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Response of Spring Barley (Hordeum vulgare) to Herbicides

Sharon A. Clay
South Dakota State University, sharon.clay@sdstate.edu

Donald C. Thill
University of Idaho

Verlan L. Cochran
USDA, Agricultural Research Service

Response of Spring Barley (*Hordeum vulgare*) to Herbicides[1]

SHARON A. CLAY, DONALD C. THILL, and VERLAN L. COCHRAN[2]

Abstract. 'Karla', 'Klages', 'Morex', and 'Steptoe' cultivars of spring barley (*Hordeum vulgare* L.) differed in susceptibility to postemergence recommended application rates of diclofop {(±)-2-[4-(2,4-dichlorophenoxy) phenoxy] propanoic acid}, difenzoquat [1,2-dimethyl-3,5-diphenyl-1*H*-pyrazolium], chlorsulfuron {2-chloro-*N*-[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)amino] carbonyl] benzenesulfonamide}, and metribuzin [4-amino-6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5(4*H*)-one] in 1981 and 1982. Metribuzin injured Morex, and difenzoquat injured all cultivars within 2 weeks after herbicide application. Metribuzin reduced height and crop biomass compared to the hand-weeded control. Herbicide treatments did not affect grain yield at Moscow, ID, in either year. However, metribuzin reduced yield of Karla and Morex, and diclofop reduced yield of Karla compared to the hand-weeded control at Pullman, WA, in 1982. Barley injury and grain yield loss depended on herbicide treatment and cultivar. Early season herbicide injury to barley did not indicate grain yield response at harvest.

Additional index words: Herbicide injury, chlorsulfuron, diclofop, difenzoquat, metribuzin.

INTRODUCTION

Differential cultivar responses to herbicides have been reported for several crops, including wheat (*Triticum aestivum* L.) (3), potato (*Solanum tuberosum* L.) (9), soybean [*Glycine max* (L.) Merr.] (10), and barley (3, 4, 7, 8). Reported injury symptoms within a crop species ranged from slight chlorosis to total crop destruction (3, 4, 7, 8). Derscheid et al. (7) reported differential tolerance to 2,4-D [(2,4-dichlorophenoxy)acetic acid] for several barley cultivars. Stage of crop development and herbicide formulation influenced the severity of injury. Elliott et al. (8) reported barley yield reductions of 5% when treated at the 3-leaf growth stage with commercial rates of 2,4-D, bromoxynil [3,5-dibromo-4-hydroxybenzonitrile], MCPA [(4-chloro-2-methylphenoxy)acetic acid], linuron [*N'*-(3,4-dichlorophenyl)-*N*-methoxy-*N*-methylurea], and diuron [*N'*-(3,4-dichlorophenyl)-*N,N*-dimethylurea] under weed-free conditions.

No-till cropping systems are being developed to reduce soil erosion by water in the Palouse region of northern Idaho and eastern Washington (12). Changes from conventional to conservation tillage systems have influenced grain yields (6, 11). Standing stubble and straw residue left on the soil surface in no-till may affect crop production either by injuring directly with phytotoxins released from decaying straw or by predisposing the crop to herbicide injury (6). Crop residue interception of the chemical may affect herbicide performance (1). Ciha (5) reported that barley yields of Steptoe, 'Advance', 'Vanguard', and 'Kimberly' were not influenced by tillage practice in the Palouse from weed control with bromoxynil plus MCPA tank mix.

The objective of this study was to determine the influence of several postemergence herbicides applied at recommended rates and timings under weed-free conditions on crop injury, growth parameters, and the yield of Steptoe, Morex, Klages, and Karla spring barley cultivars under conservation and conventional tillage practices.

MATERIALS AND METHODS

Field plots were established at Moscow, ID, on a Palouse silt loam (fine-silty, mixed mesic, Pachic Ultic Haploxeroll) soil with a pH of 4.9 in 1981 and 1982, and at Pullman, WA, on a Palouse silt loam with a pH of 5.7 in 1981 and a Thatuna silt loam (fine-silty, mixed, mesic, Xeric Argialboll) soil with a pH of 5.6 in 1982. Experimental sites at Moscow were cultivated and were planted using conventional tillage methods (moldboard plow, disk, field cultivate, fertilize, and plant), while at Pullman conventional and first-year no-till (conventionally farmed previously) practices were used. No-till plots had spring wheat residue of

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[2]Former Grad. Asst., presently USDA-ARS Post-doctoral Fellow, Soil Water Manage. Res. Unit, North Central Region, St. Paul, MN; Assoc. Prof., Dep. Plant, Soil Entomol. Sci., Univ. Idaho; and Soil Sci., USDA-ARS, Fairbanks, AK, respectively.

9400 kg/ha in 1981 and spring barley stubble of 7920 kg/ha in 1982. All plot areas were soil tested and were fertilized according to recommendations for barley production from the University of Idaho[3].

In 1981, all barley cultivars were seeded at 8.5 g/m row with a row spacing of 18 cm April 29 at Pullman and May 7 at Moscow. At Pullman in 1982, the barley cultivars were seeded at the same rate with a row spacing of 25 cm May 28. At Moscow in 1982, Steptoe, Klages, and Karla were seeded at 8.8 g/m row and Morex was seeded at 6.7 g/m row with 18-cm wide rows April 29.

Diclofop, difenzoquat, chlorsulfuron, and metribuzin were applied at 1.1, 1.1, 0.07, and 0.4 kg ai/ha, respectively. Diclofop at the Pullman location was applied at the 2- to 4-leaf stage of barley development in 1981 and 1982. All herbicides at the Moscow location and difenzoquat, chlorsulfuron, and metribuzin at the Pullman location were applied at the 4- to 6-leaf stage of barley development with at least 5-cm long adventitious roots in both years. Hand-weeded control plots were established for each tillage-cultivar combination. All plots were hand-weeded to maintain a weed-free condition after the initial herbicide application. However, bromoxynil was applied to all plots at 0.4 kg/ha to control henbit (*Lamium amplexicaule* L. #[4] LAMAM) at Pullman in 1981.

Triadimeton [1-(4-chlorophenoxy)-3,3-dimethyl-1-(1*H*-1,2,4-triazol-1-yl)-2-butanone] was applied at Moscow in 1981 at 0.6 kg/ha for leaf rust (*Puccinia recondita* f. sp. *tritici*) control. Malathion [*O,O*-dimethyl-*S*-(1,2-dicarbethoxyethyl)phosphoro-dithioate] was applied at 1.4 kg/ha in 1982 for aphid (*Rhopalosiphum* sp.) control at Moscow and Pullman. All pesticides were applied using a hand-carried six nozzle boom with a CO_2-pressurized backpack sprayer.

Visual evaluation of herbicide injury (chlorosis and necrosis) was recorded 2 weeks after herbicide application in both 1981 and 1982 at Moscow and Pullman. The rating scale was 0 to 100% with 0% for no injury to barley and 100% for complete necrosis of all plants. Barley plant populations and plant height were measured at the same time as visible herbicide injury from 1 m of crop row at Pullman.

Crop biomass at the soft dough stage of development was determined after plants from the same 1 m of row were harvested, were oven-dried at 65 C for 48 h, and were weighed. Spikes per meter of crop row were counted at the hard dough stage at Pullman. Plots were harvested at maturity with a small plot combine. Barley grain test weight was measured using de-awned grain from Pullman in 1981 and from Pullman and Moscow in 1982. The semi-automated microkjeldahl method (14) was used to determine seed protein content on grain harvested in both years at the Pullman location.

Plots at Moscow were arranged in a split-plot design with cultivars as the main plot and herbicide treatments as the subplot. Plots at Pullman were arranged in a split-split-plot design with tillage as main plots, cultivars as subplots, and herbicide treatments randomized within subplots. The subplot sizes to which the herbicides were applied were 3 by 3 m at Moscow and 3 by 4 m at Pullman. The experiment was replicated four times at each location in 1981 and 1982. Analysis of variance was performed separately for each location and year. Fisher's protected LSD test at the 5% level of probability was used to separate interaction and main effect means.

RESULTS AND DISCUSSION

Herbicide injury to barley cultivars depended on cultivar and herbicide at Pullman and Moscow (Table 1). Chlorsulfuron did not injure any cultivars appreciably, while diclofop caused leaf chlorosis at Klages at Pullman in 1981. Difenzoquat caused leaf chlorosis and leaf tip necrosis of all barley cultivars at Pullman except Steptoe in 1982. Difenzoquat injured Klages in 1981 and all cultivars in 1982 at Moscow. Metribuzin caused leaf chlorosis, tip necrosis, and stunting at Morex at Pullman in both years and at Moscow in 1981. Metribuzin did not injure other cultivars. Crop injury with difenzoquat was slightly reduced in conventional tillage compared to no-tillage (data not presented).

[3]Cooperative Extension Service. 1977. Idaho Fertilizer Guide: Malting barley. Univ. Idaho Coll. Agric. CIS 270.

[4]Letters following this symbol are a WSSA-approved computer code from Composite List of Weeds, Weed Sci. 32, Suppl. 2. Available from WSSA, 309 West Clark Street, Champaign, IL 61820.

Table 1. The influence of herbicide treatment on visible crop injury of four spring barley cultivars 2 weeks after herbicide application at Pullman, WA, and Moscow, ID, in 1981 and 1982.

Herbicide treatment	Barley cultivar	Location: Pullman[ab] 1981	Pullman[ab] 1982	Moscow[b] 1981	Moscow[b] 1982
		(%)		(%)	
Chlorsulfuron	Steptoe	3	0	4	0
	Morex	4	0	0	0
	Klages	2	0	4	0
	Karla	4	0	3	0
Diclofop	Steptoe	4	0	0	0
	Morex	2	0	5	4
	Klages	11	0	4	4
	Karla	3	0	6	1
Difenzoquat	Steptoe	11	2	4	28
	Morex	13	8	5	34
	Klages	10	4	17	21
	Karla	8	4	5	28
Metribuzin	Steptoe	3	0	3	0
	Morex	10	21	15	4
	Klages	0	0	0	4
	Karla	2	2	2	2
LSD (0.05)		4	2	6	4

[a]Summed over conventional and no-till treatments.

[b]Rated on a 0 to 100 scale: 0 = no injury; 100 = death of all plants.

Plant density in 1981, tiller number in 1982, and plant height in both years were not affected 2 weeks after herbicide treatment at Pullman, when summed over tillage practices and barley cultivars and compared to the hand-weeded control (data not shown). Difenzoquat reduced plant height <8% in conventional tillage compared to no-till. However, this difference apparently was not biologically significant. Herbicide application did not affect early plant development although visible injury was evident with some herbicide-cultivar combinations.

At the soft dough stage in 1982, biomass of metribuzin-treated plants was reduced 16% (Table 2) and height was reduced 9% (data not presented) compared to the hand-weeded control. At harvest in 1982, metribuzin-treated plants had 18% less spikes/m of row than did the hand-weeded control. The herbicide-cultivar interaction was not significant in either year for these parameters. Thus, early season injury, whether detected or not, may affect plant development.

Herbicide treatment did not affect grain yield in 1981 or 1982 at Moscow and in 1981 at Pullman (Table 3). Tillage system-herbicide treatment interactions were not significant for yield in either year at Pullman (data not presented). Heavy leaf rust infection at Moscow in 1981 reduced the overall grain yield of all barley cultivars. Late planting, which can decrease grain yield (2, 13), lowered overall yield at Pullman in 1982 (abnormally wet spring) compared to 1981 (Table 3).

Table 2. The influence of herbicide treatment on crop biomass and spike number of spring barley summed over tillage practices and cultivars at Pullman, WA, in 1981 and 1982.

Treatment	Growth parameter: Crop biomass[a] 1981	Crop biomass[a] 1982	Spikes[b] 1981	Spikes[b] 1982
	(g/m row)		(no./m row)	
Chlorsulfuron	159	108	83	86
Diclofop	193	114	86	87
Difenzoquat	160	125	84	96
Metribuzin	153	92	80	74
Hand-weeded control	194	109	83	91
LSD (0.05)	NS	14	NS	10

[a]Forage samples harvested at the soft dough stage of crop development.

[b]Spike counts taken immediately before grain harvest.

Table 3. The influence of barley cultivar and herbicide treatment on grain yield at Pullman, WA, and Moscow, ID, in 1981 and 1982.

Treatment	Barley cultivar	Location: Pullman[a] 1981	Pullman[a] 1982	Moscow 1981	Moscow 1982
		(kg/ha)			
Chlorsulfuron	Steptoe	3630	1540	1540	2670
	Morex	3230	1980	1090	3360
	Klages	3830	1560	1030	3660
	Karla	4110	1920	1360	2880
Diclofop	Steptoe	3840	1700	1600	2950
	Morex	2700	1810	1090	3250
	Klages	3600	1270	1220	3440
	Karla	4070	1740	1330	2960
Difenzoquat	Steptoe	3640	1740	1490	2730
	Morex	3230	1980	1090	3360
	Klages	3720	1550	1030	3610
	Karla	4290	2140	1070	3000
Metribuzin	Steptoe	4000	1660	1500	2660
	Morex	2540	1430	1040	3170
	Klages	3910	1530	1130	3100
	Karla	3960	1850	1290	2630
Hand-weeded control	Steptoe	3810	1710	1470	2650
	Morex	2700	1830	1000	2290
	Klages	3610	1490	900	3560
	Karla	4160	2130	1210	2700
LSD (0.05)		NS	250	NS	NS

[a]Summed over conventional and no-till tillage treatments.

Table 4. The influence of herbicide treatment on test weight and seed protein content of spring barley at Pullman, WA, and Moscow, ID, in 1981 and 1982.

	Test weight			Seed protein	
	Pullman[a]		Moscow[b]	Pullman[a]	
Treatment	1981	1982	1982	1981	1982
	(kg/hl)			(%)	
Chlorsulfuron	57.5	61.3	60.9	11.8	14.5
Diclofop	58.4	61.3	60.6	11.8	14.6
Difenzoquat	57.5	61.6	60.5	11.7	14.1
Metribuzin	58.5	61.1	60.9	11.4	14.6
Hand-weeded control	58.2	61.1	60.6	12.1	14.8
LSD (0.05)	0.6	NS	0.1	0.4	NS

[a]Data summed over tillage practice and barley cultivar.

[b]Data summed over four barley cultivars.

Metribuzin reduced the yield of Morex and Karla by 400 and 280 kg/ha, respectively, and diclofop reduced Karla yield by 390 kg/ha compared to the appropriate hand-weeded control at Pullman in 1982 (Table 3). Metribuzin visibly injured Morex in 1981 and 1982 (Table 1) but reduced yield only in 1982. The later planting date and, thus, the shorter growing season in 1982 may not have allowed time for Morex to recover adequately from the early season metribuzin injury. Diclofop and metribuzin did not injure Karla visibly (Table 1); however, yield was decreased in 1982. Barley injury, or lack of it, 2 weeks after herbicide application did not indicate grain yield loss.

Herbicide treatment did not affect grain quality (Table 4). Some herbicide treatments increased or slightly decreased grain test weights compared to the hand-weeded control in 1981 at Pullman and in 1982 at Moscow. Seed protein content when summed over tillage and cultivar was reduced unexplainably with metribuzin in 1981 but not in 1982 at Pullman compared to the hand-weeded control (Table 4).

Morex appeared to be more susceptible to metribuzin injury than the other cultivars tested. Metribuzin is metabolized slower in Morex than in Steptoe[5]. However, crop injury caused by herbicides applied at a recommended rate and timing did not indicate grain yield losses at harvest. Injury to barley and grain yield losses due to herbicide treatments depend on barley cultivar, and, possibly, environmental conditions.

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