EVALUATION OF ACHIEVE FOR CONTROL OF GRASSY WEEDS IN WHEAT

A.D. Yochim and M.D. Devine

Department of Crop Science and Plant Ecology
University of Saskatchewan

ABSTRACT

Field studies were conducted in 1989 and 1990 at Aberdeen, Outlook, and Saskatoon to evaluate the efficacy of Achieve, Hoe-Grass, Assert, and Puma Super for green foxtail (Setaria viridis) and wild oat (Avena sativa) control in wheat. Treatments were applied under both dryland and irrigated conditions and included a range of herbicide rates to determine the dose required for control under each set of environmental conditions. Different weed leaf stages at the time of herbicide application were used to determine the effect of growth stage on herbicide efficacy. Under irrigation, Achieve provided good control of both green foxtail and wild oat at rates as low as 100 g/ha. Achieve activity was greater under irrigated than dryland conditions, suggesting that reduced rates may be used under conditions where moisture is not limiting. The efficacy of Achieve was greatly reduced by a delay in application from the 4-leaf stage to the 6-leaf stage of tame oat. At the 4-leaf stage, rates as low as 25 g/ha were effective; however, at the 6-leaf stage only the full rate (250 g/ha) provided acceptable control. Puma Super provided excellent control of green foxtail under both dryland and irrigated conditions. Overall, Achieve and Puma Super both provided a high degree of control of all weed species in the study. Assert and Hoe-Grass were less effective than the former herbicides.

INTRODUCTION

Green foxtail (Setaria viridis) and wild oat (Avena fatua) are two weed species that cause significant yield losses in wheat in Saskatchewan. These weeds are commonly controlled using post-emergence grassy-weed herbicides. Three factors that influence the efficacy of post-emergence grassy-weed herbicides in controlling wild oat and green foxtail are:

1. The environmental conditions before, during, and after herbicide application.
2. The stage of growth of the weed at the time of herbicide application.
3. The rate of the herbicide applied.

A thorough understanding of these factors is important in maximizing the activity of post-emergence herbicides. This is especially important when considering a relatively new herbicide, such as Achieve, for which only limited data may be available. The objectives of this study were:

1. To evaluate the control of green foxtail and wild oat by several rates of Achieve under dryland and irrigated conditions.
2. To evaluate the control of green foxtail and wild oat by postemergence herbicides under dryland and irrigated conditions.
3. To evaluate the efficacy of postemergence grassy weed herbicides applied at two growth stages to wild oat and green foxtail.

MATERIALS AND METHODS

General

The field sites were located at Aberdeen and Outlook in 1989 and at Aberdeen and Saskatoon in 1990. The tests were duplicated under both dryland and irrigated conditions at each site. The tests were seeded to hard red spring wheat using either conventional drill seeding equipment or a disc drill plot seeder. Plot size was 3 m by 6 m. For all tests the treatments were grouped into a randomized complete block design with four replications. Check plots, to which no herbicide was applied, were used in all

tests. Data were subjected to analysis of variance, and LSD tests were used to determine treatment differences.

At all but the Saskatoon site weed pressure consisted of native stands of green foxtail and wild oat. At Saskatoon tame oat was seeded at right angles to the crop in order to simulate a stand of wild oat plants. Herbicide was applied using either a hand-held sprayer or a "walk- behind" hooded sprayer. The hand-held sprayer was 3 m wide with four 8001 nozzles which applied 110 l/ha at 240 kpa. The hooded sprayer was 2.75 m wide with four 80015 nozzles and an application rate of 110 l/ha at 245 kpa.
Crop, soil, and weed characteristics were determined by taking the following measurements:
(1) Soil moisture. Gravimetric soil moisture measurements were made for the 0-30 and 30-60 cm depths at 7 days before spraying, the day of spraying, and 21 days after spraying.
(2) Crop yield. Crop yield was determined by harvesting a 6 m^2 strip from each plot. Grain samples were air-dried to 14% moisture, cleaned and weighed.
(3) Weed biomass. Two 0.25 m^2 quadrats were taken from each plot, oven dried for 24 hours and weighed. In 1989 two sampling dates were used, the first at 21 days after spraying and the second just prior to harvest. Only one sampling time, at four weeks after spraying, was used in 1990.
(4) Weed seed production at harvest. Weed seed production was determined for a 6 m^2 area.

Experiments Performed
The objectives were met by performing the following three tests:
(1) Rates of Achieve. A range of rates of Achieve from 25 g/ha to 250 g/ha (10% to 100% of the suggested recommended rate) were applied to weeds at the 4-leaf growth stage under dryland and irrigated conditions.
(2) Rates of Achieve applied at two growth stages. Achieve was applied at doses from 25 g/ha to 250 g/ha to weeds at either the 4-leaf or the 6-leaf stage of growth.
(3) Comparison of post-emergence grassy weed herbicides applied at two rates under dryland and irrigated conditions. Achieve, Hoe-Grass, Assert, and Puma Super were applied at 50% and 100% of the suggested recommended field rate.
(4) Comparison of post-emergence grassy weed herbicides applied at two rates to weed plants at two growth stages. Achieve, Hoe-Grass, Assert, and Puma Super were applied at 50% and 100% of the suggested recommended field rate to plants at either the 4-leaf or 6-leaf growth stage.

The following is a list of the tests performed at each location in each of the two years of the study:
(1) Aberdeen 1989
- Rates of Achieve (dryland and irrigated)
- Comparison of post emergence herbicides at 4-leaf stage (dryland and irrigated)
- Comparison of post emergence herbicides applied at 6-leaf stage (dryland and irrigated)

(2) Outlook 1989
- Rates of Achieve (dryland and irrigated)
- Comparison of post emergence herbicides applied at 4-leaf stage (dryland and irrigated)

(3) Aberdeen 1990
- Rates of Achieve (dryland)
- Comparison of post-emergence herbicides applied at 4-leaf stage (dryland)
- Comparison of post emergence herbicides applied at 6-leaf stage (dryland)

(4) Saskatoon 1990
- Rates of Achieve applied at 4-leaf stage (dryland)
- Rates of Achieve applied at 6-leaf stage (dryland)
- Comparison of post-emergence herbicides applied at 4-leaf stage (dryland)
- Comparison of post-emergence herbicides applied at 6-leaf stage (dryland)

RESULTS AND DISCUSSION

Efficacy of Achieve on green foxtail and wild oat under dryland and irrigated conditions

The values for the crop yields for the tests involving different rates of Achieve applied under dryland and irrigation are given in Table 1. None of the treatments had a significant effect on crop yield at any of the sites under either dryland or irrigated conditions (Table 1).

Table 1. Effect of Achieve on wheat yield.

Treatment	Rate (g/ha)	Aberdeen		Outlook	
		Dryland	Irrigated	Dryland	Irrigated
		(g/m^2)			
Check	0	162	255	98	249
Achieve	63	150	335	108	224
Achieve	100	152	281	90	239
Achieve	150	150	326	102	240
Achieve	200	156	288	105	243
Achieve	250	142	334	101	232

* significantly different from the check

Table 2 contains the weed biomass values at 21 days after treatment under dryland and irrigated conditions. At Outlook, Achieve had lower efficacy on green foxtail under dryland as opposed to irrigated conditions (Table 2). Under irrigation the green foxtail biomass at 21 days after spraying was significantly reduced by Achieve at 40% of the suggested recommended field rate. Under dryland conditions, however, rates of at least 60% of the suggested recommended field rate were required to significantly reduce green foxtail biomass 21 days after spraying. An absence of wild oat at the dryland site at Aberdeen made it impossible to compare the efficacy of Achieve applied under dryland and irrigated conditions. At Aberdeen all rates of Achieve provided measurable control of wild oat under irrigated conditions (Table 2). The reduction of green foxtail biomass relative to the check ranged from 33% to 63% under dryland conditions and from 34% to 85% under irrigation. The 25% rate of Achieve provided similar percentage levels of reduction in green foxtail biomass under dryland and irrigated conditions (37% and 34%, respectively relative to the check). At the 100% rate the level of control of green foxtail relative to the check was much higher under irrigated than under dryland conditions; 84% for irrigation versus 52% for dryland. In terms of herbicide rates required for weed control, rates as low as 25% of the suggested recommended field rate yielded significant reductions in wild oat and green foxtail biomass under irrigation. However, under dryland conditions a rate equal to 60% of the suggested recommend field rate was required for a significant reduction in green foxtail biomass relative to the check (Table 2). The data in Table 2 indicate that for green foxtail, and possibly for wild oat, lower rates of Achieve can be used when moisture is not limiting.

The effect of various rates of Achieve on weed seed weight are shown in Table 3. Under irrigated conditions at Aberdeen, none of the rates used significantly reduced wild oat seed weight (Table 3). The lack of a significant reduction in wild oat seed weight by Achieve is likely due to high variability in the data. Although significant reductions were not observed, the percentage reductions in seed weight relative to the check were high, ranging from 43% (40% of the full rate) to 97% (80% of the full rate). Achieve was slightly more effective in reducing green foxtail seed yield under irrigated than dryland conditions at Outlook. Under irrigation, all six rates significantly reduced green foxtail seed weight. In comparison, under dryland conditions only 40%, 60%, and 80% of the suggested recommended field rate resulted in a significant reduction in the seed weight of green foxtail at harvest (Table 3).

Table 2. Effect of Achieve on weed biomass 21 days after treatment.

Treatment	Rate (g/ha)	Outlook (green foxtail) Dryland	Outlook (green foxtail) Irrigated	Aberdeen (wild oat) Irrigated
		(g/m^2)		
Check	0	250	818	360
Achieve	63	158	540*	11*
Achieve	100	168	204*	1*
Achieve	150	128*	200*	42*
Achieve	200	92*	124*	0*
Achieve	250	120*	133*	0*

* significantly different from the check

In terms of the percentage reduction in green foxtail seed weight relative to the check, a greater reduction was observed under irrigated than under dryland conditions. The percentage reduction in green foxtail seed weight relative to the check for the 20% rate of Achieve was 24% and 60% for dryland and irrigated conditions, respectively. At the 80% rate of Achieve the percentage reductions in green foxtail seed biomass for dryland and irrigation were 74% and 88%. It appears that irrigated conditions provide more acceptable control when lower rates of Achieve are used. At the higher rates of Achieve the difference in efficacy of Achieve under dryland and irrigated conditions is reduced.

Table 3. Effect of Achieve on weed seed weight.

Treatment	Rate (g/ha)	Outlook (green foxtail) Dryland	Outlook (green foxtail) Irrigated	Aberdeen (wild oat) Irrigated
		(g/m^2)		
Check	0	3.4	34.6	21.8
Achieve	63	2.6	13.7*	2.0
Achieve	100	1.7*	6.2*	12.5
Achieve	150	1.7*	7.0*	2.7
Achieve	200	0.9*	4.0*	0.6
Achieve	250	3.6	4.2*	4.7

* significantly different from the check

Control of green foxtail and wild oat by postemergence herbicides under dryland and irrigation
The control of green foxtail by the full rates of postemergence grassy-weed herbicides applied under dryland and irrigated conditions is shown in Table 4. Under dryland conditions, none of the herbicides applied had a significant effect upon either the biomass at 21 days after spraying or on the seed weight of green foxtail (Table 4). The herbicide Puma Super did prevent seed production of green foxtail under dryland conditions: however, because of high variability the value was not significantly different from the check. Puma Super and Achieve gave the highest percentage reductions in green foxtail seed weight relative to the check; 65% and 41%, respectively. Under irrigation the improved moisture conditions enhanced the performance of Achieve and Puma Super but did not affect the performance of Hoe-Grass and Assert (Table 4). Application of Achieve and Puma Super under irrigation significantly reduced both the biomass and seed weight of green foxtail relative to the check (Table 4). Puma Super reduced green foxtail biomass and seed weight more than Achieve; however, the differences between the two herbicides were not statistically significant.

Table 4. Green foxtail control by postemergence herbicides applied at full rate.

Treatment	Rate (g/ha)	Dryland Biomass 21 Days	Dryland Seed Weight	Irrigation Biomass 21 Days	Irrigation Seed Weight
		(g/m^2)			
Check	0	237	6	617	29
Achieve	250	141	6	62*	8*
Hoe-Grass	710	229	5	426	22
Assert	480	287	8	599	27
Puma Super	100	82	0	4*	0*

* significantly different from the check

None of the herbicides applied at 50% of the recommended rate significantly affected either green foxtail biomass 21days after spraying or green foxtail seed weight at harvest when applied under dryland conditions (Table 5). Under irrigation, the efficacy of the herbicides Achieve and Puma Super was improved. A similar improvement in the performance of Achieve and Puma Super under irrigation was also observed when the full rates of these herbicides were applied to green foxtail (Table 4). Achieve applied under irrigated conditions significantly reduced seed production by green foxtail, but not the biomass (Table 5). Puma Super was more effective than Achieve uner irrigation as it significantly reduced not only the seed weight of green foxtail, but also the biomass (Table 5). Also, as was observed at the full rates of Achieve and Puma Super (Table 4), the performance of Puma Super under irrigation was greater than that of Achieve. Although the differences between the values for green foxtail biomass and green foxtail seed weight control by Achieve and Puma Super are not statistically significant, Puma Super applied at half-rate resulted in lower values for both parameters when compared with Achieve. Application of Achieve under irrigation produced 51% and 62% reductions in green foxtail biomass and green foxtail seed weight relative to the check (Table 5). The corresponding values for Puma Super were 98% and 100% (Table 5). Therefore, although the differences are not statistically significant, Puma Super appeared to perform better than Achieve under irrigated conditions in this study.

Table 5. Green foxtail control by postemergence herbicides applied at 50% of the recommended rate.

Treatment	Rate (g/ha)	Dryland Biomass 21 Days	Dryland Seed Weight	Irrigation Biomass 21 Days	Irrigation Seed Weight
		(g/m^2)			
Check	0	237	6	617	29
Achieve	125	134	5	301	11*
Hoe-Grass	355	151	6	592	19
Assert	240	136	4	675	25
Puma Super	50	48	0	10*	0*

* significantly different from the check

Efficacy of postemergence herbicides applied at two growth stages

Table 6 shows the effect of oat growth stage on the efficacy of various rates of Achieve applied to oat at the 4-leaf stage and 6-leaf stage. At the 4-leaf stage, rates as low as 10% of the suggested recommended field rate provided significant reductions in both tame oat biomass and tame oat seed yield. Rates of Achieve from 40% to 100% of the suggested recommended field rate were able to prevented seed production when applied at the 4-leaf stage. The efficacy of Achieve applied at the 4-leaf stage of oat is shown by significant increases in wheat yield by all rates, including the 10% rate (Table 7). When applied at the six-leaf stage of oat, the efficacy of Achieve was reduced. Only the 100% rate of Achieve resulted in

a significant reduction in oat biomass. None of the rates applied totally prevented seed production by oat, and a minimum rate of 40% of the suggested recommended field rate was needed to significantly reduce oat seed yield (Table 6). The reduced efficacy of Achieve applied to oat at the 6-leaf stage is reflected by the fact that none of the rates applied resulted in a significant increase in wheat yield (Table 7).

Table 6. Efficacy of Achieve on oat.

		4-LS		6-LS	
Treatment	Rate (g/ha)	Oat Biomass	Oat Seed Yield	Oat Biomass	Oat Seed Yield
		(g/m^2)			
Check	0	598	135	175	112
Achieve	25	112*	74*	146	109
Achieve	50	80*	22*	133	88
Achieve	100	55*	0*	126	52*
Achieve	150	77*	0*	137	42*
Achieve	200	35*	0*	117	29*
Achieve	250	46*	0*	96*	22*

* significantly different from the check

Table 7. Effect of Achieve control of oat at two growth stages on wheat yield.

Treatment	Rate (g/ha)	4-LS Wheat Yield	6-LS Wheat Yield
		(g/m2)	
Check	0	208	239
Achieve	25	252*	255
Achieve	50	251*	259
Achieve	100	298*	282
Achieve	150	262*	293
Achieve	200	300*	273
Achieve	250	270*	245

* significantly different from the check

Table 8 shows the effect of growth stage on the efficacy of full rates of postemergence grassy-weed herbicides on tame oat. When applied at the 4-leaf stage, all four herbicides significantly reduced both the biomass and the seed yield of oat. Achieve and Puma Super had the largest percentage reductions in oat biomass relative to the check. The reduction in oat biomass attributed to Puma Super was 78% while that for Achieve was 74%. Hoe-Grass and Assert reduced oat biomass of 50% and 41%, respectively. Delaying application until the 6-leaf stage resulted in a slight reduction in the performance of the herbicides. All herbicides, except for Hoe-Grass, significantly reduced oat biomass. Oat seed yield was significantly reduced by all herbicides when applied at the 6-leaf stage (Table 8). When the percentage reductions in oat biomass and oat seed yield relative to the check at the 4-leaf stage and 6-leaf stage are compared, a reduction in performance can be seen. Achieve and Puma Super showed the largest drops in percentage control of biomass relative to the check when comparing the 4-leaf stage to the 6-leaf stage. At the 4-leaf stage the percentage reduction in oat biomass relative to the check was 74% and 78% for Achieve and Puma Super, respectively. The corresponding values for Achieve and Puma Super at the 6-leaf stage were 47% and 33%. Hoe-Grass experienced a lesser drop in the percentage reduction in oat biomass relative to the check at the 4-leaf stage relative to the 6-leaf leaf stage; 50% at the 4-leaf stage versus 20% at the 6-leaf stage. For Assert, the difference in the percentage reduction in biomass relative to the check for the 4-leaf stage and 6-leaf stage was negligible.

Table 8. Efficacy of postemergence herbicides applied at the full rate to oat.

Treatment	Rate (g/ha)	4-LS Oat Biomass	4-LS Oat Yield	6-LS Oat Biomass	6-LS Oat Yield
		(g/m^2)			
Check	0	170	112	171	133
Achieve	250	44*	0*	91*	26*
Hoe-Grass	710	85*	23*	137	87*
Assert	480	101*	2*	97*	9*
Puma Super	100	37*	46*	115*	39*

* significantly different from the check

The increased performance of the herbicides in controlling oat when applied at the 4-leaf stage as opposed to the 6-leaf stage can be seen by examining the yield of wheat (Table 9). At the 4-leaf stage all herbicides significantly increased wheat yield, but at the 6-leaf stage only Achieve and Puma Super significantly increased wheat yield. In addition, when applied at the 4-leaf stage, the yields ranged from 140% to 190% of the check. The highest yield increases were observed for Achieve and Puma Super (190% and 110% of the check, respectively). At the 6-leaf stage the percentage yield increase resulting from herbicide application was lower, ranging from 110% to 120% of the check.

Table 9. Effect of postemergence herbicides, applied to oat at two growth stages, on wheat yield.

Treatment	Rate (g/ha)	4-LS Wheat Yield	6-LS Wheat Yield
		(g/m2)	
Check	0	120	211
Achieve	250	226*	239*
Hoe-Grass	710	175*	236
Assert	480	169*	229
Puma Super	100	187*	243*

* significantly different from the check

Table 10 shows the efficacy of postemergence herbicides applied at half-rates to oat at the 4-leaf and 6-leaf stages. At the 4-leaf stage all herbicides except Hoe-Grass significantly reduced the oat biomass. Achieve and Puma Super had the largest reductions in percentage biomass relative to the check, 68% and 64% respectively. All four herbicides signicantly reduced the seed yield of oat (Table 10), with Achieve and Puma Super completely preventing seed production by oat when applied at the 4-leaf stage. At the 6-leaf stage all herbicides except Puma Super significantly reduced oat biomass (Table 10). All herbicides significantly reduced oat seed yield when applied at the 6-leaf stage. However, Achieve and Puma Super failed to prevent seed production. Comparing oat seed yields when the herbicides were applied at the 4-leaf stage to the corresponding values at the 6-leaf stage shows that delaying application resulted in greater seed production for all herbicides (Table 10).

Table 10. Efficacy of postemergence herbicides applied at half-rate to oat.

Treatment	Rate (g/ha)	4-LS Oat Biomass	4-LS Oat Yield	6-LS Oat Biomass	6-LS Oat Yield
		(g/m^2)			
Check	0	170	112	171	133
Achieve	125	54*	0*	103*	34*
Hoe-Grass	355	128	38*	114*	87*
Assert	240	92*	11*	111*	22*
Puma Super	50	61*	0*	155	63*

* significantly different from the check

At the 4-leaf stage, all four herbicides significantly increased wheat yields. At the 6-leaf stage only Achieve significantly increased wheat yield (Table 11). Since the wheat crop and the oat plants compete for available resources, reduced weed control should be reflected in lower crop yields. The percentage increases in wheat yield relative to the check indicates that lower wheat yields result from the reduced control of oat observed when herbicides are applied at the 6-leaf stage. At the 4-leaf stage wheat yields were 140% to 160% of the check value, with the greatest increases resulting from treatment with Achieve and Puma Super. At the 6-leaf stage the wheat yield increases resulting from herbicide application were only 100% to 110% those of the check. A similar relationship was observed when tame oat control was reduced by delaying herbicide application from the 4-leaf stage to the 6-leaf stage for the full and half-rates of the herbicides (Tables 9 and 11).

Table 11. Effect of postemergence herbicides, applied to oat at half-rate, on wheat yield.

Treatment	Rate (g/ha)	4-LS Wheat Yield	6-LS Wheat Yield
		(g/m2)	
Check	0	120	211
Achieve	125	189*	250*
Hoe-Grass	355	164*	230
Assert	240	163*	222
Puma Super	50	185*	226

* significantly different from the check

The efficacy of postemergence herbicides applied at the full rate to wild oat at the 4-leaf and 6-leaf stages is shown in Table 12. At the 4-leaf stage all four herbicides significantly reduced the biomass and seed yield of wild oat. At the 6-leaf stage, none of the herbicides significantly reduced wild oat biomass, but all the herbicides significantly reduced wild oat seed yield (Table 12). When the control by the four postemergence herbicides is examined, a similar pattern emerges.

At the 4-leaf stage only Assert and Puma Super significantly reduced the wild oat biomass when applied at half-rates (Table 13). All four postemergence herbicides significantly reduced wild oat yield when applied at half-rates to wild oat at the 4-leaf stage (Table 13). When applied at the 6-leaf stage all four herbicides significantly reduced wild oat seed yield, but none of the herbicides had an effect on wild oat biomass (Table 13). A failure to reduce wild oat biomass when applied at the 6-leaf stage was also observed for the full rates of the herbicides (Table 12). The control of wild oat by postemergence herbicides appears to be only slightly reduced when the rate applied is reduced from 100% to 50% of the suggested recommended field rate at the 4-leaf and 6-leaf stages (Tables 12 and 13). Only Achieve and Hoe-Grass failed to significantly reduce wild oat biomass when applied at half-rate to 4-leaf stage (Table 13). Also,

for both the full and half-rates of these herbicides, delaying application from the 4-leaf stage to the 6-leaf stage resulted in control of wild oat. Delaying application from the 4-leaf to the 6-leaf stage did not appear to greatly influence the effect of the herbicides on wild oat seed yield (Tables 12 and 13).

Table 12. Efficacy of postemergence herbicides applied at the full recommended rate to wild oat.

		4-LS		6-LS	
Treatment	Rate (g/ha)	Wild Oat Biomass	Wild Oat Yield	Wild Oat Biomass	Wild Oat Yield
		(g/m^2)			
Check	0	523	134	590	201
Achieve	250	29*	1*	11	5*
Hoe-Grass	710	48*	4*	68	3*
Assert	480	11*	1*	463	3*
Puma Super	100	0*	1*	47	2*

* significantly different from the check

Table 13. Efficacy of postemergence herbicides applied at half-rate to wild oat

		4-LS		6-LS	
Treatment	Rate (g/ha)	Wild Oat Biomass	Wild Oat Yield	Wild Oat Biomass	Wild Oat Yield
		(g/m^2)			
Check	0	523	134	590	201
Achieve	125	165	2*	43	11*
Hoe-Grass	355	119	6*	89	4*
Assert	240	6*	1*	87	4*
Puma Super	50	34*	3*	124	2*

* significantly different from the check

Table 14 shows the control of green foxtail by the full rates of four postemergence herbicides applied at two growth stages. When applied at both the 4-leaf stage and the 6-leaf stage, the only herbicide which significantly reduced the biomass of green foxtail was Puma Super (Table 14). Achieve applied at the 6-leaf stage significantly reduced the biomass of green foxtail (Table 14). The degree of control resulting from full rates of the four herbicides applied at either the 4-leaf or the 6-leaf growth stage was insufficient to significantly increase wheat yield (Table 14).

The efficacy of half-rates of the four postemergence herbicides applied to green foxtail at the 4-leaf and the 6-leaf stages is shown in Table 15. At the 4-leaf stage Hoe-Grass and Puma Super both resulted in a significant reduction in green foxtail biomass (Table 15). At the 6-leaf growth stage both Achieve and Puma Super significantly reduced green foxtail biomass when applied at half-rates (Table 15). Puma Super was the only herbicide applied at half-rate which was able to significantly reduce green foxtail biomass at both the 4-leaf and 6-leaf stages (Table 15). None of the herbicides provided sufficient green foxtail control at either the 4-leaf or the 6-leaf stages to result in significant wheat yield increases (Table 15).

Table 14. Efficacy of postemergence herbicides applied at full rate to green foxtail.

Treatment	Rate (g/ha)	4-LS Grn Fxtl Biomass	4-LS Wheat Yield	6-LS Grn Fxtl Biomass	6-LS Wheat Yield
		(g/m^2)			
Check	0	112	118	105	189
Achieve	250	71	109	66*	212
Hoe-Grass	710	72	134	74	172
Assert	480	95	84	108	215
Puma Super	100	36*	151	20*	188

* significantly different from the check

Table 15. Efficacy of postemergence herbicides applied at half-rate to green foxtail

Treatment	Rate (g/ha)	4-LS Grn Fxtl Biomass	4-LS Wheat Yield	6-LS Grn Fxtl Biomass	6-LS Wheat Yield
		(g/m^2)			
Check	0	112	118	105	189
Achieve	125	74	113	63*	164
Hoe-Grass	355	65*	121	74	270
Assert	240	119	130	117	228
Puma Super	50	53*	132	41*	210

* significantly different from the check

CONCLUSIONS

The following conclusions can be drawn from this study on the control of grassy weeds in wheat by Achieve and other grassy-weed herbicides:

(1) Under irrigation, Achieve rates as low as 100 g/ha provided good control of both weed species. Achieve activity on green foxtail was higher under irrigated conditions, suggesting that reduced rates may be used under conditions where moisture is not limiting.

(2) Achieve efficacy was greatly reduced when application was delayed from the 4-leaf stage to the 6-leaf stage. At the 4-leaf stage, rates as low as 25 g/ha can be effective; however, at the 6-leaf stage only the full rate (250 g/ha) provided acceptable control.

(3) Puma Super provided excellent control of green foxtail under both dryland and irrigated conditions. Overall, Achieve and Puma Super both provided a high degree of control of all weed species in this study. Assert and Hoe-Grass were less effective than the former herbicides.