Postemergence Grass Herbicide Activity Changes with Adjuvant and pH and Sodium Level in Spray Solutions[1]

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Abstract

Water quality is known to affect herbicide efficacy. Nursery well water containing naturally high pH and sodium levels was evaluated as spray solution for the postemergence grass herbicides Poast (sethoxydim), Fusilade (fluazifop-P) and Acclaim (fenoxapropethyl). Using crabgrass as a test plant, high pH & sodium solution water reduced the effectiveness of all herbicides in one study. Other studies revealed that Poast (sethoxydim) was influenced the most with high pH & sodium water while the activity of Fusilade (fluazifop-P) and Acclaim (fenoxaprop-ethyl) was less affected. The solution water inhibition of Poast (sethoxydim) was overcome when Dash (a proprietary blend of surfactants used as a replacement for oil concentrate) was used as an adjuvant.

Index words: crabgrass control, water quality, surfactant

Herbicides used in this study: Poast (sethoxydim), [2-[1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one]; Fusilade 2000 (fluazifop-P), [(R)-2-[4-[[5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxy]propanoic acid]; Acclaim (fenoxaprop-ethyl), [(±)-ethyl 2-[4-[(6-chloro-2-benzoxazolyl)oxy]phenoxy]propanoie acid].

Species used in this study: Azalea 'Christmas Cheer' (*Rhododendron* × 'Christmas Cheer'); Smooth crabgrass [*Digitaria ischaemum* (Schreb. ex Schweig.) Schreb. ex Muhl.]

Significance to the Nursery Industry

Many areas suffer from water quality problems which may affect herbicide phytotoxicity and effectiveness. Poast (sethoxydim), Fusilade (fluazifop-P), and Acclaim (fenoxaprop-ethyl) are routinely used for postemergence control of annual and perennial grasses in the production and maintenance of landscape plants. Reduced herbicide activity may be the result of water solutions that have high pH or high sodium levels. Results from this study indicated that high sodium levels can reduce the activity of these herbicides particularly Poast (sethoxydim). Adjuvant selection may overcome this reduced activity of Poast (sethoxydim). Azalea was not injured by herbicide water solutions in this study.

Introduction

The pH and ion content of water used for herbicides solutions can affect activity and alter weed management programs for nurseries and landscapes (4). Water containing high levels of calcium (Ca^{2+}) and/or sodium (Na^+) with high pH is often used by nursery crop producers in coastal areas of the Southeastern U.S. for pesticide mixing and application (4).

The influence of water solution pH on herbicide phytotoxicity is inconsistent. The activity of the organic arsenical herbicide (MSMA) and Roundup (glyphosate) was changed by solution pH (6, 7), while the activity of Poast (sethoxydim) and clethodim were unaffected by pH (1). The addition of inorganic salts to water soluble foliar herbicides increased herbicide phytotoxicity (6). The monovalent cations Na^+, potassium (K^+) and ammonium (NH^{4+}) generally increased penetration and phytotoxicity of the herbicides MSMA, Dowpon (dalapon) and Roundup (glyphosate) whereas divalent and trivalent cations such as calcium (Ca^{2+}), zinc (Zn^{2+}) and iron (Fe^{2+}, Fe^{3+}) decreased herbicide activity (6, 7).

Poast (sethoxydim), Fusilade (fluazifop-P), and Acclaim (fenoxaprop-ethyl) control annual and perennial grasses in the production and maintenance of landscape plants. The effectiveness of these herbicides may be reduced when other herbicides such as Basagran (bentazon), MCPA, and 2,4-D are added to the spray solution (2). Ultraviolet light exposure and ammonium nitrate/urea solution may also reduce the activity of these herbicides (2).

Spray additives such as surfactants are used to enhance the phytotoxicity of many herbicides and adjuvant selection is important in order to achieve maximum herbicide activity. Poast (sethoxydim) controlled smooth crabgrass more effectively with addition of the adjuvant Dash compared to using crop oil or non-ionic surfactant (4). Adjuvant effectiveness may also be influenced by ion and pH levels in water solution (3).

Water quality and ion content varies from location to location but high Na^+ water is often encountered along coastal areas and this Na^+ concentration can raise water pH levels influencing the stability and activity of herbicides. The objective of this study was to evaluate the activity of Poast, Fusilade, and Acclaim when mixed in spray water solutions that contain different levels of naturally occurring Na^+ and vary in pH.

Materials and Methods

The initial field study was conducted at Fairview Nursery near Edisto Island, SC. Smooth crabgrass was seeded on May 13, 1987 in a pine bark (90%) and peat media (10%)

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[3]Triton Ag-98 (alkylarylpolyoxyethylene glycols), a trademark of Rohm and Haas Company. Philadelphia, PA.

[4]Agridex, Helena Chemical Company, Memphis, TN.

[5]Dash, a trademark of BASF Wyandotte Company. Parsippany, NJ.

in #1 (3 L) containers of one month old established liners [8 in (20 cm) tall] of 'Christmas Cheer' azalea. Grass seedlings were allowed to grow to a height of 8–10 cm (3–4 in) tall, with 6–7 tillers, and 15–22 leaves prior to treatment on June 3.

Poast and Acclaim at 0.05 (0.04), 0.15 (0.13), and 0.30 (0.28) kg a.i./ha (lb ai/A) and Fusilade at 0.05 (0.04), 0.10 (0.08) and 0.20 (0.18) kg a.i./ha (lb a.i./A) were mixed with three water samples. Two water samples were obtained from local nurseries and varied in pH and Na^+ content. Distilled deionized mix water was used as a control. Water analysis determined the pH, ion content and sodium absorption ratio (Table 1). Herbicide water solutions were allowed to stand for 30 minutes before application. Spray solutions were applied with a CO_2 backpack sprayer delivering 280 L/ha (30 gpa) at 300 kpa (43 psi). A non-ionic surfactant[3] at 0.25% by volume was added to all solutions.

The experimental design was a randomized complete block with a factorial arrangement of treatments (3 waters × 3 herbicides × 3 rates) with four replications and 1 pot per treatment. Crabgrass control and azalea injury were visually evaluated weekly on a scale of 0 = no injury and 100 = complete kill.

The above study was repeated at the Clemson Botanical Gardens, Clemson, SC in July, 1987 omitting the high pH water because the results were similar to that of the distilled deionized water in the first study. The high pH & Na^+ and distilled water had different pH and Na^+ levels than for the first experiment because they were obtained at a later date (Table 1). Smooth crabgrass was seeded in a pine bark (85%) and peat (15%) media in #1 (3 L) containers without landscape plants on July 15, 1987. At treatment time, crabgrass seedlings were 15 cm (6 in) tall with 6–8 tillers. Herbicide treatments and application methods were the same as the first experiment. Crabgrass control ratings and foliage fresh weights were determined 21 days after treatment.

A third experiment was also initiated in July at Clemson to evaluate mix water and adjuvant interactions with Poast. The same rates of Poast were used with two water solutions and three different adjuvants. The adjuvant treatments were a non-ionic surfactant (Ag-98) at 0.25% v/v, or crop oil concentrate[4] at 1.25% v/v, or non-phytotoxic crop oil (Dash)[5] at 1.25% v/v. The water samples, experimental design, and crabgrass size were the same as those in the second experiment. Crabgrass control ratings and foliage fresh weights were determined 21 days after treatment. All data were subjected to analysis of variance and means separated using least significant differences at $P = 0.05$.

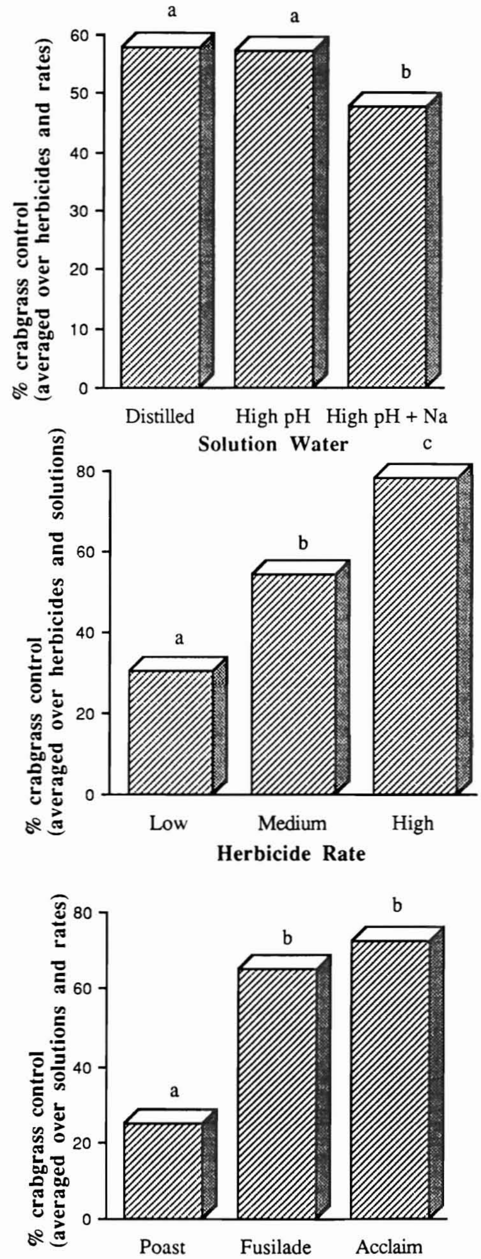

Fig. 1. Crabgrass control (%) at Fairview Nursery as influenced by water solution (averaged over herbicides and rates), herbicide rate (averaged over herbicides and solutions) and herbicides (averaged over rates and solution). Bar values with the same letter are not different according to LSD at $P = 0.05$.

Table 1. The pH, ion concentration and sodium absorption ratio for the five water samples used in the experiments.

	Water Source				
	Distilled (A)[z]	High pH (A)	High pH & Na^+(A)	Distilled (B)	High pH & Na^+(B)
pH	5.2	8.2	8.9	6.8	9.0
Na^+ (ppm)	0	32	800	0	1500
Cl^- (ppm)	2.1	38	145	0.2	0
Ca^{2+} (ppm)	0	49	1.2	2.1	155
SAR[y]	0	1.2	88.9	0	204.9

[z]Distilled water A and B were obtained at different dates. High pH water was obtained from Fairview Nursery. High pH & Na^+ water A and B were obtained at different dates from a Charleston, SC, greenhouse operation. The A mix water samples were used in the first experiment at Fairview Nursery and the B water samples were used in the second and third experiments at Clemson.

[y]SAR = sodium absorption ratio.

Table 2. Smooth crabgrass control and foliage fresh weights as influenced by herbicides, rates and solution water 21 days after treatment at Clemson, SC.

Herbicide	Rate (kg/ha)	Rate (lb/A)	% Crabgrass control		Crabgrass foliage fresh wt. (g)/pot	
			Water source[z]		Water source	
			Distilled	High pH & Na^+	Distilled	High pH & Na^+
Poast	0.05	0.04	29	6	6.6	17.7
Poast	0.15	0.13	73	32	3.9	3.7
Poast	0.30	0.28	92	77	1.1	2.3
Fusilade	0.05	0.04	40	65	4.5	1.5
Fusilade	0.10	0.08	35	70	4.6	1.2
Fusilade	0.20	0.18	62	77	2.9	1.4
Acclaim	0.05	0.04	22	40	14.8	5.3
Acclaim	0.15	0.13	75	62	3.4	2.9
Acclaim	0.30	0.28	98	80	1.6	2.2
Untreated			0		26.6	
LSD ($P=0.05$)			23		5.0	

[z]Water used for herbicide mixing was distilled water (B) and High pH & Na^+ (B) water from a Charleston greenhouse.

Results and Discussion

Azaleas were not visibly injured by any herbicide, rate or water solution (data not shown). The last evaluation (21 days after treatment) had the highest crabgrass control therefore data from this rating period are presented. Interactions of main factor (solutions, herbicides, and rates) were not significant in the first experiment, therefore data presented were for the response of crabgrass to the main factors of water solution, herbicides and rates (Figure 1).

The high pH & Na^+ herbicide water solution reduced crabgrass control by 12% averaged over herbicides and rates (Figure 1) compared to the distilled or the high pH. This solution water contained a high Na^+ concentration (800 ppm), which has been reported to enhance activity of some herbicides (7). This was not observed in this experiment. Fusilade and Acclaim controlled crabgrass more effectively with 65% and 70% control, respectively, compared to 30% with Poast averaged over all rates and solutions. The highest herbicide rate provided 78% crabgrass control averaged over herbicides and water solutions. All treatments in this study contained a non-ionic surfactant. A non-phytotoxic crop oil or Dash are labeled to be added to Poast and the difference in surfactants may explain the reduced efficacy of Poast.

Significant interactions prevented presenting the data from the second experiment by the main effects only. The primary interaction was the different response of Poast and Fusilade to the water solutions. The high pH & Na^+ water reduced the efficacy of Poast by 31% (average) at the lower two rates but increased the activity of Fusilade by 30% (average) (Table 2) This response was also reflected in the crabgrass fresh weight. The sodium concentration was higher (1500 ppm in water sample B compared to 800 ppm in sample A) in this solution water and this higher level could have increased the activity of Fusilade. Monovalent cations such as Na^+ have been shown to increase herbicide phytotoxicity (7). Water source did not effect the crabgrass control ratings

Table 3. Smooth Crabgrass control and foliage fresh weight as influenced by rates of Poast, adjuvants and solution water 21 days after treatment at Clemson, SC.

Adjuvant	POAST Rate (kg/ha)	Rate (lb/A)	% Crabgrass control		Crabgrass foliage fresh wt. (g)/pot	
			Water source[z]		Water source	
			Distilled	High pH & Na^+	Distilled	High pH & Na^+
Surfactant	0.05	0.04	29	6	6.6	17.7
Surfactant	0.15	0.13	73	32	3.9	3.7
Surfactant	0.30	0.28	92	77	1.1	2.3
Crop Oil	0.05	0.04	40	20	5.1	7.3
Crop Oil	0.15	0.13	87	72	1.0	2.3
Crop Oil	0.30	0.28	89	92	1.0	1.3
Dash	0.05	0.04	57	43	1.9	4.4
Dash	0.15	0.13	78	83	1.3	1.7
Dash	0.30	0.28	92	93	1.4	1.0
Untreated			0		26.6	
LSD ($P=0.05$)			19		2.6	

[z]Water used for herbicide mixing was distilled water (B) and High pH & Na^+ (B) water from a Charleston greenhouse.

from Acclaim, however, the low rate of Acclaim with high pH & Na^+ water reduced crabgrass fresh weight by 35% thus providing better control.

Since Poast was influenced the most in the prior two experiments, a third experiment was initiated to determine the influence of additives with Poast and high pH & Na^+ water. All rates of Poast containing Dash were not influenced by water source, whereas crabgrass control was reduced with the 0.05 kg a.i./ha (0.04 lb a.i./A) Poast rate, crop oil, and high pH & Na^+ mix water (Table 3). Crabgrass control was also reduced when the lower rates of Poast were mixed with surfactant and high pH & Na^+ water.

Water quality influenced the activity of the postemergence grass herbicides used in this study. Poast appeared the most sensitive herbicide to high pH & Na^+ solution water. Dash adjuvant was effective in overcoming the interaction associated with the high pH & Na^+ water. This shows the importance of using the correct adjuvant in herbicide sprays. In conclusion, growers should be aware of the likely effects of water quality on herbicide efficacy and plan their weed management programs accordingly.

(*Ed. note:* This paper reports the results of research only, and does not imply registration of a pesticide under amended FIFRA. Before using any of the products mentioned in this research paper, be certain of their registration by appropriate state and/or federal authorities.)

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