POSTEMERGENCE BROADLEAF WEED CONTROL IN BARLEY

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by

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TABLES

CONVERSION FACTORS FOR ENGLISH AND METRIC UNITS

To Convert Column 1 to Column 2 Multiply by	Column 1	Column 2	To Convert Column 2 to Column 1 Multiply by
2.54	in	cm	0.394
0.3048	ft	m	3.281
0.093	ft^2	m^2	10.765
1.12	lb/A	kg/ha	0.892
9.35	gal/A	l/ha	0.107
0.0703	lb/in^2	kg/cm^2	14.22
0.3797	oz/ft^2	g/m^2	2.835
1.287	lb/bu	kg/hL	0.777

ABSTRACT

Experiments were conducted from 1981-1983 to determine the efficacy and phytotoxicity of postemergence herbicides used to control broadleaf weeds in spring-planted barley. The following herbicides were evaluated: MCPA amine (0.37, 0.75, 1.5 lb/A, active ingredient), 2,4-D amine (0.25, 0.5, 1 lb/A), bromoxynil (0.21, 0.43, 0.86 lb/A), and metribuzin (0.11, 0.21, 0.43, 0.86 lb/A). In 1982 and 1983, three additional herbicides were included: dinoseb (0.25, 0.5, 1 lb/A), dicamba (0.09, 0.18, 0.36 lb/A), and chlorsulfuron (0.04, 0.07, 0.14 lb/A). Weed control was determined through measurements of weed biomass in each herbicide and control plot. Phytotoxicity was measured by barley yield and test weight in all years, and additionally by germination of seed produced in 1982. None of the herbicides except dicamba in 1982 significantly reduced the yield or test weights of barley below that of the control. Common lambsquarters was the only weed present in 1981 and 1982. Bromoxynil and metribuzin provided both early- and late-season control. MCPA, 2,4-D, and dinoseb took longer to control common lambsquarters but provided adequate control by midseason. Dicamba did not control common lambsquarters as well as the other herbicides. In 1983, prostrate knotweed was also present at the study site. None of the herbicides significantly reduced the number of prostrate knotweed below that of the control. Germination of 'Galt' barley was not affected by treating parent plants with any of the herbicides tested. The following barley varieties were screened for susceptibility to metribuzin injury in 1982: Galt, Lidal, Weal, Otal, Datal, Eero, Paavo, Otra, and Klondike. Only 'Klondike' was highly sensitive to metribuzin.

INTRODUCTION

Broadleaf weeds become an increasing problem in Alaskan barley production the longer that land has been in cultivation (Conn and DeLapp, 1983). Newly cleared agricultural land is devoid of seed of introduced weeds at the time of first cultivation (Conn et al., 1984). When introduced weeds are allowed to colonize and produce seed on new farmland, they become very difficult to eradicate totally. This is because weed seeds may lie dormant for years. Thus, every precaution should be taken to keep weeds from colonizing new farmland. Weeds that become established should be controlled to prevent them from reproducing.

Herbicides are an indispensable tool for controlling weeds and thereby minimizing weed-related crop losses in large-scale agriculture. A number of these chemicals are approved for broadleaf-weed control in spring-planted barley. However, there are no published results of experiments conducted to evaluate the suitability of these herbicides to control broadleaf weeds under Alaskan conditions.

Reported herein are results of experiments performed to satisfy the following objectives:

1) Determine whether herbicides labeled for broadleaf weed control are phytotoxic to the crop (reduce barley yields or test weights) under Alaskan conditions.
2) Determine if approved herbicides control common Alaskan broadleaf weeds.
3) Determine if herbicides applied to parent plants affect germination of produced seeds.
4) Determine if barley varieties adapted to Alaskan growing conditions are sensitive to metribuzin.

MATERIALS AND METHODS

1981 EXPERIMENTS

The study was conducted near Delta Junction, Alaska, on Nenana silt loam with a soil pH of 6.2 and organic-matter content of 4.5 per cent. The soil was fertilized with 72 lb/A N (urea). Following a single disking, 'Galt' barley was planted on May 15 at a rate of 72 lb/A (germinable seed) in 7-in. rows using a grain drill. At planting, 70 lb/A of 11-51-0 was added to the planted row. The soil was then packed using a Brillion seeder. On June 15, when common lambsquarters was in the four-leaf stage and barley was in the four-leaf stage with one or two tillers, MCPA[a], 2,4-D[b], bromoxynil[c] and metribuzin[d] were sprayed at the following rates (active ingredient): MCPA amine (0.37, 0.75, 1.5 lb/A); 2,4-D amine (0.25, 0.5, 1 lb/A); bromoxynil (0.21, 0.43, 0.86 lb/A); and metribuzin (0.11, 0.21, 0.43, 0.86 lb/A). All herbicides were sprayed using a CO_2 sprayer at a pressure of 30 lb/in^2, calibrated to deliver 25.1 g/A.

The experiment consisted of the thirteen herbicide treatments and an unweeded control, replicated four times and laid out as a randomized, complete-block design. The plots were 10 x 40 ft. To determine the efficacy of the herbicides, weed counts were made on July 2 and August 27 using a 0.25m^2 quadrat placed in each plot. After the second counting, the weeds were harvested at ground level and their dry weight determined. The barley was harvested on September 15 using a plot combine which cut a swath 4.5 x 40 ft. through each plot.

[a]Trade Name: Weedar (Union Carbide Agricultural Products Co., Inc.)
[b]Trade Name: Formula 40 (Dow Chemical Co.)
[c]Trade Name: Buctril (Rhone-Poulenc Chemical Co.)
[d]Trade Name: Sencor 50 W (Mobay Chemical Corp.)

1982 EXPERIMENTS

Efficacy—phytotoxicity. This study was carried out at the same site as the 1981 studies. The soil was fertilized with 400 lb/A 20-10-10 (N_3, P_2O_5, K_2O), then double disked and harrowed. 'Galt' barley was planted at 72 lb/A (germinable seed) on May 22. On June 24, when common lambsquarters was at the four- to six-leaf stage and the barley had four or five leaves and one or two tillers, the herbicides used in 1981 were again sprayed at the same rates and under the same application conditions. Three additional herbicides were included in the 1982 study: dinoseb[e] (0.25, 0.50, 1.00 lb/A a.i.), dicamba[f] (0.09, 0.18, 0.36 lb/A a.i.) and chlorsulfuron[g] (0.04, 0.07, 0.14 lb/A a.i.). The experimental design consisted of twenty-two herbicide treatments plus the nonweeded control replicated five times in randomized block design. On July 9 and July 30, weed counts were made and biomass determined as in 1981. The plots were harvested September 11 using a plot combine.

Germination study. To determine if herbicides used on the maternal plant affect germination of the seed produced, subsamples of the 1982 grain harvest were taken from each plot sample and tested for viability during spring 1983. From this subsample, three or four sets of 100 seeds were each placed in petri dishes on a double layer of filter paper. The seeds were watered and incubated in the dark at 20°C for 7 days. All seeds with emerged radicles were counted as viable.

Barley variety—metribuzin susceptibility studies. This study was conducted at the Agricultural Experiment Station farm at Fairbanks on a Tanana silt loam with a pH of 7.0 and an organic matter content of 2.0 per cent. After fertilizing with 400 lb/A of 20-10-10 (N, P_2O_5, K_2O), then double disking and harrowing, the following barley varieties were planted on May 16 at a rate of 72 lb/A (germinable seed): Galt, and Klondike (Canadian varieties); Weal, Otal, Datal, and Lidal (Alaskan varieties); Eero, Paavo, and Otra (Finnish varieties). 'Klondike' was included in the study since it is known to be susceptible to metribuzin injury. The varieties were planted in strips 7.5 ft wide (13 rows) using a grain drill. Various rates of metribuzin were applied in strips perpendicular to

[e]Trade Name: Premerge 3 (Dow Chemical Co.)

[f]Trade Name: Banvel (Velsicol Chemical Corp.)

[g]Trade Name: Glean (E.I. DuPont de Nemoirs and Co.)

the varieties. The rates were: 0.11, 0.21, 0.44 and 0.89 lb/A (active ingredient) applied at 30 lb/in^2 pressure and in a total volume of 25.1 gal. H^2O/ha. The herbicide was applied at the following barley growth stages: two or three leaves (June 8), three or four leaves (June 14), two or three tillers (June 22), flagleaf (June 28). The variety and metribuzin treatment strips plus a weedy control were randomized and replicated in three complete blocks. Individual plots were 10 x 11.5 ft. On July 15, average barley weight and per cent mortality data were collected from each plot. Weed control was rated on a scale of 0-9 (0 = no control, 9 = complete control) for each weed species occurring in the plots of one replicate.

1983 Experiments

Efficacy-phytotoxicity. In 1983 the study was carried out at the Agricultural Experiment Station farm at Fairbanks on a Tanana silt loam with a soil pH of 7.0 and an organic matter content of 2.0 per cent. The soil was fertilized with 400 lb/A 20-10-10 (N, P_2O_5, K_2O) and then double disked and harrowed. The plots were seeded to 'Lidal' barley at 72 lb/A (germinable seed) on May 13. The plots received the same herbicide treatments as in 1982. On June 1, when common lambsquarters was at the four-leaf stage and barley was at the two- or three-leaf stage, dicamba was applied. Dinoseb and metribuzin were applied on June 8 when common lambsquarters was at the four- to six-leaf stage and barley was at the four- to five-leaf stage with one or two tillers. MCPA, 2,4-D and bromoxynil were applied on June 13 when common lambsquarters was at the six- to eight-leaf stage and barley was at the four- or five-leaf stage with two or three tillers. Chlorsulfuron was applied on June 18 when common lambsquarters was at the eight- to twelve-leaf stage and barley was at the five- or six-leaf stage with three or four tillers. Each plot was 10 x 5 ft. The experiment consisted of twenty-two herbicide treatments plus a nonweeded control replicated five times in a randomized block design. On July 10, weeds were counted and biomass determined for each weed species using a single 0.25 m^2 quadrat placed in each plot. The plots were harvested on August 10 by clipping 7 ft of the middle three rows of each plot.

RESULTS AND DISCUSSION

Efficacy-phytotoxicity study. The herbicides had significant effects in all years (tables 1, 2, 3) on the number and total weight of common lambsquarters on all sampling dates. On the earliest sampling date in 1981 and 1982, only metribuzin and bromoxynil provided complete control of common lambsquarters (tables 4, 5). The second sampling dates in 1981 and 1982 provide a measure of late-season weed-control performance. In 1981, both metribuzin and bromoxynil maintained control of lambsquarters in terms of both numbers and dry weight. With both MCPA and 2,4-D, the lambsquarters number and dry weight decreased from July 2 to August 27 (with the exception of 2,4-D at 0.25 lb/A). By August 27, weed control in the MCPA plots equalled that of the bromoxynil and metribuzin plots (table 4). In 1982, lambsquarters control was again maintained in the metribuzin and bromoxynil plots. Lambsquarters control by July 30 was also good for MCPA at 0.75 and 1.50 lb/A, chlorsulfuron at all rates, and dinoseb at 0.50 and 1.0 lb/A (table 5). Dicamba failed to control lambsquarters, and 2,4-D was only marginally effective. In 1983, all herbicide treatments resulted in a significant reduction in lambsquarters dry weight relative to the weedy control. All herbicide treatments except chlorsulfuron at 0.04 lb/A and dicamba at 0.09 and 0.18 lb/A resulted in a significant reduction in lambsquarters number. Those treatments giving the best control of lambsquarters were bromoxynil at all rates; dinoseb at 0.50 and 1.00 lb/A; and metribuzin at 0.21, 0.43, and 0.86 lb/A. While there was a significant overall effect of herbicide treatment on knotweed number, none of the herbicide-treated plots were significantly different from the weedy control (table 6). Complete control of knotweed was realized only at the highest rates of bromoxynil and metribuzin.

In 1981, barley yield was lowest in the control plot where lambsquarters was not controlled; yield was highest in the bromoxynil plots. Yields of the metribuzin plots were greater than

Table 1. ANOVA results, 1981 lambsquarters control in barley.

Variable	Herbicide Treatments (13df) F	Blocks (3df) F	r^2
Lambsquarters population, July 2	10.25 **	1.92 NS	0.78
Lambsquarters population, August 27	7.79 **	0.01 NS	0.72
Total lambsquarters dry weight, July 2	4.67 **	1.65 NS	0.63
Total lambsquarters dry weight, August 27	7.22 **	0.84 NS	0.71
Grain yield	1.28 NS	6.05 **	0.47
Test weight	1.65 NS	2.12 NS	0.42

** significant at the .01 level
NS not significant at the .05 level

Table 2. ANOVA results, 1982 lambsquarters control in barley.

Variable	Herbicide Treatments (22df) F	Blocks (4df) F	r^2
Lambsquarters population, July 9	3.96 **	0.36 NS	0.50
Lambsquarters population, July 30	4.35 **	0.62 NS	0.52
Total lambsquarters dry weight, July 9	6.41 **	1.13 NS	0.62
Total lambsquarters dry weight, July 30	6.80 **	0.28 NS	0.63
Grain yield	9.64 **	2.05 *	0.58
Test weight	3.59 **	0.95 NS	0.29

* significant at the .05 level
** significant at the .01 level
NS not significant at the .05 level

Table 3. ANOVA results, 1983 weed control in barley.

Variable	Herbicide Treatments (22df) F	Blocks (4df) F	r^2
Lambsquarters population, July 10	2.68 **	1.63 NS	0.43
Total lambsquarters dry weight, July 10	8.37 **	1.70 NS	0.69
Knotweed population, July 10	1.78 *	1.98 NS	0.35
Grain yield	1.71 *	1.10 NS	0.32

* significant at the .05 level
** significant at the .01 level
NS not significant at the .05 level

Table 4. Effect of herbicide treatments on common lambsquarters population and dry weight and on barley yield and test weights at Delta Junction, 1981.

Treatment	Rate	Common lambsquarters Population July 2	Population August 27	Dry Weight July 2	Dry Weight August 27	Barley Yield	Barley Test Weight
	(lb/A)	(plants/m²)		(g/m²)		(bu/A)	(lb/bu)
Bromoxynil	.21	4	13	0.3	2.5	46.9	43.3
Bromoxynil	.43	0	0	0.0	0.0	50.2	42.1
Bromoxynil	.86	0	0	0.0	0.0	47.4	41.3
Metribuzin	.11	121	128	4.0	15.0	46.9	42.8
Metribuzin	.21	17	7	0.6	0.4	45.9	42.7
Metribuzin	.43	0	0	0.0	0.0	42.2	42.0
Metribuzin	.86	22	0	1.5	0.0	42.9	42.8
MCPA	.37	1057	170	18.6	8.4	43.6	43.7
MCPA	.75	767	12	12.5	0.6	45.0	36.7
MCPA	1.50	765	0	11.5	0.0	45.5	41.9
2,4-D	.25	1131	516	44.7	55.7	41.0	42.2
2,4-D	.50	882	399	15.9	13.5	45.5	43.0
2,4-D	1.00	754	46	17.2	3.4	41.6	44.0
Control		2284	1624	52.6	134.7	39.5	44.8
LSD		590	445	22.0	39.0	6.1	

Table 5. Effect of herbicide treatment on common lambsquarters population and dry weight and on barley yield and test weights at Delta Junction, 1982.

Treatment	Rate	Common Lambsquarters Population July 9	Population July 30	Dry Weight July 9	Dry Weight July 30	Barley Yield	Barley Test weight
	(lb/A)	(plants/m²)		(g/m²)		(bu/A)	(lb/bu)
MCPA	0.37	1358	370	50.6	31.8	47.6	43.5
MCPA	0.75	1234	4	44.1	0.4	41.4	43.3
MCPA	1.50	1681	25	60.5	1.5	43.8	42.2
2,4-D	0.25	680	379	29.0	29.3	48.0	42.4
2,4-D	0.50	1664	402	59.4	22.4	42.5	41.6
2,4-D	1.00	804	378	34.8	40.0	53.3	41.8
Bromoxynil	0.21	54	14	0.8	1.4	60.5	42.7
Bromoxynil	0.43	10	0	0.2	0.0	59.9	43.0
Bromoxynil	0.86	0	0	0.0	0.0	59.8	42.0
Metribuzin	0.11	874	461	24.2	20.8	58.9	43.9
Metribuzin	0.21	105	21	2.8	0.6	48.7	41.6
Metribuzin	0.43	7	6	0.1	0.1	51.2	42.4
Metribuzin	0.86	0	0	0.0	0.0	58.0	42.2
Dicamba	0.09	1706	1591	67.2	97.9	37.4	42.3
Dicamba	0.18	2080	830	115.2	114.6	33.4	41.6
Dicamba	0.36	1652	438	74.8	31.9	38.4	41.3
Chlorsulfuron	0.04	546	62	26.6	1.8	53.8	42.5
Chlorsulfuron	0.07	1555	38	41.3	1.3	55.4	42.2
Chlorsulfuron	0.14	699	0	26.6	0.0	53.0	44.1
Dinoseb	0.25	994	525	45.7	42.4	52.8	42.3
Dinoseb	0.50	102	124	4.4	6.2	58.0	43.1
Dinoseb	1.00	78	44	2.6	1.5	59.0	40.4
Control		788	806	69.2	89.7	43.7	42.6
LSD		974	523	17.4	36.7	8.3	2.4

Table 6. Effect of herbicide treatments on common lambsquarters population and dry weight, knotweed population and barley at Fairbanks, 1983.

Treatment	Rate	Common Lambsquarters Population	Common Lambsquarters Dry Weight	Knotweed Population	Barley Yield
	(lb/A)	(plants/m²)	(g/m²)	(plants/m²)	(bu/A)
MCPA	0.37	81.6	20.1	18.4	72.3
MCPA	0.75	27.2	5.2	4.0	74.2
MCPA	1.50	12.0	1.9	0.8	64.5
2,4-D	0.25	48.8	15.5	29.6	54.4
2,4-D	0.50	44.0	12.6	5.6	66.8
2,4-D	1.00	24.0	6.0	1.6	67.7
Bromoxynil	0.21	0.8	0.04	1.6	66.2
Bromoxynil	0.43	0	0	0.8	78.3
Bromoxynil	0.86	0	0	0	61.8
Metribuzin	0.11	102.4	20.4	6.4	65.1
Metribuzin	0.21	6.4	1.0	17.6	72.9
Metribuzin	0.43	2.4	0.3	2.4	70.0
Metribuzin	0.86	0	0	0	68.5
Dicamba	0.09	156.8	77.2	16.8	46.9
Dicamba	0.18	188.8	50.0	25.6	54.8
Dicamba	0.36	91.2	23.2	19.2	48.0
Chlorsulfuron	0.04	243.2	49.3	13.6	53.9
Chlorsulfuron	0.07	105.6	25.3	23.2	62.8
Chlorsulfuron	0.14	37.6	15.6	44.0	68.3
Dinoseb	0.25	139.2	33.6	23.2	52.7
Dinoseb	0.50	17.6	2.4	16.8	69.4
Dinoseb	1.00	0	0	3.2	79.3
Control		297.6	131.7	24.0	36.2
LSD		144.8	30.4	25.0	23.2

the control, but not significantly so (table 4). Moreover, there was no significant overall effect of herbicide treatment on yield (table 1). In 1982, the herbicide treatments did have a significant effect on yields (table 2). 'Galt' barley yields were lowest in the dicamba plots where the lambsquarters number and total dry weight were highest. The highest yields were realized in the bromoxynil, metribuzin, dinoseb, and chlorsulfuron plots. The 1983 herbicide treatments also had a significant effect on yields (table 3). 'Lidal' barley yields were lowest when treated with 0.09, 0.18, and 0.36 lb/A dicamba; 0.25 lb/A 2,4-D; 0.04 lb/A chlorsulfuron; and 0.25 lb/A dinoseb. However, barley yields in these plots were not significantly different from that of the weedy control plot. Yields of all other plots were significantly higher than the control plot. The highest yields were realized at 0.50 and 1.0 lb/A dinoseb; at 0.21 lb/A bromoxynil; at 0.37 and 0.75 lb/A MCPA; and 0.11, 0.21, and 0.43 lb/A metribuzin (table 6).

In all years, there does not appear to be a relationship between rates of metribuzin used and barley yield. In 1981 and 1982, the test weights of 'Galt' barley were not significantly reduced below that of the control by any of the herbicides tested during these years.

Germination study. In 1982, the herbicide treatments had no significant effect on the germinability of the grain.

Barley variety-metribuzin susceptibility study. Metribuzin treatments and barley varieties had a significant effect on barley mortality. There was also a significant interaction of varieties and treatments (table 7). 'Klondike' was much more sensitive to metribuzin than were the other varieties (table 8). Mortality was evident in all of the varieties at the 0.44 and 0.89 lb/A rates when application was made at or before the barley 3-4 leaf stage. At the 2-3 tiller stage, mortality was evident only at the 0.89 lb/A rate (table 8). Negligible mortality occurred at the flag leaf stage for all varieties at all rates.

Height reductions were noted for all barley varieties, though variety was not a significant variable affecting height (table 7). Metribuzin treatments did have a significant effect on barley-height reduction (table 7). Height reduction was generally lowest at the lowest metribuzin rates and greatest at the highest rate. Height reductions were lower at the 2-3 tiller and flag leaf stages than at the 2-3 and 3-4 leaf stages (table 9). At the proposed recommended rates and application times (2-5 leaves, 2-3 tillers,

Table 7. ANOVA results, barley variety x metribuzin rate-timing study.

Variable	Barley Varieties (8df) F	Treatments (16df) F	Variety X Treatment (128df) F
Percent Dead[1]	3.65*	39.46**	3.25**
Percent Height Reduction	1.72 NS	26.30**	1.23 NS

NS not significant at the .05 level
* significant at the .05 level
** significant at the .01 level
[1] Data were arcsine transformed

0.25-0.50 lb/A), height reduction was less than 15 per cent for all the varieties but 'Klondike.'

Metribuzin applied at the rate of 0.21 lb/A, at the 2-3 tiller stage, completely controlled lambsquarters, chickweed, pineappleweed, corn spurry, and shepherdspurse. Control of rapeseed was also excellent. Knotweed was only slightly controlled, however (table 10). At the lowest metribuzin rate (0.11 lb/A), weed control was generally best at the earliest application date. At 0.21 lb/A and above, time of application does not appear to be critical for controlling the weeds found in the study.

Table 8. Effect of metribuzin applied at various times and rates on mean per cent mortality of barley varieties grown in Alaska.

Metribuzin Treatments		Barley Variety								
Barley Growth Stage	Rate	Klondike	Paavo	Weal	Otal	Lidal	Galt	Eero	Otra	Datal
	(lb/A)	(Mean Per cent Mortality)								
2-3 leaves	0.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.24	12.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.44	46.7	0.0	0.0	1.7	0.0	2.3	1.7	3.3	0.0
	0.89	95.0	44.0	51.7	13.3	33.3	10.0	52.3	56.7	41.7
3-4 leaves	0.11	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.21	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.44	74.0	6.7	7.3	5.0	6.3	0.0	13.3	3.3	11.7
	0.89	94.7	64.0	50.0	28.3	50.0	16.7	70.0	40.7	45.0
2-3 tillers	0.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.21	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.44	9.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.89	10.0	0.0	5.0	1.7	5.0	1.7	0.0	6.7	0.0
flagleaf	0.11	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.89	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0
no herbicide		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 9. Per cent reduction in height (from control) for various barley varieties at different metribuzin rates and application dates.

Metribuzin Treatment		Barley Variety								
Barley Growth Stage	Rate	Klondike	Paavo	Weal	Otal	Lidal	Galt	Eero	Otra	Datal
	(lb/A)	(Per cent reduction in height)								
2-3 leaves	0.11	10.2	+4.1	4.9	0.0	2.0	+0.9	7.4	+4.5	+1.3
	0.21	6.1	0.8	11.0	5.2	+2.2	+2.6	5.2	+1.7	+3.1
	0.44	17.7	2.1	8.6	3.0	+1.4	3.3	8.5	2.5	3.4
	0.89	39.6	30.8	24.7	11.1	16.6	14.3	32.7	22.5	20.7
3-4 leaves	0.11	6.1	2.6	5.0	12.0	3.8	+1.3	0.7	3.0	3.4
	0.21	14.0	7.0	14.3	8.5	6.4	2.5	7.4	1.5	+0.8
	0.44	21.4	13.3	14.2	10.3	8.1	5.9	13.6	8.5	9.5
	0.89	38.8	29.4	29.6	23.9	24.4	21.9	35.1	23.5	28.1
2-3 tillers	0.11	5.7	1.7	5.3	10.3	0.8	5.5	+1.0	+2.2	5.3
	0.21	5.3	3.5	8.2	6.8	2.9	+0.9	5.7	+5.9	1.5
	0.44	6.5	5.7	7.8	6.0	4.6	4.2	9.1	3.0	6.7
	0.89	16.5	9.8	9.0	2.6	6.8	+0.9	4.6	5.7	2.5
flagleaf	0.11	4.9	+1.0	1.3	6.4	+0.5	2.0	4.6	+4.1	+1.7
	0.21	9.5	1.3	6.5	5.1	0.4	+5.2	3.5	+5.5	+0.8
	0.44	9.8	0.8	11.4	5.1	2.5	2.6	+5.0	+0.8	+1.7
	0.89	15.7	9.3	8.2	6.0	2.9	2.0	3.5	2.0	15.6
no herbicide		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

+ means greater than control

Table 10. Mean weed control ratings at various metribuzin rates and application times. Asterisks denote means significantly different from controls using Bonferroni's statistic for non-parametric data.

	Lambsquarter		Chickweed		Pineapple-weed		Corn Spurry		Knotweed		Shepherds-purse		Rapeseed		
Sencor Rate	No. Lvs.	Rating	No. Lvs.[1]	Rating	No. Lvs.	Rating	No. Lvs.[2]	Rating	No. Lvs.	Rating	No. Lvs.[3]	Rating	No. Lvs.	Rating	Barley Growth Stage
(kg/ha)															
0.12	2-4	5.2	1-4	8.0	2-4	9.0*	2-3	8.2	2-3	2.9	f	7.4	3	8.9	2-3 lvs
	6-8	1.8	7-9	6.4	7-9	6.7	4-5	7.0	11-13	3.4	1-2,f	7.0	3-7	7.0	3-4 lvs
	8-16	3.6	9+	4.2	8-10	3.7	f	5.9	f	1.0	4-6,f	3.4	f	4.3	2-3 t
	fl	3.1	f	7.2	f	6.2	f	7.2	f	3.3	f	6.8	f	7.8	fl
0.24	2-4	7.2*	1-4	8.7	2-4	8.4	2-3	9.0	2-3	5.0	f	8.0	3	8.4	2-3 lvs
	6-8	8.7*	7-9	9.0*	7-9	9.0*	4-5	9.0	11-3	6.7	1-2,f	9.0	3-7	9.0*	3-4 lvs
	8-16	9.0*	9+	9.0*	8-10	9.0*	f	9.0	f	4.0	4-6,f	9.0	f	8.2	2-3 t
	fl	3.7	f	8.3	f	7.3	f	8.3	f	4.1	f	9.0	f	¯.0*	fl
0.50	2-4	9.0*	1-4	9.0*	2-4	9.0*	2-3	9.0	2-3	7.9*	f	9.0	3	y.0*	2-3 lvs
	6-8	8.8*	7-9	9.0*	7-9	9.0*	4-5	9.0	11-13	7.6*	1-2,f	9.0	3-7	9.0*	3-4 lvs
	8-16	9.0*	9+	9.0*	8-10	9.0*	f	9.0	f	6.9*	4-6,f	9.0	f	8.6	2-3 t
	fl	8.0	f	9.0*	f	8.8	f	8.7	f	7.6*	f	9.0	f	9.0*	fl
1.00	2-4	9.0*	1-4	9.0*	2-4	9.0*	2-3	9.0	2-3	9.0*	f	9.0	3	9.0*	2-3 lvs
	6-8	9.0*	7-9	9.0*	7-9	9.0*	4-5	9.0	11-13	9.0*	1-2,f	9.0	307	9.0*	3-4 lvs
	8-16	9.0*	9+	9.0*	8-10	9.0*	f	9.0	f	9.0*	4-6,f	9.0	f	9.0*	2-3t
	fl	8.6*	f	9.0*	f	8.8	f	9.0	f	8.6*	f	9.0	f	9.0*	fl
Control		0.2		0.3		0.1		1.0		0.0		0.8		0.1	

[1] data expressed in pairs of leaves [2] data expressed in whorls of leaves

[3] The shepherd's purse population consisted of older individuals that had overwintered and younger individuals that had germinated in the spring.

fl = flagleaf f = flowering t = tillers

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