78	100	100
0	0	0	0	0	0	0	0	0	0
LSD (0.05)		11				17			

Table 2. Effect of sodium bicarbonate and herbicide on tame oat fresh weight.

		Brandon				Saskatoon			
Herbicide rate	Sodium bicarbonate	Clethodim	Sethoxydim	Fenoxaprop	Quizalofop	Clethodim	Sethoxydim	Fenoxaprop	Quizalofop
	ppm	g/m^2				g/m^2			
0.5X	0	101	236	460	574	320	60	175	60
	500	371	592	833	434	1436	711	254	78
	1000	695	578	587	205	1132	1105	481	84
1X	0	0	16	100	0	114	235	67	42
	500	0	0	44	68	860	357	87	39
	1000	156	303	245	20	673	263	63	52
0	0	721	791	835	1171	1106	1179	1119	1473
LSD (0.05)		171				300			

Table 3. Effect of sodium bicarbonate and herbicide on canola yield.

		Brandon				Saskatoon			
Herbicide rate	Sodium bicarbonate	Clethodim	Sethoxydim	Fenoxaprop	Quizalofop	Clethodim	Sethoxydim	Fenoxaprop	Quizalofop
	ppm	kg/ha				g/m^2			
0.5X	0	1220	1220	1120	1060	163	138	153	156
	500	1170	1120	1130	1180	140	128	142	161
	1000	910	1040	1120	1300	132	132	141	157
1X	0	1320	1280	1400	1250	165	153	165	157
	500	1370	1280	1370	1280	142	151	151	176
	1000	1220	1200	1210	1260	144	141	155	161
0	0	890	930	820	890	141	121	121	131
LSD (0.05)		320				23			

Table 4. Effect of calcium/magnesium sulphate and herbicide on tame oat control.

		Brandon				Saskatoon			
Herbicide rate	Calcium sulphate	Clethodim	Sethoxydim	Fenoxaprop	Quizalofop	Clethodim	Sethoxydim	Fenoxaprop	Quizalofop
	ppm	%				%			
0.5X	0	78	64	21	48	78	82	91	96
	250	87	53	23	55	85	83	91	94
	500	75	71	34	61	85	82	90	95
1X	0	84	85	62	81	94	98	97	98
	250	89	88	69	76	96	96	99	99
	500	93	87	68	86	98	93	99	98
0	0	0	0	0	0	0	0	0	0
LSD (0.05)		17				NS			

Table 5. Effect of calcium/magnesium sulphate and herbicide on tame oat fresh weight.

		Brandon				Saskatoon			
Herbicide rate	Calcium sulphate	Clethodim	Sethoxydim	Fenoxaprop	Quizalofop	Clethodim	Sethoxydim	Fenoxaprop	Quizalofop
	ppm	g/m^2				g/m^2			
0.5X	0	0	210	444	235	238	199	132	45
	250	0	170	245	142	107	79	91	43
	500	53	58	300	113	105	176	75	50
1X	0	0	0	47	0	39	42	32	22
	250	0	0	106	0	43	44	23	27
	500	0	0	67	0	40	92	30	33
0	0	669	541	944	672	1159	1205	1225	1085
LSD (0.05)		204				177			

Table 6. Effect of calcium/magnesium sulphate and herbicide on canola yield.

		Brandon				Saskatoon			
Herbicide rate	Calcium sulphate	Clethodim	Sethoxydim	Fenoxaprop	Quizalofop	Clethodim	Sethoxydim	Fenoxaprop	Quizalofop
	ppm	kg/ha				g/m^2			
0.5X	0	760	830	610	760	173	175	165	177
	250	820	1060	500	780	172	167	159	162
	500	1150	770	680	800	167	180	174	177
1X	0	1100	800	560	1080	185	173	180	171
	250	1040	1030	850	1030	168	186	180	186
	500	1060	700	820	750	178	175	176	176
0	0	670	660	790	540	141	152	151	145
LSD (0.05)		NS				19			