28-0-0 AS AN ADDITIVE FOR REDUCING SODIUM BICARBONATE ANTAGONISM OF CYCLOHEXANEDIONE HERBICIDES.

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ABSTRACT

Field tests were conducted in 1990 and 1991, to evaluate the potential of 28-0-0, (a mixture of ammonium nitrate and urea), as an additive when using sodium bicarbonate water for the dilution of cyclohexanedione herbicides. In 1990, water from: Saskatoon (surface, low bicarbonate), Unity (well, 675 ppm bicarbonate), and Maple Creek (well, 956 ppm bicarbonate), were mixed with the 0.5X and 1X rates of sethoxydim and clethodim. These combinations were tested with and without 28-0-0 at 2.3 L/ha. Unity and Maple Creek water reduced the efficacy of both herbicides. The addition of 28-0-0 overcame this antagonism in all treatments at the 1X rates of herbicide, and resulted in better control in most treatments at the 0.5X herbicide rates. The use of 28-0-0 also increased the efficacy of sethoxydim in Saskatoon water, where antagonism was not a factor. In 1991 three rates of 28-0-0 (1.15, 2.3, and 3.45 L/ha), and 4 L/ha of ammonium sulphate, were tested with the 1X rates of tralkoxydim and a high concentration formulation of sethoxydim. Medium and high concentration sodium bicarbonate water was prepared by adding sodium bicarbonate to distilled water. The bicarbonate waters reduced the efficacy of tralkoxydim, while no antagonism of sethoxydim was found, suggesting that the high concentration formulation of sethoxydim may not be as sensitive to the presence of sodium bicarbonate as the original formulation. All additives increased the efficacy of both herbicides, but no differences were found between the effect of ammonium sulphate or any rate of 28-0-0.

INTRODUCTION

The cyclohexanedione herbicides give selective control of grassy weeds in grass and broadleaf crops. Recent research has shown that sodium bicarbonate may be antagonistic to herbicides in this group, including; sethoxydim, clethodim and tralkoxydim. The use of water containing medium to high levels of sodium bicarbonate for the dilution of cyclohexanedione herbicides, has therefore become a concern.

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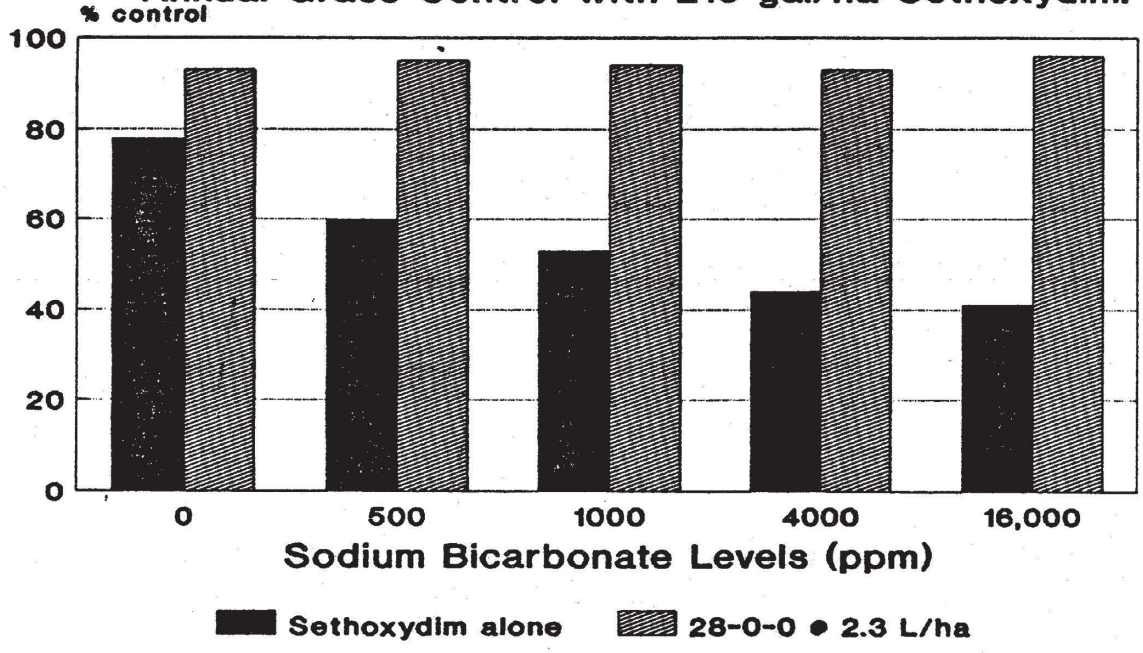
Incidences of poor grass control with sethoxydim in areas of North Dakota, led to a study at North Dakota State University, which found that sethoxydim in spray water from Halliday N.D. reduced fresh weight of tame oat by only 41%. On the other hand, sethoxydim in spray water from Fargo N.D., resulted in 80% fresh weight reduction of tame oat. The Halliday water had a bicarbonate concentration of 1635 ppm while Fargo water had just 98 ppm of bicarbonate ion, indicating that the high bicarbonate concentration of the Halliday water was to blame for the antagonism of sethoxydim (Nalewaja *et al.* 1989).

In the Maple Creek and Unity areas of Western Saskatchewan, as well as the southern edge of the province, bicarbonate levels in ground water are often near 1000 ppm. Nalewaja *et al.* (1989), showed that sodium bicarbonate levels as low as 500 mg/L may substantially reduce control of annual grasses with 210 g/ha of sethoxydim (Fig. 1). Thus antagonism of cyclohexanedione products is a valid concern in these areas.

Since alternative water sources are not always available or economically feasible, the use of adjuvants may be an important means of overcoming this antagonism. Specifically, a mixture of ammonium sulphate and urea (28-0-0 liquid fertilizer) has been shown to increase the efficacy of these herbicides in the presence of sodium bicarbonate. Nalewaja *et al.* (1989), showed that sodium bicarbonate antagonism of annual grass control with sethoxydim at 210 g/ha, could be overcome with the addition of 28-0-0 at 2.3 L/ha. Even at sodium bicarbonate concentrations of 16,000 ppm, excellent control was achieved with the addition of 28-0-0 (Fig. 1). For this, reason experiments were set up to confirm the antagonistic effect of sodium bicarbonate water on specific cyclohexanedione herbicides, to evaluate the potential of 28-0-0 as an additive to these herbicide solutions when using a bicarbonate water source for spraying, and to determine what rate of 28-0-0 might be the most economical and efficient.

Fig. 1 The Effects of Sodium Bicarbonate and 28-0-0 on Annual Grass Control with 210 gal/ha Sethoxydim. [a]



a Abstracted from Nalewaja et al., 1989.
LSD(0.05) = 5

MATERIALS AND METHODS

Field experiments were conducted in 1990 and 1991, at the Kernen Crop Research Farm, University of Saskatchewan. Tests were randomized split plot designs with four replications. Water sources were the main plots and herbicide and adjuvant combinations were the sub-plot factors. The water types and treatments tested are outlined in Tables 1 and 2. Treatments were applied using a small plot sprayer with 80 degree flat fan nozzles, and spray volumes varied from 110 L/ha in 1990 to 100 L/ha in 1991. Treatments were applied to a solid stand of tame oat at the later end of the application window suggested by the product label, so that antagonism would be more easily detected. Control of tame oat was visually rated on a scale of 0 to 100% kill, and whole plant biomass samples consisting of four meters of seeded row, were taken at regular intervals following treatment applications.

Table 1. Bicarbonate Concentration and Electrical Conductivity of Spray Solutions Containing Clethodim, Sethoxydim and 28-0-0 in Various Water Sources (1990).

Water Source and Herbicide Rate (gai/ha)	HCO_3 (ppm)	28-0-0 Rate (L/ha) 0.0	2.3
		--------conductivity---------- (uS/cm)	
Saskatoon(surface)	50	380	---
+Sethoxydim (120)	---	310	13060
(240)	---	280	13500
+Clethodim (23)	---	420	13670
(45)	---	1640	12830
Unity(well)	675	1700	---
+Sethoxydim (120)	---	1590	14300
(240)	---	1510	14200
+Clethodim (23)	---	1540	14380
(45)	---	1500	14200
Maple Creek(well)	956	1900	---
+Sethoxydim (120)	---	1790	13940
(240)	---	1730	14340
+Clethodim (23)	---	1700	14410
(45)	---	1700	14980

* Sethoxydim treatents included Merge @ 0.7% v/v, and clethodim treatments included CC16255 @ 0.5% v/v.

Table 2. Bicarbonate Concentration and Electrical Conductivity of Spray Solutions Containing Sethoxydim[1], Tralkoxydim and Adjuvants in Various Water Sources (1991).

Water Source and Herbicide Rate(gai/ha)	HCO_3 (ppm)	Adjuvants[2] (L/ha)				
		None	AMS (4)	28-0-0 (1.15)	28-0-0 (2.3)	28-0-0 (3.45)
		conductivities (uS/cm)				
Control[3]	0	30	---	---	---	---
+Sethoxydim (200)	---	50	20000+	7700	14200	20000+
+Tralkoxydim(250)	---	380	20000+	8100	14710	20000+
Med. Bicarb.[4]	1087	1550	---	---	---	---
+Sethoxydim (200)	---	1510	20000+	8720	14600	20000+
+Tralkoxydim(250)	---	2040	20000+	9200	15300	20000+
High Bicarb.[4]	1774	2910	---	---	---	---
+Sethoxydim (200)	---	2830	20000+	9250	14900	20000+
+Tralkoxydim(250)	---	3550	20000+	10050	17000	20000+

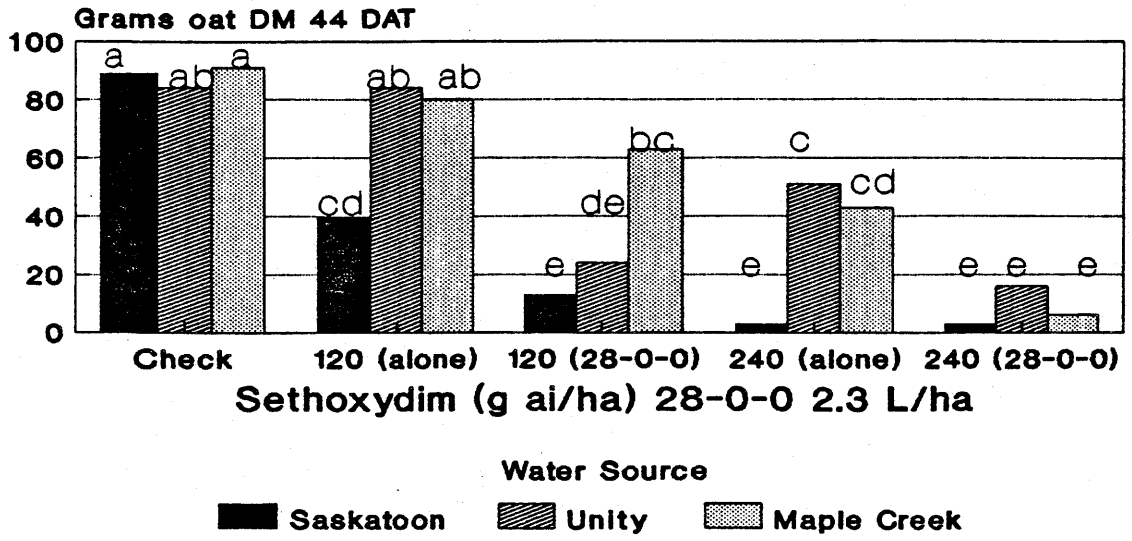
[1] HC formulation of Poast (437 gai/L).
[2] All treatments included Merge @ 0.7% v/v.
[3] Distilled water.
[4] Distilled water plus analytical grade sodium bicarbonate.

RESULTS

In 1990, both Unity and Maple Creek water significantly reduced the efficacy of both rates of sethoxydim and clethodim, as compared to Saskatoon water. The addition of 28-0-0, at 2.3 L/ha, reduced the antagonism to nonsignificant levels in all treatments at the 1X rate of herbicide, and resulted in better control in most treatments at the 0.5X herbicide rate. With both herbicides, the addition of 28-0-0 improved the level of grass control in Saskatoon water as well, even though antagonism was not a factor (Fig. 2 & 3).

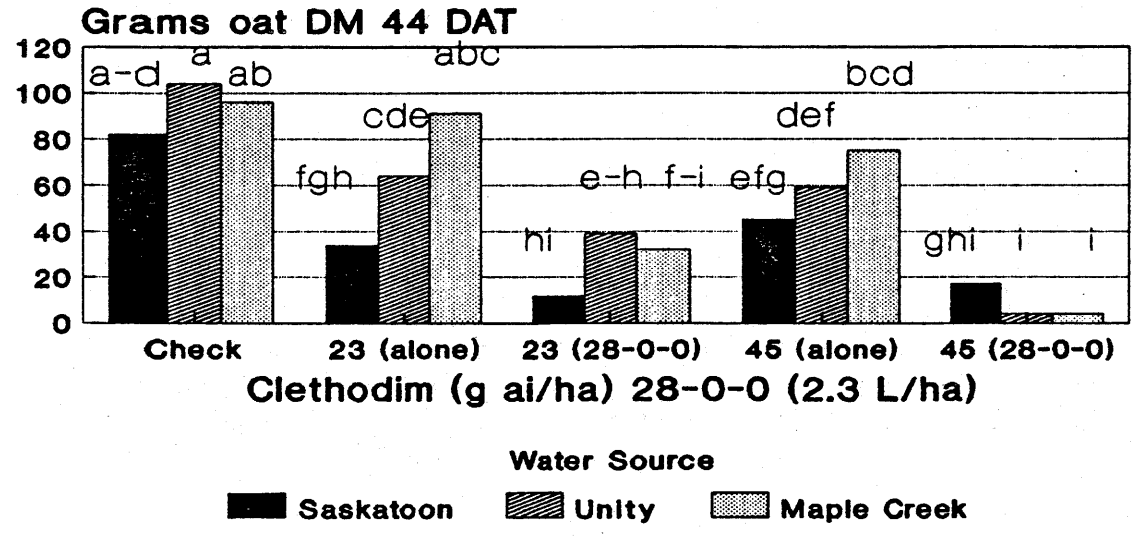
In 1991, antagonism of the new high concentration formulation of sethoxydim was visually evident, but was not reflected in fresh weight biomass accumulation (Duncans's MRT, P=0.05). The addition of 28-0-0, or ammonium sulphate, improved the efficacy sethoxydim in all treatments. However, no differences were found between the effect of ammonium sulphate or any rate of 28-0-0 (Fig. 4).

Fig. 2 Effect of water source and adjuvant on control of oat with sethoxydim. (1990)



Duncan's MRT (P = 0.05)

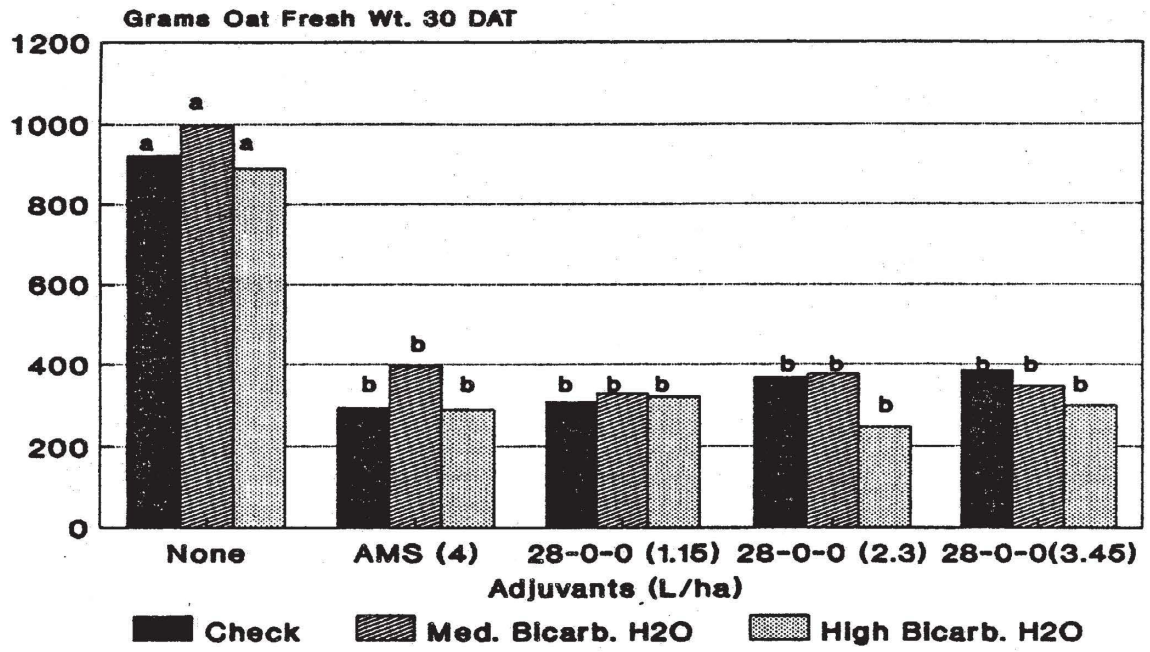
Fig. 3 Effect of water source and adjuvant on control of oat with clethodim. (1990)



Duncan's MRT (P = 0.05)

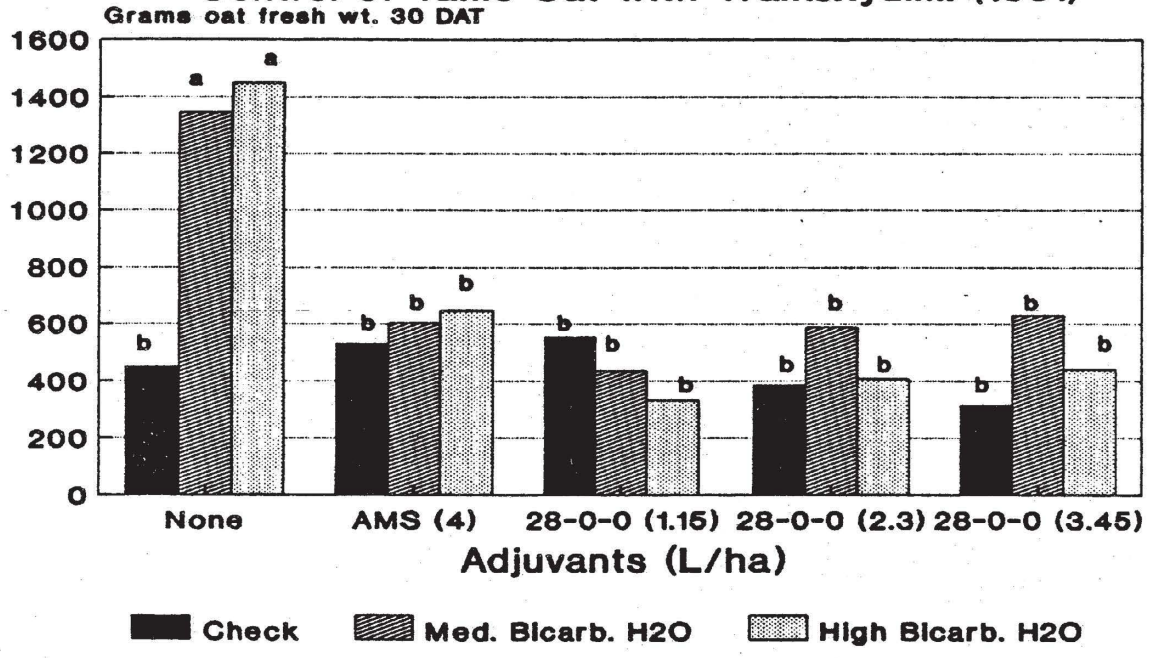
Both medium and high concentration sodium bicarbonate waters antagonized tralkoxydim. The addition of ammonium sulphate or 28-0-0, reduced antagonism to non-significant levels at all rates. There were no differences between ammonium sulphate or any rate of 28-0-0 (Fig. 5).

Fig. 4 Effect of Bicarbonate Level and Adjuvants on the Control of Tame Oat with Sethoxydim.*(1991)



* HC formulation Poast @ 1X rate, + Merge @ .7% v/v
Duncan's MRT (P = 0.05)

Fig. 5 Effect of Bicarbonate Level and Adjuvants on the Control of Tame Oat with Tralkoxydim.*(1991)



* Treatments included Merge @ .7 % v/v
Duncan's MRT (P = 0.05)

CONCLUSIONS

The results of the work carried out in 1990, confirmed the antagonistic effect of sodium bicarbonate on sethoxydim and clethodim, and showed that 28-0-0 was an effective additive for reducing this antagonism. However, the effects of sodium bicarbonate on tralkoxydim and the effects of different rates of 28-0-0, remained to be tested.

In 1991, it was shown that tralkoxydim is also antagonized by sodium bicarbonate. However, bicarbonate concentrations of 1774 ppm did not cause antagonism of sethoxydim in 1991, suggesting that the HC formulation of sethoxydim is less sensitive to the presence of sodium bicarbonate than the original formulation. As well, the results of the 1991 research confirmed that even rates as low as 1.15 L/ha of 28-0-0, may substantially increase the efficacy of cyclohexanedione herbicides in the presence of sodium bicarbonate. Since no differences were found between rates of 28-0-0, future research will be neccessary to determine if even lower rates of 28-0-0 may be used. The results of this study, however, suggest that in the future, low rates of 28-0-0 may provide an effective means of dealing with this type of antagonism at relatively low cost. Further study of this and other factors related to sodium bicarbonate antagonism, will be carried out over the next two years at the University of Saskatchewan.

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