DIFENZOQUAT (AVENGE) A NEW HERBICIDE FOR WILD OAT CONTROL

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ABSTRACT

Wild oat causes yield losses and additional production costs estimated at over $150 million per year in North Dakota. Difenzoquat (Avenge) is a new postemergence herbicide for wild oat control in barley, winter wheat, durum wheat, and several spring wheat varieties. Certain wheat varieties have been nearly as susceptible to difenzoquat as wild oat, so use only for wheat varieties listed on the label.

Introduction

Wild oat (*Avena fatua* L.) continues to be the most troublesome annual weed in small grains in North Dakota. A survey conducted in 1973 (5) indicated 57 percent of the small grain acreage in the state was moderately to heavily infested with wild oat.

Wild oat can be controlled effectively in small grains by preemergence applications of triallate (Far-go) or postemergence applications of barban (Carbyne); however, farmer acceptance of these herbicides has not been extensive. Triallate requires applications before the wild oat is visible and barban is only effective on wild oat in the 1- to 2-leaf stage (4). Further, application of barban is not always possible during the limited period of wild oat susceptibility because of adverse weather.

Difenzoquat (Avenge) has shown promise as a selective postemergence herbicide for wild oat control at the 3- to 5-leaf stage (3,7). Difenzoquat would thus allow control of larger wild oat than barban and would allow control over a longer time. Experiments were conducted at several locations throughout the state to evaluate difenzoquat for wild oat control in barley and wheat.

Materials and Methods

Wild oat control in barley and wheat. Six experiments were conducted at experiment stations throughout North Dakota in 1975 and 1976 on land moderately to heavily infested with wild oat (40 to 90 plants per square yard). Beacon barley was seeded May 10 and 31 at Minot and Langdon in 1975, April 13 and May 11 at Fargo and Minot in 1976, and Hector barley May 20 and 27 at Williston in 1975 and 1976; respectively. Olaf wheat was seeded May 16 and 31 at Williston and Langdon in 1975, April 13 and 27 at Fargo and Williston in 1976, and Ellar wheat May 10 and April 13 at Minot in 1975 and 1976; respectively.

Barban was applied with a bicycle wheel plot sprayer at the 1.5- to 2-leaf stage of wild oats and difenzoquat at the 3.5- and 5-leaf stage. The crops generally had 0.5 to 1 more leaves than the wild oat when treatments were applied. Treatments were applied in 8.5 gallons per acre (gpa) water at a pressure of 40 pounds per square inch (psi) except barban which was applied in 4.7 gpa water at 45 psi in 1976. Visual ratings for wild oat control and crop injury were made after the crop and wild oat had headed.

Difenzoquat in combination with several herbicides for broadleaf weed control. Beacon barley was seeded at Fargo in a silty clay soil April 13 in 1976. Herbicide treatments were applied to wild oat in the 4.5- to 5-leaf and barley in the 6-leaf stage. Difenzoquat-broadleaf herbicide combinations were applied as a tank-mix in 8.5 gpa water at 40 psi. Visual weed control ratings were made after the wild oat and barley had headed.

Wheat variety response. Hard red spring and durum wheat variety susceptibility to difenzoquat was evaluated at Fargo in silty clay soil from 1974 to 1976. Seeding dates ranged from April 15 to June 1 depending upon the year. Treatments were applied in

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8.5 gpa water at 40 psi when the plants were in the 4- to 5-leaf stage. Visual ratings were made three to five weeks after treatment.

Results

Wild oat control in barley and wheat. Wild oat control was 17 and 19 percent better with difenzoquat at 12 and 16 oz/A than with barban in barley (Table 1). Difenzoquat at 12 and 16 oz/A gave similar wild oat control of 86 and 88 percent, respectively. Further, barley was very tolerant of the rates of difenzoquat and barban applied. Barley yields were increased 5.2 and 4.9 bu/A by 12 and 16 oz/A of Difenzoquat or 5.4 bu/A by barban when compared to the untreated control plots. The better wild oat control with difenzoquat compared to barban was not reflected in a higher yield because of the earlier removal of wild oat with barban.

Wild oat control was 14 and 18 percent better at the 3.5-leaf stage or 27 and 31 percent better at the 5-leaf stage with difenzoquat at 12 and 16 oz/A than with barban in wheat (Table 2). Wild oat control was similar with both difenzoquat rates regardless of stage at application. However, difenzoquat application at the 5-leaf stage of wild oat was 13 percent more effective than at the 3.5-leaf stage. Difenzoquat at 16 oz/A applied at both stages of growth caused wheat injury rated visually at 6 to 10 percent. However, recovery from injury was good as no symptoms other than a two to three day delay in maturity were observed. Wheat yields were increased 5.0 and 5.9 bu/A at the 3.5-leaf stage or 4.8 and 4.6 bu/A at the 5-leaf stage by difenzoquat at 12 and 16 oz/A or 5.5 bu/A by barban when compared to the untreated control plots. Again, the better wild oat control with difenzoquat at both stages compared to barban was not reflected in a higher yield.

Difenzoquat gave 11 percent better wild oat control at the 3.5-leaf stage of wild oat in barley than wheat when averaged over 12 and 16 oz/A (Table 1,2). The better wild oat control in barley was probably because barley competes with wild oat better than wheat. Crop competitiveness has been reported to influence wild oat control with difenzoquat (3). Difenzoquat was not applied at the 5-leaf stage in barley; however, wild oat control probably would have been increased similarly to the increase observed in wheat.

Difenzoquat in combination with several herbicides for broadleaf weed control. The addition of 2, 4-D DMA (dimethylamine) or LVE (low volatile ester), MCPA DMA, or bromoxynil plus MCPA ester had no effect on wild oat control with difenzoquat (Table 3). Wild oat control with the various treatments ranged from 90 to 92 percent. O'Sullivan *et al.* (6) have reported that ester formulations of 2,4-D tended to enhance the effectiveness of difenzoquat on wild oat in Canada. However, this study indicated no enhancement or loss of wild oat control from the addition of either 2,4-D ester or amine to difenzoquat. Difenzoquat did not reduce common lambsquarters control with any of the broadleaf herbicides. Barley yields were increased 4.4 to 4.8 bu/A by difenzoquat in combination with the broadleaf herbicides when compared to the untreated control plot.

Wheat variety response. Hard red spring wheat varieties were generally more susceptible to injury with difenzoquat than durum wheat varieties (Table 4). Durum varieties were all similarly injured at about 19 percent with 16 oz/A difenzoquat; whereas, spring wheat variety injury ranged from 23 to 62 percent. Spring wheat varieties Waldron and Tioga were the most susceptible to difenzoquat. Susceptibility of Era and Kitt to difenzoquat was similar to the durums. Further, Era and Kitt tended to be slightly more resistant to difenzoquat than Olaf or Ellar at 16 oz/A and the difference was more pronounced at higher difenzoquat rates (data not shown).

Discussion

Difenzoquat provided excellent postemergence wild oat control in barley; however, selectivity in wheat was influenced by cultivar. The use of difenzoquat in a wild oat control program should be limited to barley and tolerant wheat varieties. Waldron and Tioga were the most susceptible wheat varieties to difenzoquat and on occasion were as susceptible as wild oat. Spraying Waldron and Tioga with difenzoquat is not recommended.

Difenzoquat has given more consistent wild oat control when applied at the 5- and 3-leaf stage of wild oat. However, with heavy wild oat infestations, applications should be at the earliest stage of growth to minimize competitive losses. Further, the highest labeled difenzoquat rate should be used when early applications are made to dense stands of wild oat to maximize control. Time of application could be delayed and the lowest labeled difenzoquat rate used with light wild oat infestations without greatly reducing yield.

Even though difenzoquat did not increase crop yields above those obtained with barban, wild oat seed production should have been reduced more than with barban because of the better wild oat control. The influence of a treatment on wild oat seed production is important when considering future infestations. Difenzoquat was compatible with MCPA, 2.4-D or bromoxynil plus MCPA which allows the control of both broadleaf weeds and wild oat with one application.

Greenhouse and growth chamber experiments conducted at North Dakota State University have indicated that climatic and soil factors which promote plant growth have generally enhanced wild oat control with difenzoquat. Field observations have confirmed that adequate soil moisture and fertility enhance wild oat control in wheat and barley. These conditions not only enhance difenzoquat activity, but also promote greater crop competition with wild oat.

Table 1. Barley injury, barley yield, and wild oat control with barban and difenzoquat in 1975 and 1976.

Treatment	Wild oat leaf stage	Rate oz/A	Barley[1] % Injury	Barley[1] Yield bu/A	% Wild oat control
Barban	2	4	0	38.1 a[2]	69 b
Difenzoquat	3.5	12	0	37.9 a	86 a
Difenzoquat	3.5	16	0	37.6 a	88 a
Control	---	--	0	32.7 b	0 c

[1] *Each value is the mean of six experiments conducted over two season.*

[2] *Values followed by the same letter are not statistically different.*

Table 2. Wheat injury, wheat yield, and wild oat control with barban and difenzoquat in 1975 and 1976.

Treatment	Wild oat leaf stage	Rate oz/A	Wheat[1] % Injury	Wheat[1] Yield bu/A	% Wild oat control
Barban	2	4	0 b[2]	22.5 a	60 c
Difenzoquat	3.5	12	2 b	22.0 a	74 b
Difenzoquat	3.5	16	10 a	22.9 a	78 b
Difenzoquat	5	12	6 a	21.8 a	87 a
Difenzoquat	5	16	10 a	21.6 a	91 a
Control	---	--	0 b	17.0 b	0 d

[1] *Each value is the mean of six experiments conducted over two seasons.*

[2] *Values followed by the same letter are not statistically different.*

Table 3. Wild oat control, common lambsquarters control and barley yield with difenzoquat alone or in combination with herbicides for broadleaf weed control at Fargo in 1976.

Treatment	Rate oz/A	% Control wild oat	% Control common lambsquarter	Barley yield bu/A
Difenzoquat	12	91 a[1]	0 b	28.0 ab
Difenzoquat + 2,4-D (DMA)	12 + 4	92 a	100 a	29.5 a
Difenzoquat + 2,4-D (LVE)	12 + 4	91 a	100 a	29.6 a
Difenzoquat + MCPA	12 + 4	90 a	100 a	29.8 a
Difenzoquat + Bromoxynil + MCPA	12 + 4 + 4	92 a	100 a	29.4 a
Control	---------	0	0 b	25.0 b

[1] *Values followed by the same letter are not statistically different.*

Table 4. Wheat cultivar response to 16 oz/A difenzoquat at Fargo from 1974 to 1976.

Cultivar	% Crop Injury	% Yield reduction
Hard red spring		
Waldron	63 a[1]	30 a
Olaf	31 b	15 b
Era	25 bc	12 b
Kitt	23 bc	9 bc
Ellar	32 b	15 b
Tioga	56 a	24 a
Durum		
Leeds	19 c	10 bc
Ward	19 c	3 c
Rugby	18 c	3 c
Botno	19 c	3 c

[1] *Values in a column follwed by the same letter are not statistically different.*

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