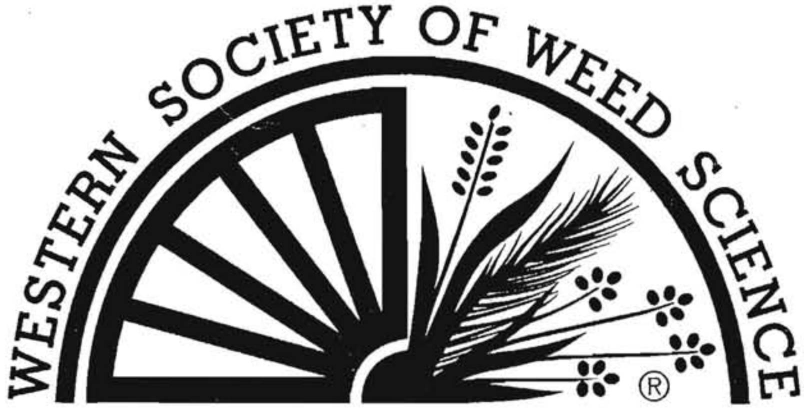

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FOREWORD

The 2004 Research Progress Report of the Western Society of Weed Science (WSWS) is a compilation of research investigations contributed by weed scientists in the western United States of America. The objective of the Research Progress Report is to provide an avenue for presentation and exchange of on-going research to the weed science community. The information in this report is preliminary; therefore, it is not for the development of endorsements or recommendations.

The reports contained herein and their respective content, format, and style are the responsibility of the author(s) who submitted them. Reports are printed as received from the authors.

WSWS appreciates the time and effort of the authors who shared their research results with the members of WSWS.

Joan Campbell and Traci Rauch
Co-editors, Research Progress Report
Western Society of Weed Science

WESTERN SOCIETY OF WEED SCIENCE ®

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Downy brome control on Colorado rangeland with imazapic. James R. Sebastian and K.G. Beck. (Department of Bioagriculture Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523) Downy brome (BROTE) is a common annual grass weed that is a problem on rangeland and along roadsides throughout Colorado.

An experiment was established near Fort Collins, CO to evaluate control of BROTE with imazapic herbicide. The experiment was designed as a randomized complete block with four replications. Imazapic was applied on October 11, 2001 when BROTE was 85 to 90% dormant and 10 to 15% of the plants were at 3 leaf to 1 tiller growth stage. All treatments were applied with a CO_2-pressurized backpack sprayer using 11002LP flat fan nozzles at 21 gal/A and 14 psi. Other application information is presented in Table 1. Plot size was 10 by 30 feet.

Visual evaluations for control compared to non-treated control plots were collected on May 30, June 30, and October 18, 2002, and April 12, 2003 approximately 6, 7, 12, and 18 months after treatment (MAT). Imazapic at 0.5 oz ai/a controlled more than 80% of downy brome 6 and 7 MAT, while 1.0 to 3.0 oz ai/a controlled 100% of downy brome at these same evaluation dates (Table 2). Late summer and fall rain stimulated downy brome germination in 2002, and residual control from imazapic declined. When data was collected 12 MAT, imazapic controlled from 51 to 74% of downy brome. At 18 MAT, 24 to 71% of BROTE was controlled.

Table 1. Application data for downy brome control on Colorado rangeland with imazapic.

Environmental data	
Application date	October 11, 2001
Application time	11:00 am
Air temperature, F	55
Relative humidity, %	45
Wind speed, mph	0 to 1

Application date	Species	Common Name	Growth stage	Height (in.)
October 11, 2001	BROTE	Downy brome	Dormant	
	BROTE	Downy brome	3 leaf to 1 tiller	4 to 7

Table 2. Downy brome control on Colorado rangeland with imazapic.

		Downy Brome Control			
Herbicide[1]	Rate	May 2002	June 2002	October 2002	April 2003
	(oz ai/a)	(%)			
Imazapic	0.5	85	84	51	24
Imazapic	1.0	100	96	63	43
Imazapic	1.5	100	99	63	51
Imazapic	2.0	100	100	67	63
Imazapic	3.0	100	100	74	71
Control		0	0	0	0
LSD (0.05)		1	5	10	13

[1] Non-ionic surfactant added to all treatments at 0.25% v/

Oxeye daisy control on pastureland. James S. Jacobs. (Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717-3120) A study was established on pastureland to evaluate oxeye daisy control with metsulfuron and picloram in spring 2001. Plots were 2 by 6 m arranged in a randomized complete block design with three replications. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 30 liters/ha at 30 psi (Table 1). Grass injury and weed control were evaluated visually on 27 August 2001 and 8 July 2002. Density of oxeye daisy was counted in five 20 by 50 mm frames placed randomly within each plot on 6 October 2003.

Table 1. Application data.

Location	Bozeman, Montana
Application data	17 May 2001
Oxeye daisy growth stage	rosette
Air temperature (C)	12
Relative humidity (%)	43
Wind (km/h, direction)	3, W
Cloud cover (%)	90
Soil temperature at 50 mm (C)	12
Soil texture	loam

Visible injury in the form of stunted growth of smooth brome and orchardgrass was noted in the picloram and 0.90 rate of metsulfuron treatments on 27 August 2001. No grass injury was noted on 8 July 2002 or 6 October 2003. All treatments controlled oxeye daisy by 96% or more for two years and density was reduced by 76% or more in all treatments three years after application.

Table 2 Oxeye daisy control and density using metsulfuron or picloram near Bozeman, MT.

Treatment[1]	Rate	27 August 2001 Control	8 July 2002 Control	6 October 2003 Density
	g ai/ha	%	%	rosettes/m^2
Untreated check		0	0	99
Metsulfuron	3.4	96	98	23
Metsulfuron	5.2	99	99	5
Metsulfuron	6.9	99	99	9
Metsulfuron	10.3	99	99	19
Picloram	45.9[2]	99	99	23
LSD (0.05)		2	2	39

[1] Nonionic surfactant (R-11) at 0.25% v/v was applied with all metsulfuron treatments.

[2] Picloram rate is expressed as g ae/ha.

Oxeye daisy control on Colorado rangeland. James R. Sebastian and K.G. Beck. (Department of Bioagriculture Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523) Two experiments were established near Durango, CO to evaluate oxeye daisy (CHYLE) control. The experiments were designed as a randomized complete block with four replications.

The studies were established in 1999 and 2000 at adjacent locations. Herbicides (Table 2) were applied on July 27, 1999 (first study) and July 19, 2000 (second study) when CHYLE was in the full bloom growth stage. All treatments were applied with a CO_2-pressurized backpack sprayer using 11003LP flat fan nozzles at 21 gal/A and 14 psi. Other application information is presented in Table 1. Plot size was 10 by 30 feet.

Visual evaluations for control compared to non-treated plots were collected each fall from 1999 through 2003 for study 1 (Table 1). Evaluations were taken 1, 2 and 3 years after treatment (YAT) for the second study (Table 2). Metsulfuron treatments controlled CHYLE faster than others in study 1. For example, CHYLE control from metsulfuron 60 DAT was 73 to 84% whereas picloram controlled 53% of CHYLE. Metsulfuron treatments controlled 90 to 100% of CHYLE 1 and 2 YAT in both studies. CHYLE control dropped to approximately 70% at the 3 YAT evaluation and 60% at the 4 YAT evaluation from all metsulfuron treatments in study 1. Picloram at 4 oz ai/a controlled 60 to 74% of CHYLE 1 to 3 evaluation in study 1, and 90 and 73% of CHYLE 1 and 2 YAT, respectively, in study 2. Clopyralid plus 2,4-D, clopyralid plus triclopyr, and 2,4-D amine controlled less than 70% of CHYLE at all evaluation dates in both studies. Imazapic controlled less than 60% of CHYLE 1 YAT and control deteriorated thereafter. Grass injury (stand reduction) from imazapic was 36% 1YAT; injury persisted through the study and was 43% 4 YAT. Our data indicates metsulfuron is the best choice to control oxeye daisy and the addition of nitrogen fertilizer as an adjuvant may not always be necessary.

Table 1. Application data for oxeye daisy control on Colorado rangeland.

Environmental data	Study 1	Study 2
Application date	July 27, 1999	July 19, 2000
Application time	1:00 pm	12:00 am
Air temperature, F	78	75
Relative humidity, %	69	10
Wind speed, mph	0 to 5	0 to 4

Application date	Species	Common name	Growth stage	Height (in.)
July 27, 1999	CHYLE	Oxeye daisy	Full bloom	12 to 27
July 19, 2000	CHYLE	Oxeye daisy	Full bloom	12 to 22

Table 2. Oxeye daisy control on Colorado rangeland (Study 1).

		Oxeye daisy control				Grass injury			
Herbicide[1]	Rate	2000	2001	2002	2003	2000	2001	2002	2003
	(oz ai/a)	(%)				(%)			
Metsulfuron	0.3	100	97	73	53	3	5	0	0
Metsulfuron	0.45	100	100	79	60	4	0	0	0
Metsulfuron	0.6	100	100	73	64	3	0	0	0
Metsulfuron + nitrogen fertilizer[2]	0.45 +32.0	100	100	85	74	4	0	0	0
Picloram	4.0	74	73	60	39	4	5	0	5
Clopyralid + 2,4-D amine	1.5 +8.0	13	8	0	0	5	0	0	0
Clopyralid + 2,4-D amine	3.0 +16.0	23	14	10	13	0	0	0	0
Clopyralid + 2,4-D amine	6.0 +32.0	54	65	55	41	0	0	0	0
Imazapic	8.0	54	34	10	9	36	34	44	43
2,4-D amine	16.0	16	14	5	5	0	0	0	0
2,4-D amine	32.0	36	36	28	21	0	0	0	0
Nitrogen fertilizer[2]	32.0	0	0	0	0	0	0	0	0
Control		0	0	0	0	0	0	0	0
LSD (0.05)		10	12	21	24	7	6	6	7

[1] Non-ionic surfactant added to all treatments at 0.25% v/v.
[2] Nitrogen fertilizer is liquid nitrogen solution 32.

Table 3. Oxeye daisy control on Colorado rangeland (Study 2).

		Oxeye daisy control		
Herbicide[1]	Rate	2001	2002	2003
	(oz ai/a)	(%)		
Metsulfuron	0.3	94	66	58
Metsulfuron	0.45	96	90	87
Metsulfuron	0.6	100	98	95
Metsulfuron	0.9	100	100	99
Picloram	4.0	90	73	86
Clopyralid +triclopyr	6.0 +18.0	46	10	15
Control		0	0	0
LSD (0.05)		7	15	13

[1] Non-ionic surfactant added to all treatments at 0.25% v/v.

Clematis control on Colorado rangeland. James R. Sebastian and K.G. Beck. (Department of Bioagriculture Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523) *Clematis orientalis* (CLEOR) was established locally in the Clear Creek Valley dating back to the mining times in the late 19th century. CLEOR has extensive climbing vines that smothers grass, trees, and shrubs. In recent times, CLEOR has rapidly expanded its range to the steep slopes and canyons of the Front Range in Colorado. Due to its growth pattern and location, CLEOR is difficult to control. It often grows on trees and along ditches where many herbicides cannot be used. CLEOR grows as a dense viney canopy and is often found in rough terrain, making herbicide application very difficult.

Two experiments were established near Georgetown, CO to evaluate chemical control of CLEOR. Both studies were sprayed on July 25, 2001 at adjacent sites but included different herbicides. The experiments were designed as randomized complete blocks with four replications.

Herbicides were applied when CLEOR was in early flower growth stage in both studies. All treatments were applied with a CO_2-pressurized backpack sprayer using 11002LP flat fan nozzles at 20 gal/A and 30 psi. Plot size was 10 by 30 feet. Application information for both studies is presented in Table 1. Visual evaluations for control compared to non-treated plots were collected on October 3, 2001, July 25, 2002, and July 25, 2003. Tables 2 and 3 reflect data for each study and will be discussed separately.

Study 1. Metsulfuron controlled 50 to 70% CLEOR approximately 70 days after treatment (DAT). Metsulfuron at 3 oz ai/a controlled only 52% of CLEOR 1 YAT and 21% at 2 YAT. However, metsulfuron at 0.6 or 0.9 oz ai/a controlled more than 89% of CLEOR 1 YAT and 2 YAT. Clopyralid failed to control CLEOR, but 2,4-D amine at 32 oz ai/a controlled 100% of CLEOR 1 and 2 YAT.

Study 2. Imazapic controlled CLEOR slowly. Imazapic at 3 oz ai/a controlled only 36% of CLEOR 70 DAT, but controlled 96% of CLEOR 1 YAT and 86% 2 YAT. Quinclorac failed to control CLEOR. Picloram at 8 oz ai/a controlled 100% of CLEOR at all 3 evaluation dates.

All treatments prevented seedset 70 DAT in both studies. Picloram was the only treatment that caused grass injury (leaf curling). Snowberry and common gooseberry were killed by 2,4-D, picloram, and imazapic + 2,4-D treatments. Metulfuron, imazapic, and clopyralid treatments injured snowberry and common gooseberry but it recovered 2 YAT. CLEOR often grows over neighboring plants and smothers them. Temporary minor herbicide injury may be more acceptable than death from CLEOR that often occurs. Evaluations will continue through the 2004 growing season to provide an indication of long term CLEOR control.

Table 1. Application data for clematis control on Colorado rangeland.

Environmental data	
Application date	July 25, 2001
Application time	10:30 am
Air temperature, F	80
Relative humidity, %	31
Wind speed, mph	0 to 2

Application date	Species	Common Name	Growth stage	Height (in.)
July 25, 2001	CLEOR	Oriental clematis	Early flower	36 to 72
	AGRSM	Western wheatgrass	Flower	12 to 18
	BROIN	Smooth brome	Flower	18 to 26

Table 2. Clematis control on Colorado rangeland (study 1).

Herbicide[1]	Rate	October 2001	Clematis control July 2002	July 2003
	(oz ai/a)		(%)	
Metsulfuron	0.3	50	52	21
Metsulfuron	0.5	64	94	76
Metsulfuron	0.6	65	93	95
Metsulfuron	0.9	70	95	89
2,4-D amine	32.0	89	100	100
Clopyralid	4.0	26	36	0
Control		0	0	0
LSD (0.05)		11	25	19

[1] Non-ionic surfactant added to all treatments at 0.25% v/v.

Table 3. Clematis control on Colorado rangeland (study 2).

Herbicide[1]	Rate	October 2001	Clematis control July 2002	July 2003
	(oz ai/a)		(%)	
Imazapic	3	36	96	86
Imazapic +2,4-D	6 +12	55	100	100
Quinclorac	6	20	38	0
Picloram	8	100	100	100
Control		0	0	0
LSD (0.05)		12	13	21

[1] Methylated seed oil added to all treatments at 32 oz/a.

Control of greasewood with metsulfuron. Steven A. Dewey and R. William Mace. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820) Six postemergence herbicides, metsulfuron, dicamba, fluroxypyr, picloram, triclopyr+clopyralid and 2,4-D were evaluated for effectiveness in controlling greasewood (SARVE) located in an alkali pasture near Plain City, Utah. Individual treatments were applied to 10 by 30 foot plots with a CO_2 sprayer using Turbojet 015 nozzles providing a 10 foot spray width calibrated to deliver 25 gpa at 40 psi. The soil was a Sunset loam with 7.6 pH and O.M. content of 1%. Treatments were applied postemergence June 26, 2002 in a randomized block design, with three replications. Greasewood plants averaged two feet in height at treatment time and were in mid to late bloom. Visual evaluations for weed control were completed Oct 20, 2002 and June 9, 2003.

No treatment visibly injured the light understory of grass at either evaluation date. Increasing rates of metsulfuron provided increasing control of greasewood one year after application. Fluroxypyr and metsulfuron+fluroxypyr were not as effective as other treatments in controlling greasewood. Metsulfuron and 2,4-D+dicamba combinations gave the greatest control of greasewood one year after treatment applications.

Table. Evaluation of greasewood control.

		Grass injury		SARVE control	
Treatment	Rate	10/3/02	6/9/03	10/3/02	6/9/03
	lb/A	-------%-------		--------%--------	
Metsulfuron[1]	0.0112	0	0	62	57
Metsulfuron	0.0225	0	0	80	72
Metsulfuron	0.0448	0	0	78	69
Metsulfuron	0.0672	0	0	75	73
Metsulfuron	0.0896	0	0	70	89
Untreated		0	0	17	0
2,4-D amine+dicamba	0.5+0.5	0	0	88	93
2,4-D amine+dicamba	1.0+0.5	0	0	90	90
2,4-D amine+dicamba+metsulfuron	0.5+0.5+0.0112	0	0	93	91
2,4-D amine+dicamba+metsulfuron	1.0+0.5+0.0112	0	0	95	94
2,4-D amine+dicamba+metsulfuron	1.0+0.5+0.0225	0	0	92	87
Fluroxypyr	0.375	0	0	77	60
Metsulfuron+fluroxypyr	0.0112+0.375	0	0	78	64
Picloram	1.0	0	0	67	80
Triclopyr/clopyralid	1.5	0	0	87	78
2,4-D ester	2	0	0	93	88
$LSD_{(0.05)}$				18.4	20.7

[1] NIS added at 0.25% v/v added to all metsulfuron treatments.

Russian knapweed control in pasture with metsulfuron. Steven A. Dewey and R. William Mace. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820) Six postemergence herbicides, metsulfuron, dicamba, fluroxypyr, picloram, triclopyr+clopyralid and 2,4-D were evaluated for effectiveness in controlling Russian knapweed (CENRE) located in an alkali pasture in Salt Lake City, Utah. Individual treatments were applied to 10 by 30 foot plots with a CO_2 sprayer using Turbojet 015 nozzles providing a 10 foot spray width calibrated to deliver 25 gpa at 40 psi. The soil was a gravely loam with 7.9 pH and O.M. content of less than 1%. Treatments were applied postemergence June 26, 2002 in a randomized block design, with three replications. Knapweed plants averaged one to two feet in height and were in mid bloom stage when treated. Visual evaluations for weed control were completed June 9, 2003.

Initial evaluations taken in the fall of 2002 showed no effect from any treatment application except for 2,4-D ester. In June of 2003 that treatment was numbered among the least effective at controlling Russian knapweed. The most effective treatments included the highest rate of metsulfuron alone, picloram and the triclopyr/clopyralid combination.

Table. Evaluation of russian knapweed control.

		CENRE control
Treatment	Rate	6/9/03
	lb/A	--------%--------
Metsulfuron[1]	0.0112	10
Metsulfuron	0.0225	30
Metsulfuron	0.0448	33
Metsulfuron	0.0672	55
Metsulfuron	0.0896	90
Untreated		0
2,4-D amine+dicamba	0.5+0.5	58
2,4-D amine+dicamba	1.0+0.5	57
2,4-D amine+dicamba+metsulfuron	0.5+0.5+0.0112	42
2,4-D amine+dicamba+metsulfuron	1.0+0.5+0.0112	62
2,4-D amine+dicamba+metsulfuron	1.0+0.5+0.0225	80
fluroxypyr	0.375	0
Metsulfuron+fluroxypyr	0.0112+0.375	12
Picloram	1.0	100
Triclopyr/clopyralid	1.5	99
2,4-D ester	2	76
$LSD_{(0.05)}$		20.9

[1] NIS added at 0.25% v/v added to all metsulfuron treatments.

Very late-season Russian knapweed control with various herbicides. Rodney G. Lym. (Plant Sciences Department, North Dakota State University, Fargo, ND 58105). Russian knapweed (*Acroptilon repens* L.) is an invasive perennial weed that is very difficult to control with herbicides. Recently, research in Wyoming and Colorado found that herbicides applied very late in the growing season to Russian knapweed following several hard frosts provided greater than 85% control for several seasons (Arnold et al. 2002, WSWS Res. Prog. Rep. p. 3; Whitson and Rose 1999, WSWS Res. Prog. Rep. p. 3; Whitson and Ferrell 2002, WSWS Res. Prog. Rep. p. 2). Similar treatments applied to Russian knapweed in September in North Dakota provided less than 40% control 1 yr after treatment (Lym and Christianson 2002, WSWS Res. Prog. Rep. p. 4-5). The purpose of this research was to evaluate Russian knapweed control with various herbicides applied after a killing frost in North Dakota.

The experiment was established in the South Unit of Theodore Roosevelt National Park near Medora, ND, on October 8, 2002. Russian knapweed plants were 24 to 30 inches tall, and the stems were grey in color and appeared dormant. The minimum air temperature had reached 29 F or lower five times prior to herbicide application, including three consecutive mornings immediately prior to treatment. The herbicides were applied using a hand-held boom sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 25 feet and replicated three times in a randomized complete block design. The air temperature was 48 F, with a 43 F dew point, and the soil temperature at the 4 inch depth was 46 F.

Table. Russian knapweed control with several herbicides applied after a killing frost in North Dakota.

		Control					
		8 MAT[1]		10 MAT		12 MAT	
Treatment	Rate	RUKW[1]	GI[1]	RUKW	GI	RUKW	GI
	—— oz/A ——			—— % ——			
Picloram	6	100	0	100	0	91	3
Clopyralid	4	100	3	99	0	94	0
Clopyralid / triclopyr[2]	6 + 1.1	98	0	97	0	92	1
Imazapic + MSO[3]	3 + 1 qt	100	27	100	21	79	3
Metsulfuron / dicamba / 2,4-D[4] + MSO[3]	0.6 + 8 + 23 + 1 qt	100	30	97	22	66	17
Picloram + clopyralid / 2,4-D[5]	4 + 3 + 16	100	13	100	7	96	3
Quinclorac + MSO[3]	8 + 1 qt	97	0	30	0	30	0
LSD (0.05)		NS	19	36	17	29[6]	NS

[1] Abbreviations: MAT = Months after treatment, RUKW = Russian knapweed, GI= grass injury.

[2] Commercial formulation - Redeem by Dow AgroSciences, Indianapolis, IN.

[3] MSO is methylated seed oil, Scoil by AGSCO, Grand Forks, ND.

[4] Commercial formulation - Cimarron Max by DuPont, Wilmington, DE.

[5] Commercial formulation - Curtail by Dow AgroSciences, Indianapolis, IN.

[6] LSD (0.15).

Treatments that contained picloram or clopyralid provided greater than 90% Russian knapweed control 12 months after treatment (MAT) with little to no visible grass injury (Table). Imazapic at 3 oz/A provided 100% control up to 8 MAT but suppressed grass production, and Russian knapweed control declined to 79% by 12 MAT. Metsulfuron applied with dicamba and 2,4-D did not provide season-long Russian knapweed control and grass injury 8 MAT averaged 30%. Quinclorac only provided short-term Russian knapweed control. Very late-season treatments that contained picloram or clopyralid cost approximately $15 to $30/A at the rates used in this study and could be used to control Russian knapweed in a variety of environments.

Leafy spurge control with herbicide combinations that included imazapic, quinclorac, and diflufenzopyr. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). Research at North Dakota State University has shown that long-term leafy spurge control can be improved when a mixture of herbicides are applied compared to a single herbicide applied alone. Also, both initial and long-term leafy spurge control was increased when diflufenzopyr, an auxin transport inhibitor, was applied with several auxin herbicides. The purpose of this research was to evaluate various combinations of imazapic, quinclorac, and diflufenzopyr for leafy spurge control.

The first experiment compared various mixtures of picloram, 2,4-D, imazapic, and quinclorac applied with diflufenzopyr for leafy spurge control on the Sheyenne National Grassland (SNG) and near Walcott, ND. Herbicides were applied on June 8 and 22, 2001, respectively, when the leafy spurge was in the true-flower growth stage and 14 to 28 inches tall using a hand-held boom sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 30 feet at Walcott and 8 by 25 feet on the SNG, and treatments were replicated four times in a randomized complete block design. Leafy spurge topgrowth control was visually evaluated based on percent stand reduction compared to the untreated check.

The combinations of picloram plus 2,4-D with imazapic or with imazapic plus diflufenzopyr provided better leafy spurge control than picloram plus 2,4-D applied alone (Table 1). For instance, leafy spurge control 12 MAT (months after treatment) averaged over both locations was 78% with picloram plus 2,4-D compared to 92% when picloram plus 2,4-D were applied with imazapic or imazapic plus diflufenzopyr. The addition of quinclorac or quinclorac plus diflufenzopyr to picloram plus 2,4-D only tended to increase control 12 MAT compared to picloram plus 2,4-D alone and averaged 84%. In general, leafy spurge control 12 MAT was similar when quinclorac was applied alone or with diflufenzopyr, dicamba, or dicamba plus diflufenzopyr and averaged 88% over both locations. The combination of picloram plus 2,4-D plus quinclorac plus dicamba plus diflufenzopyr tended to provide the best long-term control at the SNG and averaged 82% 24 MAT. However, the same treatment at Walcott 24 only averaged 40% MAT.

The second experiment evaluated leafy spurge control with the commercial formulation of dicamba plus diflufenzopyr (Distinct) applied alone or with imazapic, quinclorac, or imazapic plus 2,4-D. Herbicide treatments were applied at the same locations and dates as the first experiment to leafy spurge in the true-flower growth stage, except the imazapic alone treatments were applied in mid-September 2001. Herbicides were applied as previously described, and plots at both locations were 10 by 30 feet with three replications.

In general, dicamba plus diflufenzopyr spring-applied provided similar leafy spurge control when applied alone or with imazapic or imazapic plus 2,4-D at comparable rates regardless of evaluation date (Table 2). Also, quinclorac alone spring-applied generally provided similar leafy spurge control compared to quinclorac applied with dicamba plus diflufenzopyr. Imazapic alone fall-applied provided the best long-term leafy spurge control, which averaged 99% over both rates 12 months after treatment. However, grass injury 9 MAT averaged over both locations was 11 and 22% with imazapic at 2 and 3 oz/A, respectively. Grass injury only slightly declined by 12 MAT. Leafy spurge control averaged of 85 and 98% 18 MAT when imazapic was applied at 2 and 3 oz/A, respectively. Leafy spurge control with imazapic at 3 oz/A averaged 94% 24 MAT at the SNG, but only 62% at Walcott, while imazapic applied at 2 oz/A averaged 71 and 55%, respectively (data not shown). Grass injury was not observed with either treatment 24 MAT.

The third experiment compared leafy spurge control with imazapic applied alone or with diflufenzopyr or diflufenzopyr plus dicamba or quinclorac and quinclorac plus diflufenzopyr. The experiment was established as previously described near Valley City on September 10, 2002 and on the SNG on September 11, 2002.

Leafy spurge control 12 MAT with imazapic was similar when applied at 1 oz/A alone or with diflufenzopyr or diflufenzopyr plus dicamba and averaged 92 and 73% at the SNG and Valley City, respectively(Table 3). Imazapic at 2 oz/A averaged 95% leafy spurge control 12 MAT regardless of location compared to 49% with picloram plus 2,4-D at 8 + 16 oz/A. Also, quinclorac applied with imazapic provided similar leafy spurge control to the herbicides applied alone (Table 4). Again, the addition of diflufenzopyr with imazapic or quinclorac provided similar leafy spurge control to the herbicides applied alone.

In summary, imazapic applied with picloram plus 2,4-D improved long-term leafy spurge control compared to the standard treatment of picloram plus 2,4-D. In general, imazapic fall-applied provided the best long-term leafy spurge control while imazapic applied with diflufenzopyr, dicamba, or quinclorac in various combinations provided similar leafy spurge control to imazapic applied alone at comparable rates. Dicamba plus diflufenzopyr did not provide long-term leafy spurge control.

Table 1. Leafy spurge control 3 to 24 months after treatment from various herbicide mixtures applied in June 2001 near Walcott and on the Sheyenne National Grassland (SNG) in ND.

		Location/months after treatment[1]							
		3		12		15		24	
Treatment	Rate	Walcott	SNG	Walcott	SNG	Walcott	SNG	Walcott	SNG
	—— oz/A ——	—— % ——							
Picloram + 2,4-D	4 + 16	68	82	79	77	19	12	31	41
Imazapic +MSO[2]+28%N	1 + 1 qt + 1 qt	45	93	89	70	42	0	35	31
Picloram+2,4-D+imazapic+MSO+28%N	4+16+1+1 qt +1qt	96	99	87	95	40	52	44	53
Picloram+2,4-D+imazapic+diflufenzopyr +MSO+28%N	4+16+1+2+1 qt+1qt	100	100	89	95	44	66	40	68
Picloram+2,4-D+quinclorac+MSO	4+16+8+1 qt	96	99	81	89	35	17	40	82
Picloram+2,4-D+quinclorac+diflufenzopyr +MSO	4+16+6+2.5+1 qt	97	95	79	85	22	27	43	64
Quinclorac+diflufenzopyr+MSO	6+1.2+1 qt	93	96	88	88	36	45	43	40
Quinclorac+dicamba+MSO	6+3+1 qt	90	92	89	83	35	51	41	51
Quinclorac+dicamba/diflufenzopyr[3]+MSO	6+3+1.2+1 qt	97	97	86	92	34	63	58	68
Quinclorac+dicamba/diflufenzopyr[3]+ imazapic+MSO	6+3+1.2+1+1 qt	97	96	92	96	51	88	26	22
LSD (0.05)		16	7	18	12	NS	29	NS	36

[1] Months after treatment.

[2] Methylated seed oil Scoil by AGSCO, Grand Forks, ND.

[3] Commercial formulation - Distinct, by BASF Corp., Research Triangle Park, NC.

Table 2. Leafy spurge control from dicamba plus diflufenzopyr applied alone or with various other herbicides in June 2001 for leafy spurge control near Walcott and on the Sheyenne National Grassland in North Dakota.

		Location/MAT[1]													
		Walcott							Sheyenne National Grassland						
		3	12/9		15/12		24/18		3	12/9		15/12		24/18	
Treatment	Rate	Cont	Cont	GI[2]	Cont	GI	Cont	GI	Cont	Cont	GI	Cont	GI	Cont	GI
	- oz/A -	%													
Imazapic + picloram + 2,4-D + MSO[3] + 28%N	1 + 4 + 16	97	95	3	68	0	58	0	97	83	0	33	5	32	0
Dicamba / diflufenzopyr[4]+ MSO	3 + 1.2	73	69	0	13	0	27	0	72	68	0	22	0	8	0
Dicamba / diflufenzopyr[4]+ MSO	4 + 1.6	86	79	0	37	0	28	0	58	63	0	15	0	3	0
Dicamba / diflufenzopyr[4] + imazapic + MSO	2 + 0.8 + 1	82	62	0	11	0	24	0	84	78	0	25	0	10	0
Dicamba / diflufenzopyr[4] + imazapic + MSO	3 + 1.2 + 1	82	64	0	7	0	20	2	89	89	0	22	0	20	0
Dicamba / diflufenzopyr[4] + imazapic + MSO	4 + 1.6 + 1	96	93	0	40	0	27	0	83	72	0	25	0	21	0
Dicamba / diflufenzopyr[4] + imazapic / 2,4-D[5]+ MSO	2 + 0.8 + 1 + 2	95	92	3	35	0	38	3	93	80	0	20	0	9	0
Dicamba / diflufenzopyr[4] + imazapic / 2,4-D[5]+ MSO	3 + 1.2 + 1 + 2	94	86	0	30	0	20	0	81	63	0	18	0	4	0
Dicamba / diflufenzopyr[4] + imazapic / 2,4-D[5]+ MSO	4 + 1.6 + 1 + 2	92	86	0	45	0	51	0	97	79	0	23	0	30	0
Quinclorac + MSO	6	85	87	0	18	0	3	0	59	61	0	6	0	0	0
Dicamba / diflufenzopyr[4] + quinclorac+MSO	2 + 0.8 + 6	88	88	0	37	0	44	0	80	67	0	27	0	25	0
Imazapic + MSO - fall applied	2	●●	100	17	99	11	80	1	●●	99	5	98	4	89	5
Imazapic + MSO - fall applied	3	●●	100	31	100	23	97	3	●●	98	12	99	15	99	10
LSD (0.05)		10	14	8	28	4	38	NS	26	23	11	34	5	30	2

[1] Months after treatment; spring/fall.

[2] Grass injury.

[3] MSO = methylated seed oil at 1 qt/A , Scoil by AGSCO, Grand Forks, ND for all treatments.

[4] Commercial formulation - Distinct by BASF Corp., Research Triangle Park, NC.

[5] Commercial formulation - Oasis by BASF Corp., Research Triangle Park, NC.

Table 3. Leafy spurge control with imazapic applied alone or with diflufenzopyr and diflufenzopyr plus dicamba on the Sheyenne National Grassland (SNG) and near Valley City, North Dakota in September 2002.

		Location/time after treatment					
		9 MAT[1]				12 MAT	
		SNG		Valley City		SNG	Valley City
Treatment	Rate	Control	GI[2]	Control	GI	Control	
	oz/A	%					
Imazapic + MSO[3]	1 + 1 qt	99	1	100	8	93	67
Imazapic + diflufenzopyr + MSO	1 + 0.2 + 1 qt	99	1	99	9	94	72
Imazapic + diflufenzopyr + MSO	1 + 0.1 + 1 qt	94	2	100	6	92	76
Imazapic + diflufenzopyr + MSO	1 + 0.5 + 1 qt	96	1	99	5	93	81
Imazapic + dicamba / diflufenzopyr[4] + MSO	1 + 0.6 + 0.2 + 1 qt	92	3	99	5	87	77
Imazapic + dicamba / diflufenzopyr[4] + MSO	1 + 0.3 + 0.1 + 1 qt	98	1	100	17	88	82
Imazapic + dicamba / diflufenzopyr[4] + MSO	1 + 0.5 + 0.15 + 1 qt	98	5	100	8	94	56
Dicamba / diflufenzopyr[4] + MSO	3 + 1.2 + 1 qt	70	0	99	4	3	36
Dicamba / diflufenzopyr[4] + MSO	0.3 + 0.1 + 1 qt	85	0	88	4	0	15
Imazapic + MSO	2 + 1 qt	99	6	100	24	96	94
Picloram + 2,4-D	8 + 16	99	2	99	9	41	56
LSD (0.05)		15	5	7	9	11	22

[1] Months after treatment.

[2] Grass injury.

[3] MSO = methylated seed oil, Scoil by AGSCO, Grand Forks, ND.

[4] Commercial formulation - Distinct by BASF, Research Triangle Park, NC.

Table 4. Leafy spurge control with imazapic applied alone or with quinclorac or quinclorac plus diflufenzopyr on the Sheyenne National Grassland (SNG) and near Valley City, North Dakota in September 2002.

		Location / time after treatment					
		9 MAT[1]				12 MAT	
		SNG		Valley City		SNG	Valley City
Treatment	Rate	Control	GI[2]	Control	GI	Control	
	oz/A	%					
Imazapic + MSO[3]	1 + 1 qt	95	7	99	6	93	89
Imazapic + diflufenzopyr + MSO	1 + 0.1 + 1 qt	90	9	99	8	79	90
Imazapic + quinclorac + MSO	1 + 2 + 1 qt	96	3	100	9	94	91
Imazapic + quinclorac + MSO	1 + 4 + 1 qt	97	7	100	11	92	93
Imazapic + quinclorac + diflufenzopyr + MSO	1 + 2 + 0.1 + 1 qt	93	6	99	9	90	94
Imazapic + quinclorac + diflufenzopyr + MSO	1 + 4 + 0.1 + 1 qt	96	7	99	3	84	91
Imazapic + dicamba / diflufenzopyr[4] + quinclorac + MSO	1 + 0.5 + 0.15 + 3 + 1 qt	99	16	100	6	89	92
Quinclorac + diflufenzopyr + MSO	2 + 0.1 + 1 qt	71	0	99	1	68	72
Quinclorac + diflufenzopyr + MSO	4 + 0.1 + 1 qt	89	2	99	1	63	90
Quinclorac + MSO	4 + 1 qt	87	0	99	0	61	78
Quinclorac + dicamba / diflufenzopyr[4] + MSO	8 + 6 + 3 + 1 qt	98	2	99	1	64	97
Picloram + 2,4-D	8 + 16	99	4	99	2	72	74
LSD (0.05)		7[5]	6	NS	7	16	8

[1] Months after treatment.

[2] Grass injury.

[3] Methylated seed oil was Scoil by AGSCO, Grand Forks, ND

[4] Commercial formulation - Distinct by BASF Research Triangle Park, NC.

[5] LSD (0.10).

Leafy spurge control with imazapic combined with picloram plus 2,4-D or at reduced rates. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). Research at North Dakota State University has shown that imazapic fall-applied provides good leafy spurge control but can injure grass, especially cool-season species. Also, imazapic spring-applied with picloram plus 2,4-D generally provides better leafy spurge control than picloram plus 2,4-D applied alone. The purpose of this study was to evaluate the optimum rate of imazapic applied alone or with picloram plus 2,4-D for leafy spurge control.

The first study was established at the Sheyenne National Grassland (SNG) near Lisbon, ND in June 2001. Leafy spurge was in the true-flower growth stage when treatments were applied with a hand-held sprayer delivering 8.5 gpa at 35 psi. The experiment was in a randomized complete block design with three replicates and plots were 10 by 30 feet. Control was based on a visual estimate of percent stand reduction as compared to the untreated check.

Imazapic applied with picloram or picloram plus 2,4-D provided better leafy spurge control than picloram and picloram plus 2,4-D applied alone and control increased as the imazapic rate increased (Table 1). For instance, picloram plus 2,4-D applied alone provided an average of 78% leafy spurge control 12 MAT (months after treatment) but control averaged 95% when picloram or picloram plus 2,4-D was applied with imazapic at 1 oz/A.

Leafy spurge control was similar whether or not 2,4-D or 28% N was included in the combination treatment. However, control declined or tended to decline when the imazapic rate was reduced from 1 to 0.25 oz/A. Leafy spurge control 15 MAT with imazapic at 1 oz/A with picloram or picloram plus 2,4-D averaged 43% compared to 8% with picloram plus 2,4-D and 13% with imazapic applied alone. Leafy spurge control 24 MAT averaged 31% with imazapic at 1 oz/A applied with picloram and picloram plus 2,4-D.

The second study was established at the Albert Ekre Research Center near Walcott and near Valley City, ND on June 20, 2002 to further evaluate leafy spurge control with reduced rates of imazapic plus picloram and 2,4-D. The experiment was established as previously described except there were four replicates at both locations.

As in the first experiment, leafy spurge control with the combination treatment of imazapic plus picloram plus 2,4-D provided better leafy spurge control than the herbicides applied alone (Table 2). For instance, leafy spurge control with picloram plus 2,4-D 12 and 15 MAT averaged 81 and 36% at Walcott, but when applied with imazapic control averaged 96 and 69%. In general, leafy spurge control was not influenced by a reduction in imazapic rates as seen in the first experiment. Control was similar whether or not 28% N or 2,4-D were included in the treatment. Leafy spurge control at Valley City was variable, not only between treatments but between observation dates, and may have been influenced by *Aphthona* spp. flea beetle biocontrol agents.

The third study was established at four locations in North Dakota to evaluate leafy spurge control and grass injury from imazapic at 1 to 3 oz/A. Herbicides were applied on September 10, 2002 at Jamestown and Valley City and on September 11, 2002 near Walcott and on the Sheyenne National Grassland. Leafy spurge was in the fall regrowth stage and 18 to 26 inches tall at all locations. Plots were 10 by 30 feet and replicated four times at all locations, plots at Valley City were 8 by 30 feet.

Leafy spurge control 9 MAT was 99% averaged across all locations regardless of imazapic rate (Table 3). However, grass injury increased as the imazapic rate increased and averaged 29% with imazapic at 3 oz/A. Leafy spurge control increased from 74 to 93% 12 MAT as the imazapic rate increased from 1 to 3 oz/A. Grass injury was negligible by 12 MAT regardless of imazapic application rate. Leafy spurge control 12 MAT was similar when imazapic was applied at 2 or 3 oz/A at three of the four study locations but grass injury was much less at the lower rate.

In summary, long-term leafy spurge control from a June-applied treatment was improved when imazapic was applied with picloram. The addition of 28% N or 2,4-D to the imazapic plus picloram treatment did not affect leafy spurge control. In general, imazapic at 2 oz/A in the fall-applied provided similar leafy spurge control to imazapic at 2.5 and 3 oz/A but caused less grass injury and would be a more cost-effective treatment.

Table 1. Leafy spurge control from various combinations of imazapic plus picloram plus 2,4-D applied in June 2001 at Sheyenne National Grassland near Lisbon, ND.

		Control/MAT[1]			
Treatment	Rate	3	12	15	24
	oz/A	%			
Picloram + 2,4-D	4 + 16	90	78	8	0
Imazapic + MSO[2] + 28% N	1 + 1 qt + 1 qt	82	87	13	5
Picloram + 2,4-D + imazapic + MSO[2] + 28% N	4 + 16 + 1 + 1 qt + 1 qt	98	94	33	33
Picloram + 2,4-D + imazapic + MSO[2] + 28% N	4 + 16 + 0.5 + 1 qt + 1 qt	95	90	29	10
Picloram + 2,4-D + imazapic + MSO[2] + 28% N	4 + 16 + 0.25 + 1 qt + 1 qt	95	87	13	0
Picloram + 2,4-D + imazapic + MSO[2]	4 + 16 + 1 + 1 qt	96	94	49	26
Picloram + 2,4-D + imazapic + MSO[2]	4 + 16 + 0.5 + 1 qt	99	89	23	14
Picloram + 2,4-D + imazapic + MSO[2]	4 + 16 + 0.25 + 1 qt	99	84	18	7
Picloram + imazapic + MSO[2]	4 + 1 + 1 qt	89	96	47	32
Picloram + imazapic + MSO[2]	4 + 0.5 + 1 qt	88	91	30	24
Picloram + imazapic + MSO[2]	4 + 0.25 + 1 qt	95	86	17	6
LSD (0.05)		8	5	24	13.5[3]

[1] Months after treatment.

[2] MSO = methylated seed oil by AGSCO, Grand Forks, ND.

[3] LSD (0.10).

Table 2. Leafy spurge control various combinations of imazapic plus picloram plus 2,4-D applied in June 2002 at Walcott and Valley City, ND.

		Location / time after treatment				
		2 MAT[1]		12 MAT		15 MAT
Treatment	Rate	Walcott	Valley City	Walcott	Valley City	Walcott
	oz/A	%				
Picloram + 2,4-D	4 + 16	84	42	81	87	36
Imazapic + MSO[2] + 28% N	1 + 1 qt + 1 qt	69	26	92	74	50
Picloram + 2,4-D + imazapic + MSO[2] + 28% N	4 + 16 + 1 + 1 qt + 1 qt	96	58	98	59	71
Picloram + 2,4-D + imazapic + MSO[2]	4 + 16 + 1 + 1 qt	93	61	93	66	66
Picloram + imazapic + MSO[2]	4 + 1 + 1 qt	98	72	98	94	70
Picloram + imazapic + MSO[2]	4 + 0.75 + 1 qt	89	69	90	86	57
Picloram + imazapic + MSO[2]	4 + 0.5 + 1 qt	97	56	95	93	69
Picloram + imazapic + MSO[2]	2 + 1 + 1 qt	98	59	97	74	72
Picloram + imazapic + MSO[2]	2 + 0.75 + 1 qt	85	53	88	90	54
LSD (0.05)		9	17	9	14[3]	21[3]

[1] Months after treatment.

[2] Methylated seed oil was Scoil by AGSCO, Grand Forks, ND.

[3] LSD (0.10).

Table 3. Leafy spurge control 9 and 12 months after treatment with imazapic at various rates applied in September 2002 at Walcott, Jamestown, Valley City, and the Sheyenne National Grassland (SNG), ND

		9 months after treatment										12 months after treatment					
		Walcott		Jamestown		Valley City		SNG		Mean[2]		Walcott	Jamestown		Valley City	SNG	Mean[2]
Treatment	Rate	Cont.	GI[1]	Cont.	GI	Cont.	GI	Cont.	GI	Cont.	GI	Cont.	Cont.	GI	Cont.	Cont.	Cont.
	— oz/A —	%															
Imazapic + MSO[3]	3 + 1 qt	100	22	100	33	100	33	99	13	100	29	99	83	6	95	96	93
Imazapic + MSO[3]	2.5 + 1 qt	100	17	99	13	99	23	96	8	99	18	97	80	4	90	91	90
Imazapic + MSO[3]	2 + 1 qt	100	16	99	12	100	17	93	6	99	15	95	63	3	95	94	87
Imazapic + MSO[3]	1.5 + 1 qt	100	7	99	11	100	11	94	6	99	10	87	58	3	78	88	78
Imazapic + MSO[3]	1 + 1 qt	100	3	99	1	100	10	88	1	99	4	66	73	1	73	84	74
Picloram + 2,4-D	8 + 16	100	5	99	2	100	0	97	1	99	2	45	81	0	76	48	62
LSD (0.05)		NS	8	NS	12	NS	14	NS	4	NS	7	20	15	NS	15	20	8.5

[1] Grass injury.

[2] Does not include the SNG data.

[3] MSO = Methylated seed oil, Scoil by AGSCO, Grand Forks, ND.

Cutleaf teasel control on Colorado rangeland. James R. Sebastian and K.G. Beck. (Department of Bioagriculture Sciences and Pest Management, Colorado State University, Fort Collins, CO 80523) Cutleaf teasel (DIWLA) is a biennial that has recently become a problem on rangeland and along roadsides in Colorado.

An experiment was established in Jefferson County, CO to evaluate cutleaf teasel control. The experiment was designed as a randomized complete block with four replications. Herbicides (table 2) were applied on May 16 or June 12, 2002 when DIWLA was in rosette or bolting growth stage. All treatments were applied with a CO_2-pressurized backpack sprayer using 11003LP flat fan nozzles at 21 gal/A and 14 psi. Other application information is presented in Table 1. Plot size was 10 by 30 feet. Nonionic surfactant was added at 0.25% v/v to all metsulfuron and clopyralid treatments and methylated seed oil was added to all imazapic treatments at 1 qt/A.

Visual evaluations for control compared to non-treated plots were collected on June 12, July 11, and September 23, 2002, and April 15, 2003 (Table 2). Herbicides controlled DIWLA slowly, although metsulfuron at 0.5 and 0.6 oz ai/a applied at rosette controlled about 80% of teasel 7 weeks after treatment (WAT). Metsulfuron, imazapic, and 2,4-D ester appeared to control teasel better when applied during the bolting growth stage. For example, metsulfuron at 0.3 oz ai/a applied at rosette controlled 31% of teasel by the April 2003 evaluation date, but this same rate applied during bolting controlled 100% of DIWLA by April 2003. Metsulfuron, imazapic, or 2,4-D ester applied at bolting controlled 100, >93, or 96% of teasel by the April 2003 evaluation.

Clopyralid controlled 99 to 100% of DIWLA regardless of treatment timing. Clopyralid had the additional benefit of controlling 93 to 99% of the Canada thistle (CIRAR). None of the other treatments provided adequate CIRAR control. If both teasel and Canada thistle are present it would be advantageous to use clopyralid to control both weed species, except where a high water table is present.

Table 1. Application data for cutleaf teasel control on Colorado rangeland.

Environmental data		
Application date	May 16, 2002	June 12, 2002
Application time	7:00 am	10:30 am
Air temperature, F	65	75
Relative humidity, %	44	19
Wind speed, mph	0	2 to 6

Application date	Species	Common name	Growth stage	Height (in.)
May 16, 2002	DIWLA	Cutleaf teasel	1st year rosettes	3 to 6 diameter
	DIWLA	Cutleaf teasel	2nd year rosettes	10 to 18 diameter
June 12, 2002	DIWLA	Cutleaf teasel	1st year rosettes	5 to 12 diameter
	DIWLA	Cutleaf teasel	2nd year plants	12 to 30 tall

Table 2. Cutleaf teasel control on Colorado rangeland.

Herbicide[1,2]	Rate	Application timing	Teasel			Canada Thistle
			July 10	Sept 2002	April 2003	April 2003
	(oz ai/a)		(% Control)			
Metsulfuron	0.3	Rosette	66	56	31	21
Metsulfuron	0.5	Rosette	83	93	84	55
Metsulfuron	0.6	Rosette	81	98	100	21
Imazapic	8.0	Rosette	63	61	80	47
Imazapic	10.0	Rosette	55	35	63	48
Imazapic	12.0	Rosette	60	40	80	47
Clopyralid	6.0	Rosette	75	89	99	99
2,4-D ester	16.0	Rosette	34	24	53	38
Metsulfuron	0.3	Bolting	39	96	100	2
Metsulfuron	0.5	Bolting	54	99	100	33
Metsulfuron	0.6	Bolting	46	100	100	34
Imazapic	8.0	Bolting	35	53	93	38
Imazapic	10.0	Bolting	48	68	95	40
Imazapic	12.0	Bolting	45	79	93	29
Clopyralid	6.0	Bolting	43	93	100	93
2,4-D ester	16.0	Bolting	46	40	96	17
Control			0	0	0	0
LSD (0.05)			21	23	14	31

[1] Non-ionic surfactant added to all metsulfuron and clopyralid treatments at 0.25% v/v.

[2] Methylated seed oil added to all imazapic treatments at 1 quart/acre.

Control of Canada thistle, perennial sowthistle, fringed sage and other troublesome weeds with herbicide mixtures that contain metsulfuron. Rodney G. Lym. (Plant Sciences Department, North Dakota State University, Fargo, ND 58105). Metsulfuron is a relatively low cost alternative to auxin-type herbicides for weed control in pasture, rangeland, and wild lands. However, metsulfuron generally has a narrow weed control spectrum and only moderate soil residual, which may be needed for long-term weed control. The purpose of this research was to evaluate metsulfuron applied alone and in combination with other herbicides for control of several noxious and troublesome weeds.

The first experiment was established on cropland that had been unused for 2 yr on the campus of North Dakota State University, Fargo. Metsulfuron applied alone or with several other herbicides was evaluated for control of Canada thistle (*Cirsium arvense* L.), plumeless thistle (*Carduus acanthoides* L.), prickly lettuce (*Lactuca serriola* L.), prostrate knotweed (*Polygonum aviculare* L.), and scentless chamomile (*Matricaria chamomilla* L.), also called false chamomile. The herbicides were applied on June 14, 2002 when the weeds were 3 inches or less in height and the thistles were in the rosette growth stage. The herbicides were applied using a hand-held boom sprayer delivering 17 gpa at 35 psi. The plots were 9 by 30 feet and replicated four times in a randomized complete block design. Control was based on a visual estimate of percent stand reduction as compared to the untreated check.

Metsulfuron at 0.06 oz/A alone provided 98 and 100% control of prickly lettuce and scentless chamomile 2 MAT (months after treatment) but did not provide satisfactory control of Canada thistle, plumeless thistle or prostrate knotweed (Table 1). Plumeless thistle and prostrate knotweed control improved to 90% or greater when metsulfuron was applied with 2,4-D plus dicamba or MCPA plus dicamba, but Canada thistle control still averaged less than 50% 2 MAT. Weed control for all species evaluated was similar whether metsulfuron was applied alone or with fluroxypyr or thifensulfuron plus tribenuron.

The second experiment was established on fallow cropland near Fargo to evaluate metsulfuron applied alone at various rates or with thifensulfuron plus tribenuron for perennial sowthistle (*Sonchus arvensis* L.) and Canada thistle control. Treatments were applied on June 20, 2002 as previously described, except the plots were 9 by 25 feet. Perennial sowthistle and Canada thistle were in the rosette growth stage with 4 to 10 leaves.

Metsulfuron provided nearly complete control of perennial sowthistle 15 MAT regardless of application rate (Table 2). Canada thistle control was similar regardless of metsulfuron rate or the addition of thifensulfuron plus tribenuron and averaged 74% control 15 MAT compared to only 43% control with clopyralid plus 2,4-D.

The third experiment was established to evaluate Canada thistle control by metsulfuron applied with dicamba plus 2,4-D in the fall. Herbicides were applied on Sept. 25, 2002 following a light frost when Canada thistle was in the rosette growth stage or had bolted and flowered and was 10 to 36 inches tall. The study was established as previously described near Fargo except the plots were 10 by 30 feet.

Metsulfuron plus dicamba plus 2,4-D provided short-term Canada thistle control and control 9 MAT increased from 86 to 96% as application rate increased (Table 3). However, control declined rapidly with all treatments that contained metsulfuron to less than 60% 12 MAT. Clopyralid plus triclopyr provided the best long-term control which averaged 90% 12 MAT.

The fourth and fifth experiments were established to evaluate metsulfuron applied with dicamba plus 2,4-D in the spring or fall for fringed sage control. The experiment was established on a pasture southwest of Jamestown, ND, with a dense stand of fringed sage. Herbicides were applied in separate experiments on June 25, 2002 when the fringed sage was in the vegetative growth stage or on Sept. 10, 2002 after the plants had flowered and were 10 to 12 inches tall. The plots were 10 by 30 feet, and treatments were replicated four times in a randomized complete block design.

Fringed sage control tended to increase as the metsulfuron plus dicamba plus 2,4-D rate increased (Table 4). Although not directly comparable, treatments applied in June tended to provide better control 12 MAT than the same treatment applied in September. For instance, metsulfuron plus dicamba plus 2,4-D at 0.15 + 2 + 5.8 oz/A applied in spring or fall provided 58 and 41% fringed sage control, respectively, 12 MAT. The mixture of metsulfuron with dicamba plus 2,4-D tended to provide better fringed sage control than clopyralid plus triclopyr when spring-applied but not fall-applied.

In summary, metsulfuron alone provided excellent control of perennial sowthistle and scentless chamomile but not the thistle species evaluated in these studies. Plumeless thistle control but not Canada thistle was improved when metsulfuron was applied with dicamba plus 2,4-D. The addition of thifensulfuron plus tribenuron to metsulfuron did not affect weed control regardless of the species evaluated in these studies. Fringed sage control with metsulfuron applied with dicamba plus 2,4-D was acceptable, especially when applied in June. Metsulfuron plus dicamba plus 2,4-D costs $6 to $14/A at the general use rates and, depending on the weed species present, is a cost-effective option for broadleaf weed control in pasture and rangeland.

Table 1. Control of prickly lettuce, Canada thistle, plumeless thistle, prostrate knotweed, and scentless chamomile by metsulfuron alone and with other herbicides applied in June 2002 at Fargo, ND.

		Time after treatment/weed species							
		2 MAT[1]				12 MAT			
Treatment[2]	Rate	PRLE[1]	CT[1]	PLTH[1]	PRKW[1]	PRLE	CT	PLTH	Cham[1]
	oz/A	%							
Metsulfuron	0.06	98	23	63	100	96	10	67	79
Metsulfuron + 2,4-D + dicamba	0.3 + 16 + 8	100	43	100	100	100	8	99	96
Metsulfuron + 2,4-D + dicamba	0.6 + 16 + 8	100	48	100	100	99	5	96	100
Metsulfuron + MCPA + dicamba	0.3 + 8 + 8	100	62	100	100	100	5	96	94
Metsulfuron + fluroxypyr	0.3 + 1	100	30	89	100	100	0	84	100
Metsulfuron / thifensulfuron / tribenuron[3]	0.03 + 0.075 + 0.037	99	20	37	100	94	14	31	50
Metsulfuron / thifensulfuron / tribenuron[3]	0.06 + 0.15 + 0.074	99	31	73	100	99	8	61	97
2,4-D + dicamba	16 + 8	100	35	98	92	83	9	57	66
MCPA + dicamba	8 + 8 +	100	44	98	41	87	18	91	67
Fluroxypyr	1	6	0	25	53	91	0	23	63
Clopyralid / triclopyr[4]	13.5 + 4.5	100	73	100	90	91	45	73	73
LSD (0.05)		6	NS	36	28	NS	22	27[5]	NS

[1] Abbreviations: MAT = months after treatment; PRLE = Prickly lettuce; CT = Canada thistle; PLTH = plumeless thistle; PRKW = prostrate knotweed; Cham = scentless chamomile.

[2] Surfactant X-77 at 0.25% v/v was applied with all treatments.

[3] Commercial formulation - Ally Extra by DuPont, Wilmington, DE.

[4] Commercial formulation - Redeem by Dow AgroSciences, Indianapolis, IN.

[5] LSD = (0.10).

Table 2. Control of perennial sowthistle and Canada thistle by metsulfuron alone and with other herbicides applied in June 2002, at Fargo, ND.

		Time after treatment/weed species					
		1 MAT[1]		12 MAT		15 MAT	
Treatment[2]	Rate	PEST[1]	CT[1]	PEST	CT	PEST	CT
	oz/A	%					
Metsulfuron	0.06	100	87	99	84	98	80
Metsulfuron	0.075	94	83	97	71	99	74
Metsulfuron	0.15	98	91	97	81	95	75
Metsulfuron	0.3	100	94	96	85	99	78
Metsulfuron / thifensulfuron / tribenuron[3]	0.03 + 0.075 + 0.037	97	85	96	80	92	70
Metsulfuron / thifensulfuron / tribenuron[3]	0.06 + 0.15 + 0.074	99	81	98	68	99	68
Clopyralid / 2,4-D[4]	1.52 + 8	96	76	94	73	65	43
Glyphosate	6	65	24	55	10	43	0
LSD (0.05)		9	12	10	18	34	28

[1] Abbreviations: MAT = months after treatment; PEST = perennial sowthistle; CT = Canada thistle.

[2] Surfactant X-77 at 0.25% was applied with all treatments.

[3] Commercial formulation - Ally Extra by DuPont, Wilmington, DE.

[4] Commercial formulation - Curtail by Dow AgroSciences, Indianapolis, IN.

Table 3. Canada thistle control by metsulfuron with dicamba plus 2,4-D applied in September 2002, at Fargo, ND.

Treatment	Rate	Control	
		9 MAT[1]	12 MAT
	oz/A	%	
Metsulfuron + dicamba / 2,4-D[2] + MSO[3]	0.15 + 2 +5.76 + 1 qt	86	12
Metsulfuron + dicamba / 2,4-D[2] + MSO[3]	0.3 + 4 + 11.5 + 1 qt	93	35
Metsulfuron + dicamba / 2,4-D[2] + MSO[3]	0.6 + 8 + 23 + 1 qt	96	57
Clopyralid / triclopyr[4] + X-77[5]	4.5 + 13.5 + 0.25%	97	90
LSD (0.05)		6	21

[1] MAT = Months after treatment.

[2] Commercial formulation - Range Star by DuPont, Wilmington, DE.

[3] MSO = methylated seed oil, Scoil by AGSCO, Grand Forks, ND.

[4] Commercial formulation - Redeem by Dow AgroSciences, Indianapolis, IN.

[5] X-77 = nonionic surfactant from Loveland Industries, Greeley, CO.

Table 4. Control of fringed sage by metsulfuron with dicamba plus 2,4-D applied in June or September 2002 near Jamestown, ND.

Treatment	Rate	Control		
		2 MAT[1]	12 MAT	15 MAT
Spring applied	oz/A	%		
Metsulfuron + dicamba / 2,4-D[2] + MSO[3]	0.15 + 2 + 5.76 + 1 qt	82	58	64
Metsulfuron + dicamba / 2,4-D[2] + MSO[3]	0.3 + 4 + 11.5 + 1 qt	88	62	67
Metsulfuron + dicamba / 2,4-D[2] + MSO[3]	0.6 + 8 + 23 + 1 qt	95	80	70
Clopyralid / triclopyr[4] + X-77[5]	4.5 + 13.5 + 0.25%	85	48	46
LSD (0.05)		10	26[6]	18
			9 MAT	12 MAT
Fall applied			%	
Metsulfuron + dicamba / 2,4-D[2] + MSO[3]	0.15 + 2 + 5.76 + 1 qt		41	33
Metsulfuron + dicamba / 2,4-D[2] + MSO[3]	0.3 + 4 + 11.5 + 1 qt		60	51
Metsulfuron + dicamba / 2,4-D[2] + MSO[3]	0.6 + 8 + 23 + 1 qt		86	76
Clopyralid / triclopyr[4] + X-77[5]	4.5 + 13.5 + 0.25%		80	69
LSD (0.05)			19[7]	21

[1] MAT = Months after treatment.

[2] Commercial formulation - Range Star by DuPont, Wilmington, DE.

[3] MSO = methylated seed oil, Scoil by AGSCO, Grand Forks, ND.

[4] Commercial formulation - Redeem by Dow AgroSciences, Indianapolis, IN.

[5] X-77 = nonionic surfactant from Loveland Industries, Greeley, CO.

[6] LSD= (0.15)   [7] LSD= (0.10)

Canada thistle control with clopyralid applied alone or with 2,4-D or triclopyr in the spring or fall. Rodney G. Lym. (Plant Sciences Department, North Dakota State University, Fargo, ND 58105). Clopyralid is one of the best herbicides available for long-term Canada thistle control in pasture, rangeland, and wildlands. Until recently. clopyralid was only available pre-mixed with 2,4-D or triclopyr for non-cropland use in North Dakota, even though clopyralid applied alone often provided better long-term Canada thistle control than the premixes. The purpose of this research was to evaluate clopyralid alone or with 2,4-D or triclopyr applied in the spring or fall for long-term Canada thistle control.

The experiment was established at two locations on non-grazed land managed by the U.S. Army Corp. of Engineers near Valley City and Jamestown, ND. Spring herbicides treatments were applied on June 25,2002 at Jamestown and on June 26, 2002 at Valley City when Canada thistle was in the rosette to early bolt growth stage. Fall herbicide treatments were applied in separate experiments on Sept. 25, 2002 at both locations after Canada thistle had flowered and rosettes were present. The herbicides were applied using a hand-boom sprayer delivering 17 gpa at 35 psi. The plots were 10 by 30 feet and replicated four times in a randomized complete block design at both locations. Control was based on a visual estimate of percent stand reduction as compared to the untreated check.

Canada thistle control at Jamestown was better than at Valley City, so the data could not be combined over locations (Tables 1 and 2). Although not directly comparable, Canada thistle control 12 MAT (months after treatment) was much better when herbicides were applied in the fall (Table 2) compared to the same treatments applied in the spring (Table 1). Picloram at 6 oz/A applied in the spring at Jamestown averaged 79% control 12 MAT and tended to provide the best Canada thistle control compared to all other spring applied treatments. However, the same treatment only averaged 10% control at Valley City.

Clopyralid alone or with triclopyr in the fall-applied provided similar Canada thistle control, but control generally declined when clopyralid was applied with 2,4-D at comparable rates (Table 2). For instance, clopyralid applied alone at 4.8 oz/A provided 88 and 91% Canada thistle control at Valley City and Jamestown, respectively, 12 MAT, but control declined to 48 and 80%, respectively, when clopyralid at 4.8 oz/A was applied with 2,4-D. Control also tended to decline when clopyralid at 6.4 oz/A was applied with 2,4-D compared to clopyralid at 6.4 oz/A alone 12 MAT. The most cost-effective treatment evaluated was picloram at 6 oz/A, which provided 98% Canada thistle control 12 MAT averaged over both locations and cost approximately $16/A. Clopyralid plus triclopyr at 6 + 18 oz/A and clopyralid alone at 6.4 oz/A provided an average of 92% control 12 MAT but cost about $33 and $43/A, respectively.

In summary, picloram at 6 oz/A applied in the fall is a cost-effective treatment for Canada thistle control. In areas where picloram cannot be used, clopyralid plus triclopyr provided acceptable Canada thistle control but was twice as expensive as the picloram treatment. Clopyralid alone generally provided better long-term Canada thistle control than clopyralid plus 2,4-D applied at comparable application rates.

Table 1. Canada thistle control with clopyralid applied alone or with 2,4-D or triclopyr in June 2002 at two locations in North Dakota.

		Time after treatment/location			
		2 MAT[1]		12 MAT	
Treatment	Rate	Valley City	James-town	Valley City	James-town
	oz/A	%			
Clopyralid	2.4	36	30	6	30
Clopyralid	4.8	75	80	10	48
Clopyralid	6.4	82	82	10	31
Clopyralid / 2,4-D[2]	4.8 + 25.5	85	82	8	58
Clopyralid / 2,4-D[2]	6.4 + 33.6	86	88	10	45
Clopyralid / triclopyr[3] + X-77[4]	4.5 + 13.5 + 0.25%	74	74	8	25
Clopyralid / triclopyr[3] + X-77[4]	6 + 18 + 0.25%	73	81	4	44
Picloram	6	89	90	10	79
LSD (0.05)		11	9	NS	29

[1] MAT = months after treatment.

[2] Commercial formulation - Curtail by Dow AgroSciences Indianapolis, IN.

[3] Commercial formulation - Redeem by Dow AgroSciences Indianapolis, IN.

[4] X-77 = a nonionic surfactant from Loveland Industries, Greeley, CO.

Table 2. Canada thistle control with clopyralid applied alone or with 2,4-D or triclopyr in September 2002 at two locations in North Dakota.

		Time after treatment/location			
		9 MAT[1]		12 MAT	
Treatment	Rate	Valley City	James-town	Valley City	James-town
	oz/A	%			
Clopyralid	2.4	96	99	43	85
Clopyralid	4.8	98	99	88	91
Clopyralid	6.4	98	99	89	95
Clopyralid / 2.4-D[2]	4.8 + 25.5	96	99	48	80
Clopyralid / 2,4-D[2]	6.4 + 33.6	98	99	72	87
Clopyralid / triclopyr[3] + X-77[4]	4.5 + 13.5 + 0.25%	97	99	80	94
Clopyralid / triclopyr[3] + X-77[4]	6 + 18 + 0.25%	97	99	90	93
Picloram	6	98	99	97	99
LSD (0.05)		NS	NS	25	10

[1] Months after treatment.

[2] Commercial formulation - Curtail by Dow AgroSciences, Indianapolis, IN.

[3] Commercial formulation - Redeem by Dow AgroSciences, Indianapolis, IN.

[4] X-77 = a nonionic surfactant from Loveland Industries, Greeley, CO.

Evaluation of new herbicides in newly planted blackberries. Diane Kaufman and Judy Kowalski. (North Willamette Research and Extension Center, Oregon State University, Aurora, OR 97002) A study was established in newly planted 'Marion' blackberry to evaluate the quality of weed control and effect on plant growth with selected herbicides. 'Marion' blackberry plants transplanted the previous fall into 1gallon size pots were planted in a Quatama silt loam soil with 4% organic matter at the North Willamette Research and Extension Center (NWREC) on June 25, 2003. Herbicides were applied over the top of the plants on July 1, 2003 and irrigated in the same day with 1 inch of water. Plots were 10 feet wide and 30 feet long (5 plants per plot) arranged in a randomized complete block design with four replications. Herbicides were applied using a CO_2 pressurized backpack sprayer with a 3-nozzle boom (TeeJet 8002, flat fan) set at 40 psi and a rate of 20 gallons of water per acre.

Plant growth was evaluated August 4 and 19, 2003, with final growth measurements recorded September 29, 2003. Quality of weed control was evaluated August 4, 18, and September 30, 2003.

Table 1. Treatments and herbicide rates.

Treatment	Rate
	(lb ai/A)
Metolachlor	1.25
Isoxaben + dimethenamid-P	0.75 + 0.35
Dimethenamid-P	0.75
Pendimethalin	3.00
Simazine	1.33
Sulfentrazone	0.225
Oryzalin	2.00 and 4.00
Thiazopyr	0.50

Plant growth was rated based on a scale of 2 to 4 with 2 = growth below normal compared to standard of oryzalin at 2 lb ai/A; 3 = growth similar to standard; 4 = growth above standard.

Table 2. Marion blackberry growth response to herbicides.

Treatment	August 4, 2003	August 19, 2004
Metolachlor	4.00	3.88
Isoxaben + dimethenamid-P	3.75	3.25
Dimethenamid-P	3.50	3.38
Pendimethalin	3.25	2.75
Simazine	3.00	3.00
Sulfentrazone	3.00	2.88[1]
Oryzalin 4 lb ai	3.50	3.50
Thiazopyr	3.00	2.88
LSD (0.05)	0.65	0.69

[1] Growth rate evaluations complicated by the fact that plots became overrun with crabgrass.

There were no signs of phytotoxicity to young 'Marion' blackberry plants from any treatment. Plants treated with metolachlor, isoxaben + dimethenamid-P, dimethenamid-P, or oryzalin grew most vigorously.

Canes were counted and total cane growth measured September 29, 2003.

Table 3. Cane number and total cane length of 'Marion' blackberry plants at the end of the growing season.

Treatment	Total number of canes/plot	Total cane growth/plot (feet)
Metolachlor	14.50	86.27
Isoxaben + dimethenamid-P	12.25	77.10
Dimethenamid-P	15.75	91.31
Pendimethalin	12.25	62.23
Simazine	14.75	81.56
Sulfentrazone	13.25	66.23
Oryzalin 4 lb ai	11.00	62.08
Thiazopyr	10.25	54.98
LSD (0.05)	3.39	23.87
Oryzalin 2 lb ai[1]	14.75	78.13

[1] Oryzalin at the standard 2 lb ai/A rate was applied to plants in rows next to treatment rows and was, therefore, not within the experimental design.

Plots treated with dimethenamid-P, metolachlor, and simazine had more canes than plots treated with thiazopyr or the 4 lb ai rate of oryzalin. Although there is some concern among blackberry growers that simazine applied at planting reduces initial plant growth compared to the standard practice of oryzalin applied at 2 lb ai, plots treated with simazine and oryzalin at 2 lb ai had the same number of canes per plot and similar cane growth. Plots treated with dimethenamid-P had more total cane growth than plots treated with pendimethalin, sulfentrazone, thiazopyr, or oryzalin at the 4 lb ai rate.

Table 4. Quality of weed control, expressed as percent control compared to weedy control areas between plots, August 4 and 19, 2003.

Treatment	Broadleaf weeds 8/4/03[1] (33 DAT)	Grass weeds 8/4/03	Overall weed control 8/19/03 (47 DAT)
Metolachlor	99.50	93.25	91.50
Isoxaben+ dimethenamid-P	100	92.25	96.25
Dimethenamid-P	93.75	83.75	65.00
Pendimethalin	98.75	100	98.50
Simazine	100	67.50	81.25
Sulfentrazone	100	30.00	5.00
Oryzalin 4 lb ai	100	98.25	97.75
Thiazopyr	98.00	99.50	96.75
LSD (0.05)	NS	14.64	13.25

[1] Primary weeds – 8/4/03:redroot pigweed, black nightshade, annual sowthistle, common groundsel, large crabgrass, barnyardgrass. 8/19/03: annual sowthistle, common groundsel, white clover, large crabgrass. Level of weed pressure on both dates: high.

All herbicides provided excellent (90-100%) control of broadleaf weeds on August 4, 2003. Grass weed control was also excellent with metolachlor, isoxaben + dimethenamid-P, pendimethalin, oryzalin, and thiazopyr. Dimethenamid provided good (80-89%) control of barnyardgrass and fair (70-79%) control of crabgrass. Crabgrass control was marginal with simazine and poor to non-existent with sulfentrazone. Metolachlor, isoxaben + dimethenamid-P, pendimethalin, oryzalin, and thiazopyr continued to provide excellent overall weed control through August. Simazine provided good overall weed control through August, however control of crabgrass and annual sowthistle was fair. Weed control in plots treated with dimethenamid-P alone was marginal by August 19 due to poor control of crabgrass, annual sowthistle, and clover. Plots treated with sulfentrazone were completely overrun with crabgrass.

The final weed evaluation was conducted on 9/30/03. By this time annual bluegrass was becoming the predominant grass.

Table 5. Quality of weed control, expressed as percent control compared to weedy control areas between plots, and primary weeds* coming through each herbicide, September 30, 2003 (90 DAT).

Treatment	Overall weed control	Crabgrass	Annual bluegrass	Annual sowthistle	Common groundsel	Common mallow	Ladys thumb	Hawks beard	Pigweed
Metolachlor	67.5	***	**	***	****	*		*	
Isox+dim	80.0	**	***	****	**		*		
Dimethenamid	27.0	***	**	****	*		*		*
Pendimethalin	78.0	*			***	*			
Simazine	70.0	****	***	***	*				*
Sulfentrazone	50.0	****	*						
Oryzalin	58.8	**	*	****	***	*			*
Thiazopyr	79.2			**		*		*	
LSD (0.05)	31.0								

* Weed occurrence: * = 1 of 4 reps; **= 2 of 4 reps; *** = 3 of 4 reps; **** = 4 of 4 reps. Weed pressure: high.

By the end of September, quality of weed control had been reduced among all treatments due to severe weed pressure, particularly in the last replication. In some cases (pendimethalin, metolachlor, thiazopyr) overall weed control on September 30 was good to excellent in the first three replications. However, severe weed pressure in the last replication tended to skew averages. The mixture of isoxaben + dimethenamid-P continued to provide good overall weed control (80-89%), however control of annual bluegrass and annual sowthistle was poor. Pendimethalin, thiazopyr, and simazine provided fair (70-79%) weed control. Weed control in the metolachlor plots was marginal due to poor control of large crabgrass, annual sowthistle, and common groundsel. Oryzalin at 4 lb ai/A was providing poor control of annual sowthistle and common groundsel. Plots treated with sulfentrazone were overrun by grasses. Eventhough dimethenamid-P is primarily a grass herbicide, it was providing poor control of large crabgrass and annual bluegrass, in addition to annual sowthistle and common groundsel.

All canes were removed in early October, 2003 and experimental fall herbicides were applied over the plants on October 6, 2003. Cane growth and quality of weed control will once again be monitored next year.

Evaluation of post-transplant oxyfluorfen applications in broccoli and cauliflower. Steven A. Fennimore and Jose A. Valdez. (Weed Science Program, University of California-Davis, Salinas, CA 93905) A field evaluation was conducted to evaluate oxyfluorfen 2E and 4F formulations as post-transplant over-the-top treatments in transplanted broccoli and cauliflower. The trial was conducted near Salinas, CA in a sandy loam soil, with 1.9% organic matter and pH 7.1. Pre-transplant herbicide applications of DCPA at 7.5 lb/A and bensulide at 6.0 lb/A were made on June 23, 2003 and incorporated with sprinkler irrigation. Cauliflower (cv. Apex) and broccoli (cv. Marathon) were transplanted on June 24, 2003. Post-transplant herbicide applications of the oxyfluorfen 4F formulation were made at 0.0625, 0.125, 0.25, and 0.5 lb ai/A and the oxyfluorfen 2E formulation at 0.0625, 0.125, and 0.25 lb ai/A were made on July 11, 2003. The experiment was a randomized complete block design and treatments were replicated 4 times. The plots were one 80-inch bed wide by 20 ft. long. On each 80-inch bed, little mallow (seeded), cauliflower, burning nettle (seeded), and broccoli were set in lines at 12 inches apart. Growth stages at the July 11 application were: broccoli 4 to 5 leaves, cauliflower 7 to 9 leaves, nettle 2 leaves, and little mallow cotelydon to 3 leaves. Weed biomass was collected and weighed by species on July 30, 2003. Crop injury ratings (0 = no injury, 10 = dead) were taken on July 14, 21, and 31, 2003. Broccoli and cauliflower were harvested and sorted by marketable and non-marketable heads on August 28, September 2, 8, and 12, 2003.

All oxyfluorfen 4F and 2E treatments provided near-complete control of little mallow and burning nettle (Table 1). DCPA provided complete control of burning nettle and good control of little mallow. Bensulide provided complete control of burning nettle, but did not control little mallow. Broccoli was injured by all the oxyfluorfen treatments during the first phytotoxicity rating (3 days after post-plant application) compared to bensulide and DCPA (Table 1). Twenty days after post-plant applications, oxyfluorfen 4F at 0.25 and 0.5 lb/A and oxyfluorfen 2E at 0.125 and 0.25 lb/A still showed some phytotoxicity symptoms on broccoli. Cauliflower was lightly damaged by oxyfluorfen 4F at 0.25 and 0.5 lb/A and oxyfluorfen 2E at 0.125 and 0.25 lb/A at 3 days after the post-transplant applications were made, but by 20 days after application most of the injury had been outgrown except for oxyfluorfen 2E at 0.25 lb/A which had persistent injury. In general the oxyfluorfen 4F formulation was less injurious to both crops than the oxyfluorfen 2E formulation. None of the oxyfluorfen treatments significantly reduced the number of marketable heads or fresh weights of broccoli and cauliflower, compared to the DCPA treatment (Table 2). The results of this study indicate that the lowest doses of oxyfluorfen achieved near complete control of weeds while the higher rates did not reduce the broccoli or cauliflower yields. The oxyfluorfen 4F 0.0625 to 0.125 lb/A and oxyfluorfen 2E 0.0625 lb/A treatments provided a combination of excellent weed control and crop safety.

Table 1. Little mallow and burning nettle fresh weights (lb/A) and visual crop injury evaluations.

Herbicides	Rate	Application timing	Weed fresh weights		Broccoli		Cauliflower	
			Little mallow	Burning nettle	3 DAA [1]	20 DAA	3 DAA	20 DAA
	lb ai/A		----------------lb/A----------------		----------------------(0 = no injury, 10 = dead)----------------------			
Untreated	0.0		1206.1	605.3	0.0	0.0	0.0	0.0
Oxyfluorfen 4F	0.0625	Post-transplant	6.5	0.0	0.6	0.2	1.3	0.3
Oxyfluorfen 4F	0.125	Post-transplant	0.0	0.0	1.3	0.4	1.5	0.4
Oxyfluorfen 4F	0.25	Post-transplant	0.0	0.0	1.6	0.8	2.0	0.9
Oxyfluorfen 4F	0.5	Post-transplant	0.0	0.0	1.6	0.7	2.5	0.9
Oxyfluorfen 2E	0.0625	Post-transplant	0.3	0.1	1.0	0.6	1.1	0.4
Oxyfluorfen 2E	0.125	Post-transplant	0.0	0.0	1.8	1.4	2.4	0.9
Oxyfluorfen 2E	0.25	Post-transplant	0.0	0.0	2.4	2.0	3.3	1.4
DCPA	7.5	Pre-transplant	104.1	0.0	0.0	0.0	0.1	0.0
Bensulide	6.0	Pre-transplant	1258.2	0.0	0.0	0.2	0.0	0.1
LSD (0.05)			449.4	233.1	0.8	0.6	0.7	0.4

[1] Days after post-transplant application (DAA)

Table 2. Broccoli and cauliflower marketable yield by number of heads (1000/A) and weight (1000 lb/A).

Herbicides	Rate	Application timing	Broccoli marketable yield		Cauliflower marketable yield	
			No. heads	Weight	No. heads	Weight
	lb ai/A		1000/A	1000 lb/A	1000/A	1000 lb/A
Untreated	0.0		31.7	24.2	32.4	47.9
Oxyfluorfen 4F	0.0625	Post-transplant	33.3	30.4	33.3	53.0
Oxyfluorfen 4F	0.125	Post-transplant	35.7	28.8	28.8	41.7
Oxyfluorfen 4F	0.25	Post-transplant	30.7	27.0	33.3	45.0
Oxyfluorfen 4F	0.5	Post-transplant	33.3	27.7	29.8	41.7
Oxyfluorfen 2E	0.0625	Post-transplant	35.9	27.8	32.4	44.0
Oxyfluorfen 2E	0.125	Post-transplant	33.1	25.3	33.1	44.8
Oxyfluorfen 2E	0.25	Post-transplant	31.8	25.6	30.5	41.8
DCPA	7.5	Pre-transplant	33.7	25.9	35.3	54.1
Bensulide	6.0	Pre-transplant	33.7	26.5	35.9	47.4
LSD (0.05)			3.8	4.4	7.0	12.6

Herbicide combinations for cucumber, pumpkin, and winter squash. Timothy W. Miller, Brian G. Maupin, and Robert K. Peterson. (Washington State University, Mount Vernon, WA 98273) Several herbicides used alone or in combination were tested for crop safety and weed control in curcubit crops. Nine varieties of three cucurbit types (cucumber: 'Calypso' and 'Turbo'; pumpkin: 'Wee-B-Little', 'Small Sugar', and 'Howden'; and winter squash: 'Delicata', 'Early Butternut', 'Hubbard Blue', and 'Table Ace') were planted May 9, 2003 at WSU Mount Vernon. Plots measured 10 by 160 ft and each contained two rows of crop plants. Herbicides were applied across crop rows May 13 (PRE) and June 16 (POST) using a CO_2-pressurized, ATV-mounted sprayer delivering 20 gpa at 20 psi, resulting in split-plots measuring 10 by 10 ft. At the same time as the PRE applications, one row in each plot was treated with supplemental clomazone at 0.25 lb ai/a. Major weed species present in the plots were pale smartweed, ladysthumb, and common lambsquarters. Plots were hand weeded prior to POST applications. Weed control was visually evaluated June 4 and July 11 while crop injury was visually estimated June 4, June 30, and July 11 (0 = no injury or control, 100 = dead plants). Cucurbit fruits were harvested when commercially mature from late July through October 15, at which time fruit number and weight was tallied. The statistical design was a split-split-plot RCB with 3 replicates. Means were separated using Fisher's Protected LSD (P = 0.05). Application data are presented in Table 1, and results in Tables 2 and 3.

Table 1. Herbicide application data.

6:30 a.m., May 13, 2003	7:00 a.m., June 16, 2003
Broadcast, PRE	Broadcast, POST
70% cloud cover	100% cloud cover
Winds 1 to 3 mph, from NW	Winds 1 to 3 mph, from S
Air temp. = 50 F; soil temp (4") = 58 F	Air temp. = 56 F; soil temp (4") = 65 F
Relative humidity = 89%	Relative humidity = 78%
Soil surface was moist	Soil surface was dry, light dew present
No weeds present	Plots hand weeded prior to application

Crop injury was less than 10% for all treatments except clomazone + ethalfluralin, halosulfuron PRE + POST, halosulfuron POST alone, halosulfuron + bentazon POST, or bentazon alone (Table 2). Injury from clomazone + ethalfluralin was due to inadvertent over-application of the two products: ethalfluralin at 2x and clomazone at 6x use rate. Most of the injury from bentazon was on squash and pumpkin (10 to 40%), while cucumber injury from bentazon was 3% or less (data not shown). Halosulfuron POST caused similar injury to all cucurbits (10 to 11%). Using clomazone with the tested herbicide combinations improved weed control by 29% by June 4; improvement was still 2% by July 11 (data not shown). Greater than 90% weed control by July 11 was achieved by clomazone + ethalfluralin (higher rate as noted earlier), halosulfuron alone PRE at 0.75 oz, and by halosulfuron PRE + either dimethenamid-p or s-metolachlor PRE (Table 2). Fruit counts did not vary by herbicide treatment, but fruit weights did (weights ranged from 14 to 25 kg/plot and from 1.9 to 2.8 kg/fruit)(data not shown). Supplemental clomazone (PRE) slightly injured 'Small Sugar' pumpkin (Table 3) early in the season, although injury was still acceptable (injury in both cases was less than 5%); crops showed no difference in injury due to clomazone June 30 or July 11. Fruit number and fruit weight mostly increased with supplemental clomazone in cucumber and pumpkin, while yield response among winter squash varieties was mixed.

Table 2. Crop injury and weed control from several herbicide combinations in cucumber, squash, and pumpkin.

			Crop injury[2]			Weed control[2]	
Treatment	Rate	Timing[1]	June 4[3]	June 30	July 11	June 4[3]	July 11
	lb ai/a		%	%	%	%	%
ethalfluralin	0.75	PRE	0	0	0	89	87
dimethenamid-p	0.2	PRE	0	0	0	78	85
s-metolachlor	0.3	PRE	1	0	1	81	88
halosulfuron	0.063	PRE	0	0	0	80	93
halosulfuron	0.083	PRE	0	1	0	74	88
clomazone + ethalfluralin	1.5 + 1.5[4]	PRE	17	1	1	99	97
halosulfuron + dimethenamid-p	0.042 + 0.25	PRE + PRE	1	0	0	86	92
halosulfuron + s-metolachlor	0.042 + 0.25	PRE + PRE	1	0	0	79	92
halosulfuron	0.042	POST	1	11	0	42	85
bentazon	0.25	POST	1	14	13	41	78
dimethenamid-p	0.2	POST	0	1	0	41	88
s-metolachlor	0.3	POST	0	1	1	39	85
halosulfuron + halosulfuron	0.063 + 0.042	PRE + POST	0	10	1	71	88
halosulfuron + bentazon	0.063 + 0.25	PRE + POST	1	14	9	75	85
halosulfuron + dimethenamid-p	0.042 + 0.25	PRE + POST	1	1	0	78	89
halosulfuron + s-metolachlor	0.042 + 0.25	PRE + POST	0	0	0	66	84
hand weeded	---	---	0	0	0	33	77
$LSD_{0.05}$	---	---	1	1	2	3	2

[1] PRE = preemergence; POST = postemergence.

[2] Analyzed across crop varieties and supplemental clomazone treatments.

[3] Only PRE treatments applied at this evaluation (analyzed across supplemental clomazone treatments).

[4] Products inadvertently applied at rates of 1.5 lb/a each for clomazone + ethalfluralin (6x and 2x the target rate of 0.25 + 0.8 lb ai/a, respectively).

Table 3. Cucurbit injury and fruit production following application of several herbicide combinations[1].

	Crop injury						Harvested fruit			
	With clomazone			Without clomazone			With clomazone		Without clomazone	
Variety	June 4	June 30	July 11	June 4	June 30	July 11	Fruit no.	Fruit wt.	Fruit no.	Fruit wt.
	%	%	%	%	%	%	no./plot	kg/plot	no./plot	kg/plot
Calypso	3	2	0	2	2	1	42.0	3.7	29.5	2.6
Turbo	1	2	2	1	2	1	22.6	3.7	20.3	3.0
Wee-B-Little	1	3	1	1	3	1	33.9	10.6	30.3	9.3
Small Sugar	5	3	0	2	3	0	13.6	22.6	13.3	22.4
Howden	2	3	0	1	3	0	4.7	39.8	5.1	43.2
Delicata	2	3	1	2	3	2	28.9	13.3	30.2	14.3
Early Butternut	1	4	2	1	4	2	13.9	20.5	9.8	15.1
Hubbard Blue	0	5	6	0	5	6	5.4	38.3	5.0	31.2
Table Ace	1	5	2	1	3	1	18.5	17.0	17.4	15.4
Pr > F	0.0382	0.3369	0.8514	0.0382	0.3369	0.8514	0.0011	0.0090	0.0011	0.0090

[1] Analyzed across herbicide treatments.

Weed control in fallow beds prior to lettuce planting. Steven A. Fennimore and Jose A. Valdez. (Weed Science Program, University of California-Davis, Salinas, CA 93905) A study was established to evaluate herbicides for weed control on fallow beds prior to lettuce planting. The study was initiated on Jan. 27, 2003 near Salinas, CA in a sandy loam soil, with 2.1% organic matter and a pH of 7.0. Pre-plant herbicides, flumioxazin at 0.063, 0.094, and 0.188 lb ai/A, oxyfluorfen 4F at 0.25 and 0.5 lb ai/A, oxyflurofen 2E at 0.25 and 0.5 lb ai/A, and carfentrazone at 0.032 lb ai/A were applied to fallow raised beds at 90, 60, and 30 days prior to lettuce planting. After lettuce ('Sharpshooter') was planted by direct seeding on April 30, 2003, pronamide at 1.2 lb ai/A was applied to the entire trial as a preemergence treatment. Pronamide was applied as a 5-inch band over each seed line with 2 seed lines per 40-inch bed. The experiment was a randomized complete block design with 4 replications per treatment. The plots were one 40-inch bed wide by 25 ft. long. The major weeds were burning nettle and shepherd's-purse. Lettuce stand counts were measured 16 days after planting on May 16, 2003. Weed densities were measured on April 16 and May 21, 2003 using a 2.7 ft.^{2} quadrat. Crop injury ratings (0 = no injury, 10 = dead) were taken on May 21, 30 and June 6, and 13, 2003. Marketable heads were harvested and sorted on July 8, 2003.

Flumioxazin at 0.188 lb ai/A applied 90, 60, and 30 days before planting and flumioxazin at 0.094 lbs ai/A applied 60 and 30 days before planting reduced the lettuce stand (Table1). The carfentrazone and oxyfluorfen treatments did not reduce lettuce stand. In visual injury symptoms, flumioxazin at 0.188 lb ai/A damaged the lettuce at all application dates, while flumioxazin at 0.063 and 0.094 lb/A resulted in lettuce injury ratings >2.2 only at the 30-day interval (Table 1). In the first weed density count done prior to planting all the treatments reduced the weed population compared to the untreated check, with the exception of the carfentrazone 90-day treatment (Table 2). In the second weed density count at 3 weeks after planting, all flumioxazin treatments, except 0.094 lb ai/A applied 60 days before planting, reduced the weed population relative to the untreated. None of the carfentrazone or oxyfluorfen treatments provided better weed control than the untreated in the second weed count. Flumioxazin at 0.188 lb/A applied 60 and 30 days prior to planting, were the only treatments that reduced the lettuce yields in number of heads and fresh weights, and the 0.188 lb ai/A 90 day treatment reduced lettuce head number, but not fresh weight (Table 2). The results indicate that the highest rate of flumioxazin at any pre-plant interval would significantly damage and reduce the crop stand count, therefore reducing the yield. The carfentrazone and oxyfluorfen treatments did not reduce yield. The lowest rates of flumioxazin and carfentrazone, and all the oxyfluorfen treatments show promising results and have some potential use as pre-plant fallow bed herbicides for lettuce.

Table 1. Lettuce stand (no. of plants per 25 ft.), and visual crop injury (0-10).

Herbicide	Rate	Timing	Stand count	Lettuce injury			
	lb ai/A		No. of Plants/25 ft.	(0 = no injury, 10 = dead)			
				21 DAP[1]	30 DAP	38 DAP	43 DAP
Flumioxazin	0.063	90 days	143.5 a-e	0.63 e	0.63 d	0.50 ef	0.50 d
Flumioxazin	0.094	90 days	134.5 a-e	1.38 e	1.13 d	0.50 ef	1.00 d
Flumioxazin	0.188	90 days	98.3 ef	3.75 c	2.88 c	3.25 bc	3.00 bc
Oxyfluorfen 4F	0.25	90 days	155.8 a-d	0.63 e	0.50 d	0.38 ef	0.38 d
Oxyfluorfen 4F	0.5	90 days	168.5 ab	0.00 e	0.13 d	0.00 f	0.38 d
Oxyflourfen 2E	0.25	90 days	155.8 a-d	0.75 e	0.50 d	0.50 ef	0.63 d
Oxyflourfen 2E	0.5	90 days	146.5 a-e	0.75 e	0.25 d	0.13 ef	0.13 d
Carfentrazone	0.032	90 days	158.0 a-d	0.25 e	0.75 d	0.88 ef	0.88 d
Flumioxazin	0.063	60 days	121.8 b-e	1.25 e	1.00 d	1.13 ef	0.88 d
Flumioxazin	0.094	60 days	106.3 c-f	2.13 de	1.75 cd	1.50 def	1.13 d
Flumioxazin	0.188	60 days	68.5 f	5.75 b	4.13 b	4.38 b	4.00 b
Oxyfluorfen 4F	0.25	60 days	160.3 abc	0.25 e	0.38 d	0.13 ef	0.00 d
Oxyfluorfen 4F	0.5	60 days	152.0 a-d	0.13 e	0.25 d	0.13 ef	0.25 d
Oxyflourfen 2E	0.25	60 days	163.5 ab	0.13 e	0.25 d	0.13 ef	0.00 d
Oxyflourfen 2E	0.5	60 days	167.0 ab	0.38 e	0.50 d	0.38 ef	0.63 d
Carfentrazone	0.032	60 days	170.3 ab	0.13 e	0.25 d	0.25 ef	0.63 d
Flumioxazin	0.063	30 days	122.0 b-e	2.13 de	1.38 d	2.25 cde	1.88 cd
Flumioxazin	0.094	30 days	104.3 def	3.38 cd	2.75 c	2.75 cd	3.13 bc
Flumioxazin	0.188	30 days	31.0 g	8.00 a	7.00 a	6.25 a	6.13 a
Oxyfluorfen 4F	0.25	30 days	184.8 a	0.63 e	0.25 d	0.25 ef	0.25 d
Oxyfluorfen 4F	0.5	30 days	169.3 ab	0.38 e	0.63 d	0.50 ef	0.13 d
Oxyflourfen 2E	0.25	30 days	171.5 ab	0.50 e	0.38 d	0.63 ef	0.50 d
Oxyflourfen 2E	0.5	30 days	165.5 ab	0.25 e	0.38 d	0.13 ef	0.25 d
Carfentrazone	0.032	30 days	171.8 ab	0.25 e	0.38 d	0.88 ef	0.63 d
Untreated			178.3 ab	0.13 e	0.25 d	0.38 ef	0.25 d
LSD (0.05)			32.8	1.22	1.12	1.21	1.19

[1] Days after planting (DAP)

Table 2. Weed density (no./yd^2) and lettuce yield by no. of heads (1000/A) and fresh weight (1000 lb/A).

Herbicide	Rate	Timing	------------------ Weed densities ------------		----------------------------Yield----------------------	
	lb ai/A		Apr-16-03----(No./yd^2)----	May-21-03	No. of heads (1000/A)	Weight (1000 lb/A)
Flumioxazin	0.063	90 days	0.4 bc	0.7 bcd	29.3 a	63.9 a
Flumioxazin	0.094	90 days	0.8 bc	0.4 cd	27.5 a	66.1 a
Flumioxazin	0.188	90 days	0.0 c	0.0 d	18.1 b	42.6 a
Oxyfluorfen 4F	0.25	90 days	1.3 bc	2.4 a-d	29.6 a	67.3 a
Oxyfluorfen 4F	0.5	90 days	0.4 bc	1.1 a-d	29.6 a	65.0 a
Oxyflourfen 2E	0.25	90 days	0.8 bc	3.4 abc	29.3 a	65.2 a
Oxyflourfen 2E	0.5	90 days	0.3 c	1.9 a-d	30.8 a	70.5 a
Carfentrazone	0.032	90 days	10.8 a	2.4 a-d	31.7 a	68.0 a
Flumioxazin	0.063	60 days	1.1 bc	0.4 cd	27.5 a	62.9 a
Flumioxazin	0.094	60 days	0.3 c	1.3 a-d	27.5 a	61.1 a
Flumioxazin	0.188	60 days	0.8 bc	0.0 d	6.3 c	11.8 b
Oxyfluorfen 4F	0.25	60 days	0.4 bc	3.8 ab	31.9 a	73.7 a
Oxyfluorfen 4F	0.5	60 days	1.1 bc	1.1 a-d	31.1 a	66.8 a
Oxyflourfen 2E	0.25	60 days	0.4 bc	2.4 a-d	31.9 a	70.1 a
Oxyflourfen 2E	0.5	60 days	0.0 c	1.9 a-d	33.2 a	69.6 a
Carfentrazone	0.032	60 days	3.4 bc	4.0 a	30.9 a	73.3 a
Flumioxazin	0.063	30 days	4.2 b	0.3 cd	28.0 a	59.7 a
Flumioxazin	0.094	30 days	1.1 bc	0.7 bcd	26.7 a	57.3 a
Flumioxazin	0.188	30 days	2.8 bc	0.0 d	6.3 c	12.7 b
Oxyfluorfen 4F	0.25	30 days	3.4 bc	2.8 a-d	28.7 a	57.6 a
Oxyfluorfen 4F	0.5	30 days	3.2 bc	2.8 a-d	30.6 a	70.0 a
Oxyflourfen 2E	0.25	30 days	2.8 bc	1.7 a-d	31.9 a	64.9 a
Oxyflourfen 2E	0.5	30 days	0.4 bc	1.1 a-d	30.8 a	61.8 a
Carfentrazone	0.032	30 days	2.1 bc	1.7 a-d	31.4 a	58.0 a
Untreated			9.7 a	4.0 a	28.7 a	60.4 a
LSD (0.05)			2.1	1.8	6.7	17.9

Preemergence and postemergence herbicide combinations for weed control in melons. Kai Umeda. (University of Arizona Cooperative Extension, 4341 E. Broadway Rd., Phoenix, AZ 85040) A small plot field experiment was conducted at the University of Arizona Maricopa Agricultural Center, Maricopa, AZ. Cantaloupe cv. Mission was planted on 28 April 2003 on every other raised and shaped 40-inch bed such that the single seedlines were 80-inches apart. The melons were furrow irrigated with water running in every other furrow as opposed to every furrow to prevent salt buildup in the seedline of the beds. Each plot consisted of one 40-inch bed measuring 50 ft in length. Herbicide treatments were replicated three times in a randomized complete block design. All herbicide applications were made using a backpack CO_2 sprayer equipped with a hand-held boom consisting of two flat fan 8002 nozzles spaced 20-in apart. Treatments were applied in water at 30 gpa at 45 psi. Preemergence herbicide applications were made one day after planting on 29 April. At the time of applications, the weather was clear with a slight wind, the air temperature was 85EF, and the dry soil surface was 88EF. Furrow irrigation was applied immediately after applications and beds were sub-irrigated to wet the soil surface across the bed top to activate the herbicides. The first postemergence (POST1) herbicide applications were made on 20 May when the cantaloupe was at the 2 leaf stage of growth. Junglerice was at the 4 to 6 leaf stage of growth, prostrate pigweed was at the 4 leaf stage and with several branches, Palmer amaranth was 6 to 8 leaf, common lambsquarters ranged from cotyledon to 6 leaf, and purple nutsedge was 4 to 6 leaf. Weather data was not collected at the time of application; however, the high temperature for the day was 86EF. The second postemergence (POST2) herbicide applications were made on 29 May when the cantaloupe was at the 5 leaf stage of growth. The temperature at the time applications was 100EF, clear sky, and there was a very slight breeze. Junglerice was tillering, prostrate pigweed had several branches measuring 2 to 3 inches, Palmer amaranth was 3 inches tall and showed herbicide injury from the previous POST1 application, common lambsquarters was 6 leaf, and purple nutsedge was 6 leaf and also showed injury. All POST herbicide treatments included an adjuvant, Latron CS-7 at 0.25% v/v. Cantaloupe injury and weed control were rated at various intervals after herbicide applications.

Halosulfuron at 0.05 lb ai/A tank-mixed with rimsulfuron at 0.02 lb ai/A applied POST following bensulide on cantaloupes gave very good control of pigweeds, lambsquarters, purple nutsedge, and junglerice. Melon injury was barely acceptable at 15%. The tank-mix POST treatment was similarly effective on the pigweeds, lambsquarters, and nutsedge but grass weed control decreased slightly and melon injury increased when following preemergence herbicide treatments of *s*-metolachlor, dimethenamid-p, or flumioxazin. Single or multiple POST applications of halosulfuron were not effective against pigweeds.

Table. Preemergence and postemergence herbicide combinations for melon weed control.

				Weed control					
Treatment	Rate	Timing	Melon injury	ECHCO	AMABL	AMAPA	AMAAL	CHEAL	CYPRO
	lb ai/A		%	%					
Untreated check			0	0	0	0	0	0	0
Bensulide +	6.0 +	PREE	8	97	82	83	82	95	90
Halosulfuron	0.05	POST1							
Bensulide +	6.0 +	PREE	15	99	97	94	96	96	93
Halosulfuron +	0.05 +	POST1							
Rimsulfuron	0.02	POST1							
s-metolachlor +	0.25 +	PREE	20	92	95	93	95	93	87
Halosulfuron +	0.05 +	POST1							
Rimsulfuron	0.02	POST1							
Dimethenamid-p +	0.25 +	PREE	20	85	95	95	95	93	93
Halosulfuron +	0.05 +	POST1							
Rimsulfuron	0.02	POST1							
Flumioxazin +	0.05 +	PREE	18	78	95	95	95	95	92
Halosulfuron +	0.05 +	POST1							
Rimsulfuron	0.02	POST1							
Halosulfuron +	0.05 +	POST1	13	60	88	85	83	92	93
Halosulfuron +	0.03 +	POST2							
Clethodim	0.188	POST2							
Halosulfuron +	0.05 +	POST1	10	67	85	87	83	95	93
Halosulfuron +	0.05 +	POST2							
Clethodim	0.188	POST2							
LSD (P=0.05)			5.6	7.8	2.2	5.1	4.3	3.5	5.6

PREE applications on 29 Apr 2003, POST1 applications on 20 May, and POST2 applications on 29 May.
Crop injury and weed control rated on 13 Jun at 2 weeks after last applications.
ECHCO = *Echinochloa colona*, AMABL = *Amaranthus blitoides*, AMAPA = *A. palmeri*, AMAAL = *A. albus*, CHEAL = *Chenopodium album*, CYPRO = *Cyperus rotundus*

Potato tolerance and varietal response to preemergence dimethenamid-p, sulfentrazone, and flumioxazin in 2002 at Aberdeen, ID. Pamela J.S. Hutchinson, Brent R. Beutler, and Felix E. Fletcher. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210). The objective of this trial was to evaluate dimethenamid-p, sulfentrazone, and flumioxazin tolerance of six major potato varieties grown in Idaho, 'Russet Burbank', 'Ranger Russet', 'Russet Norkotah', 'Shepody', 'Alturas', and 'Bannock Russet'.

The experimental area was fertilized with 100 lb N, 150 lb P_2O_5, 100 lb K_2O, and 7 lb Zn/A before planting potatoes on May 8, 2002. Potatoes were planted 5 inches deep at 12-inch intervals in rows spaced 36 inches apart in a Declo loam soil with 1.2% organic matter and pH 8.1 at the Aberdeen Research and Extension Center in Aberdeen, Idaho. The experimental design was a split block design with three replications. Main plots were herbicide treatments with a weed-free control and dimethenamid-p rates of 0.64 (1X), or 1.28 (2X) lb/A, sulfentrazone rates of 0.94 (1X), 1.25 (1.3X), or 0.188 (2X) lb/A, and flumioxazin rates of 0.94 (1X), 1.25 (1.3X), or 0.188 (2X) lb/A. Sub-plots were potato varieties. Rate by variety plot size was 12 by 30 feet.

Potatoes were hilled and 0.27 lb/A imidacloprid was applied on May 31, 2002, just prior to potato emergence. Herbicide treatments were applied on June 3, 2002 with a CO_2-pressurized backpack sprayer that delivered 17.5 gpa at 25 psi. There were no potato or weed plants exposed at the time of application. Herbicides were incorporated by sprinkler irrigation with 0.6 inch of water immediately after application. The trial area was maintained weed-free by hand weeding throughout the growing season.

Potatoes were sprinkler irrigated as needed throughout the growing season, and received additional N and P_2O_5 through the irrigation system based on petiole test results. Mancozeb (1.5 lb/A) was applied through the irrigation system July 18, 2002. Potato vines were desiccated with 0.375 lb ai/A diquat September 12, 2002. Tubers were harvested from 25 feet of each of the two center rows in each plot using a single-row mechanical harvester on Oct. 1, 2002, and graded according to USDA standards.

Plant height measurements were taken 2, 4, and 8 weeks after treatment (WAT) from 20 plants total in the two center rows of each plot. Plant height measurements in each treatment were averaged, and when analyzed, the herbicide treatment by variety interaction was significant, so plant height is shown in Table 1 grouped by variety. Russet Burbank plant height was reduced by the 2X rate of sulfentrazone at 4 and 8 WAT, and all flumioxazin treatments 4 WAT. Two or more herbicide treatments reduced Alturas plant height, and one or more treatments reduced Ranger Russet plant height compared to the untreated control all three times plant height measurements were taken. Shepody plant height was affected by sulfentrazone 2 WAT, and by sulfentrazone and flumioxazin 4 WAT, while no plant height reduction compared to the untreated control was observed 8 WAT. Russet Norkotah plant height was only affected 4 WAT, and then, by all herbicide treatments. By 8 WAT, plant death in this early maturing variety was already occurring, and no plant height differences were observed. Bannock Russet plant height was reduced at 4 and 8 WAT only, by all herbicide treatments except 1X dimethenamid-p or sulfentrazone at 4 WAT.

The herbicide treatment by variety interaction was not significant for crop injury or tuber yields. Herbicide treatment and variety were significant for injury. Averaged over varieties, crop injury ranged from 0 to 4% 2 WAT, 0 to 21% 4 WAT, and 0 to 4% 8 WAT (Table 2). All flumioxazin rates and the two highest sulfentrazone rates resulted in greater injury than the untreated controls 2 and 4 WAT, and the two highest sulfentrazone and flumioxazin rates resulted in greater injury than the untreated controls 8 WAT. Averaged over herbicide treatments, injury to varieties ranged from 0 to 2% 2 WAT, and 5 to 10% 4 WAT, and there were no differences between varieties 8 WAT (Table 2). Alturas had the least visual crop injury numerically, and all varieties, except Shepody were injured more than Alturas early, while at 4 WAT, Shepody and Russet Burbank were not injured more than Alturas. Crop injury and plant height reduction during the season did not translate to reduced tuber yields by herbicide treatments compared to the untreated checks (Table 2). As could be expected, there were tuber yield differences between varieties.

Table 1. Potato variety plant height response to dimethenamid-p, sulfentrazone, and flumioxazin applied preemergence in a weed-free study in 2002 at Aberdeen, ID. The herbicide treatment by variety interaction for plant height was significant.

		Russet Burbank			**Ranger Russet**		
		Height					
Treatment	Rate	2 WAT[1]	4 WAT	8 WAT	2 WAT	4 WAT	8 WAT
	lb/A	cm					
Untreated control	-	17	61	63	16	50	56
Dimethenamid-p	0.64	20	60	61	14	47	55
Dimethenamid-p	1.28	19	61	58	14	46	53
Sulfentrazone	0.094	18	58	60	14	45	52
Sulfentrazone	0.125	19	58	60	14	47	54
Sulfentrazone	0.188	17	53	54	16	48	50
Flumioxazin	0.094	18	55	58	13	47	55
Flumioxazin	0.125	17	55	62	14	44	56
Flumioxazin	0.188	17	55	58	12	40	59
LSD (0.05)		2	4	5	2	3	5

		Russet Norkotah			**Shepody**		
		Height					
Treatment	Rate	2 WAT	4 WAT	8 WAT	2 WAT	4 WAT	8 WAT
Untreated control	-	16	56	36	15	52	63
Dimethenamid-p	0.64	17	48	35	15	50	56
Dimethenamid-p	1.28	16	51	39	14	52	56
Sulfentrazone	0.094	16	48	38	13	47	59
Sulfentrazone	0.125	16	51	33	13	47	56
Sulfentrazone	0.188	16	44	33	13	46	55
Flumioxazin	0.094	14	46	37	16	50	58
Flumioxazin	0.125	16	48	33	15	45	58
Flumioxazin	0.188	14	43	33	14	44	56
LSD (0.05)		NS	3	4	2	3	NS

		Bannock Russet			**Alturas**		
		Height					
Treatment	Rate	2 WAT	4 WAT	8 WAT	2 WAT	4 WAT	8 WAT
Untreated control	-	14	54	68	20	61	69
Dimethenamid-p	0.64	16	55	63	18	59	61
Dimethenamid-p	1.28	16	50	63	18	55	63
Sulfentrazone	0.094	16	52	58	15	55	61
Sulfentrazone	0.125	15	49	59	16	56	62
Sulfentrazone	0.188	14	44	52	16	54	58
Flumioxazin	0.094	14	47	61	17	54	63
Flumioxazin	0.125	14	47	57	18	57	60
Flumioxazin	0.188	15	45	56	16	46	63
LSD (0.05)		2	3	5	2	3	5

[1] WAT = weeks after treatment.

Table 2. Potato variety response to dimethenamid-p, sulfentrazone, and flumioxazin applied preemergence in a weed-free study in 2002 at Aberdeen, ID. The herbicide treatment by variety interaction for crop injury and tuber yields was not significant. Herbicide treatment and variety were significant for injury, and variety was significant for tuber yields.

Treatment	Rate	Injury 2 WAT[1]	Injury 4 WAT	Injury 8 WAT
	lb/A		---%---	
Untreated control	-	0	0	0
Dimethenamid-p	0.64	0	0	0
Dimethenamid-p	1.28	0	3	0
Sulfentrazone	0.094	0	3	0
Sulfentrazone	0.125	1	10	1
Sulfentrazone	0.188	4	21	3
Flumioxazin	0.094	1	5	0
Flumioxazin	0.125	2	13	2
Flumioxazin	0.188	4	31	4
LSD (0.05)		1	3	1

Variety	Injury 2 WAT	Injury 4 WAT	Injury 8 WAT	Tuber yield U.S. No.1	Tuber yield Total
		---%---		---cwt/A---	
Russet Burbank	2	8	1	240	422
Ranger Russet	2	10	1	321	386
Russet Norkotah	2	9	1	334	387
Shepody	1	8	1	269	379
Bannock Russet	2	10	1	33	377
Alturas	0	5	1	366	416
LSD (0.05)	1	3	NS	27	25

[1] WAT = weeks after treatment.

Potato desiccation and late-season hairy nightshade control with desiccants. Pamela J.S. Hutchinson, Felix E. Fletcher, and Brent R. Beutler. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210). The objectives of these trials were to determine the effectiveness of several potato desiccants and their combinations with adjuvants (see Table 1) for potato desiccation and late-season hairy nightshade control in a field trial at the Aberdeen Research and Extension Center in Aberdeen, Idaho.

The trial areas were fertilized with 70 lb N, based on soil tests, before planting. 'Russet Burbank' potato were planted 5 inches deep at 12-inch intervals in rows spaced 36 inches apart on April 30, 2002. The soil was a Declo loam soil with 1.5% organic matter and pH 7.9. Experimental design was a randomized complete block with three replications. Potato vine desiccation plot size was 12 by 30 feet, and hairy nightshade control plots were 6 by 12 feet.

In the potato vine desiccation trial, potatoes were hilled and 0.27 lb/A imidacloprid was applied on May 20, 2002, just prior to potato emergence. The trial area was treated with a postemergence application of metribuzin to limit weed population. Desiccant treatments were applied August 27, and September 3, 2002 with a tractor-mounted CO_2-pressurized sprayer that delivered 30 gpa at 25 psi. Potato vines and leaves were visually rated for desiccation one week after the first application, just prior to the second application, and again one week after the second application. Potatoes were sprinkler irrigated as needed throughout the growing season and received additional N and P_2O_5, based on petiole test results, through the irrigation system. Mancozeb (1.5 lb/A) was applied through the irrigation system July 18, 2002.

A second trial was initiated with selected treatments from the potato vine desiccation study applied to adjacent plots consisting of a heavy stand of hairy nightshade (SOLSA). Application was made September 13, 2002 with a CO_2-pressurized backpack sprayer that delivered 30 gpa at 30 psi. Plots were visually rated for SOLSA control one and two weeks after treatment (WAT) and a SOLSA plant biomass and berry collection from two 0.25 m^2 quadrants per plot was conducted one month after treatment (MAT). Berries were separated from plants and counted, and plants were dried and weighed. Further tests for seed germination will be performed winter 2003.

Leaf death was occurring in the untreated check plots 1 WAT (17%), and by 2 WAT, 30% death had occurred, while vine death in the untreated plots was only evident 2 WAT (27%) (Table 1). At one week after the 1st application, diquat at 0.5 lb/A, paraquat, CT-311 sulfuric acid (100%), commercial grade sulfuric acid, glufosinate alone, glufosinate combined with AMS Plus (ammonium sulfate), and glufosinate combined with AMS Plus and carfentrazone at 0.00083 lb/A were providing $\geq$90% leaf desiccation. Only the CT-311 sulfuric acid and the glufosinate combined with the AMS Plus and carfentrazone treatments resulted in >90% vine desiccation 1 WAT. CT-311 sulfuric acid (30%), endothall, or single applications of carfentrazone at 0.0375, or 0.05 lb/A resulted in less leaf desiccation than the other treatments 1 WAT. At two weeks after the 1st application/one week after the 2nd application, glufosinate alone resulted in 82 and 87% leaf and vine desiccation, respectively, while all other treatments except the single applications of CT-311 sulfuric acid (30%) or endothall, and the sequential applications of carfentrazone at 0.05 lb/A provided >90% leaf and vine desiccation. Glufosinate alone resulted in less leaf and vine desiccation at both ratings than glufosinate combined with AMS plus and carfentrazone.

SOLSA control in the second trial was 95% at 1 WAT with diquat at 0.5 lb/A, commercial grade sulfuric acid, or glufosinate plus AMS Plus, and control with these treatments was greater than with all other treatments except paraquat or glufosinate alone (92%) (Table 2). All treatments except CT-311 sulfuric acid and endothall resulted in $\geq$93% SOLSA control 2 WAT. Glufosinate combined with AMS Plus reduced SOLSA biomass compared to paraquat, CT-311 sulfuric acid, commercial grade sulfuric acid, endothall, and carfentrazone plus endothall (0.05 plus 0.5 lb/A). Berry number/m^2 was not significantly different between treatments including the untreated check, although there was a trend towards berry number reduction for most desiccant treatments.

Table 1. Potato leaf and vine desiccation 8 and 15 days after treatment at Aberdeen, ID.

			Potato desiccation			
			Leaf		Vine	
Treatment	Rate	Timing[1]	9/3[2]	9/10	9/3	9/10
	lb/A		%			
Untreated control	-	-	17	30	0	27
Diquat[3]	0.375	A	88	95	87	92
Diquat[3]	0.5	A	90	94	88	92
Diquat[3]	0.25+	A	82	95	77	98
+diquat	0.25	B				
Paraquat[3]	0.47	A	92	96	88	97
Sulfuric Acid (CT-311)[4]	30%	A	70	88	68	87
Sulfuric Acid (CT-311)[4]	100%	A	93	99	90	97
Sulfuric Acid	100%	A	95	99	88	96
Glufosinate	0.375	A	93	99	82	87
Glufosinate	0.375+	A	93	99	88	93
+AMS Plus	1% v/v					
Glufosinate	0.375+	A	95	99	92	99
+carfentrazone	0.0083+					
+AMS Plus	1% v/v					
Endothal[5]	0.5	A	27	80	30	78
Carfentrazone[5]	0.05	A	82	95	75	87
Carfentrazone[5]	0.0375+	A	77	98	73	92
+carfentrazone	0.0375	B				
Carfentrazone[5]	0.05+	A	80	99	77	93
+carfentrazone	0.05	B				
Carfentrazone[5]	0.075+	A	87	98	85	97
+carfentrazone	0.075	B				
Carfentrazone[6]	0.05+	A	73	87	72	85
+carfentrazone	0.05	B				
Carfentrazone[5]	0.0375+	A	82	99	80	92
+diquat	0.25+					
+carfentrazone	0.0375+	B				
+diquat	0.25					
Carfentrazone[5]	0.05+	A	83	99	82	97
+diquat	0.25+					
+carfentrazone	0.05+	B				
+diquat	0.25					
Carfentrazone[5]	0.0375+	A	85	98	85	98
+endothal	0.5+					
+carfentrazone	0.0375+	B				
+endothal	0.5					
Carfentrazone[5]	0.05+	A	83	98	82	96
+endothal	0.5+					
+carfentrazone	0.05+	B				
+endothal	0.5					
LSD (0.05)	-	-	10	7	10	7

[1] Timing 'A' and 'B' applications were applied August 27 and September 3, 2002, respectively.

[2] 9/3/02 ratings were conducted the same day as Application B

[3] Treatment included non-ionic surfactant at 0.25% v/v.

[4] CT-311 is an experimental formulation of sulfuric acid, property of Cheltec, Inc.

[5] Treatment included methylated seed oil at 1qt/A.

[6] Treatment included Silwet L-77 (organo-silicone surfactant) at 0.125% v/v.

Table 2. Late-season hairy nightshade response to potato vine desiccants at Aberdeen, ID.

		Hairy nightshade response			
		Control		Hairy nightshade	
Treatment	Rate	1WAT[1]	2 WAT	Biomass/m^2	Berries
	lb/A	------------------%------------------		(g dry weight)	number/m^2
Untreated control	-	0	0	339	2059
Diquat[2]	0.375	88	95	321	1386
Diquat[2]	0.5	95	95	300	1872
Paraquat[2]	0.47	92	95	400	2834
Sulfuric Acid (CT-311)[3]	100%	88	88	365	3651
Sulfuric Acid	100%	95	96	354	2149
Glufosinate	0.375	92	96	282	1289
Glufosinate +AMS Plus	0.375+ 1% v/v	95	96	168	1634
Endothal[4]	0.5	3	13	357	1853
Carfentrazone[4]	0.05	83	93	299	2435
Carfentrazone[4] +diquat	0.05+ 0.25+	88	93	264	1841
Carfentrazone[4] +endothal	0.05+ 0.5+	85	95	414	3317
LSD (0.05)	-	5	4	174	ns

[1] Applications made on September 13, 2002. Ratings were conducted 1 and 2 weeks after treatment (WAT).

[2] Treatment included non-ionic surfactant at 0.25% v/v.

[3] CT-311 is an experimental formulation of sulfuric acid, property of Cheltec, Inc.

[4] Treatment included methylated seed oil at 1qt/A.

Weed control and crop response to low rates of metribuzin and sulfentrazone applied postemergence alone or in tank mixtures. Pamela J.S. Hutchinson, Brent R. Beutler, and Felix E. Fletcher. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210). This experiment was designed to evaluate the efficacy and crop safety of low rates of metribuzin and sulfentrazone alone and as tank mix partners applied postemergence (POST). A weedy check and a weed-free control were included in the trial. The trial area was infested with 10 redroot pigweed (AMARE), 5 common lambsquarters (CHEAL), 1 kochia (KCHSC), 5 hairy nightshade (SOLSA), and 10 volunteer oat (AVESA)/m^2.

The experimental area was fertilized with 100 lb N, 150 lb P_2O_5, 100 lb K_2O, and 7 lb Zn/A before planting 'Russet Burbank' potatoes on May 8, 2002. Potatoes were planted 5 inches deep at 12-inch intervals in rows spaced 36 inches apart in a Declo loam soil with 1.2% organic matter and pH 8.1 at the Aberdeen Research and Extension Center, ID. The experimental design was a randomized complete block with three replications. Plot size was 12 by 30 feet.

Potatoes were hilled and 0.27 lb/A imidacloprid was applied on May 31, 2002, just prior to potato emergence. POST herbicide treatments were applied June 26, 2002 with a CO_2-pressurized backpack sprayer that delivered 17.5 gpa at 30 psi. Potato plants were approximately 12 inches high at time of application, and weed sizes were as follows: CHEAL 1 inch, SOLSA 1 inch, AMARE 1 to 3 inches, KCHSC 1 to 2 inches, and AVESA 2 to 3 inches.

Potatoes were sprinkler irrigated as needed throughout the growing season, and received additional N and P_2O_5 based on petiole test results, through the irrigation system. Mancozeb (1.5 lb/A) was applied through the irrigation system July 18, 2002. Potato vines were desiccated with 0.375 lb/A diquat September 12, 2002. Tubers were harvested from 20 feet of each of the two center rows in each plot using a single-row mechanical harvester on Oct. 3, 2002, and graded according to USDA standards.

Crop injury ratings were performed 6 and 17 days after treatments (DAT), and weed control ratings were performed 17 DAT (at row closure). Tank mix combinations of metribuzin and sulfentrazone provided $\geq$90% control of all weeds present in the trial (Table 1). Weed control was improved when sulfentrazone at 0.012 or 0.0235 lb/A was combined with metribuzin at 0.25 or 0.375 lb/A, compared to those rates of sulfentrazone applied alone. Sulfentrazone at 0.047 lb/A resulted in 83 to 85% control of all broadleaf weeds, and control was not different than control by metribuzin alone or any tank mixture treatment.

Crop injury 6 and 17 DAT was 0 to 62%, and 0 to 22%, respectively, and consisted mainly of stunting and some leaf necrosis and malformation (Table 2). Metribuzin alone did not result in any crop injury. At 6 and 17 DAT, sulfentrazone at 0.012 lb/A applied alone caused similar injury to sulfentrazone at 0.012 lb/A plus metribuzin at 0.25 or 0.375 lb/A. While sulfentrazone at 0.0235 lb/A alone (52%) resulted in injury similar to sulfentrazone at 0.0235 lb/A plus metribuzin at 0.25 lb/A 6 DAT (42%), injury caused by sulfentrazone at 0.0235 lb/A alone was less than injury caused by sulfentrazone at 0.0235 lb/A plus metribuzin at the higher rate of 0.375 lb/A (35%). Similarly, injury by sulfentrazone at 0.047 lb/A plus metribuzin at 0.375 lb/A (48%) 6 DAT was less than injury by that rate of sulfentrazone applied alone (62%). At 17 DAT, injury caused by sulfentrazone at 0.0235 or 0.047 lb/A applied alone (12 or 22%) was less compared to those respective rates combined with either 0.25 or 0.375 lb/A metribuzin (3 to 4% and 13 to 17%).

There were no differences between treatments including the weedy and weed-free control for U.S. No. 1 tuber yields (Table 2). Metribuzin at 0.25 lb/A plus sulfentrazone at 0.0235 lb/A, and metribuzin at 0.375 lb/A plus sulfentrazone at 0.012 or 0.047 lb/A were the only treatments with total tuber yields higher than the weedy check. Sulfentrazone alone at 0.0235 or 0.047 lb/A were the only treatments with total tuber yields less than the weed-free control. Less injury with tank mixtures of metribuzin with sulfentrazone at 0.0235 lb/A sulfentrazone compared to that rate of sulfentrazone applied alone, translated to greater total tuber yields with the those tank mixtures compared to that rate of sulfentrazone alone. Similarly, metribuzin at 0.375 lb/A plus sulfentrazone at 0.047 lb/A resulted in greater total tuber yields than that rate of sulfentrazone applied alone.

Table 1. Weed control with low rates of metribuzin and sulfentrazone applied postemergence alone and in tank mixtures at Aberdeen, ID.

		Weed control[1]				
		AMARE	CHEAL	KCHSC	SOLSA	AVESA
Treatment	Rate	7/12	7/12	7/12	7/12	7/12
	lb/A	----	----	%	----	----
Metribuzin	0.25	99	99	99	91	95
Metribuzin	0.375	99	99	99	94	96
Sulfentrazone	0.012	50	37	43	47	0
Sulfentrazone	0.0235	62	58	50	62	0
Sulfentrazone	0.047	85	85	85	83	0
Metribuzin + sulfentrazone	0.25 + 0.012	99	99	99	90	95
Metribuzin + sulfentrazone	0.25 + 0.0235	97	97	97	93	95
Metribuzin + sulfentrazone	0.25 + 0.047	98	98	98	95	96
Metribuzin + sulfentrazone	0.375 + 0.012	99	99	99	94	93
Metribuzin + sulfentrazone	0.375 + 0.0235	97	97	97	95	96
Metribuzin + sulfentrazone	0.375 + 0.047	99	99	99	95	98
LSD (0.05)	-	16	14	19	17	6

[1] AMARE redroot pigweed; CHEAL common lambsquarters; KCHSC kochia; SOLSA hairy nightshade; AVESA tame oat.

Table 2. Potato crop response to low rates of metribuzin and sulfentrazone applied postemergence alone or in tank mixtures at Aberdeen, ID.

		Potato crop response			
		Injury		Yield	
Treatment	Rate	7/2	7/12	U.S. No. 1	Total tuber
	lb/A	--------%	--------	-----cwt/A	-----
Weedy check	-	0	0	306	387
Weed-free control	-	0	0	297	453
Metribuzin	0.25	0	0	317	445
Metribuzin	0.375	0	0	293	425
Sulfentrazone	0.012	27	2	363	442
Sulfentrazone	0.0235	52	12	279	348
Sulfentrazone	0.047	62	22	261	383
Metribuzin + sulfentrazone	0.25 + 0.012	27	0	291	440
Metribuzin + sulfentrazone	0.25 + 0.0235	42	4	344	465
Metribuzin + sulfentrazone	0.25 + 0.047	53	13	295	444
Metribuzin + sulfentrazone	0.375 + 0.012	22	2	366	483
Metribuzin + sulfentrazone	0.375 + 0.0235	35	3	248	418
Metribuzin + sulfentrazone	0.375 + 0.047	48	17	350	481
LSD (0.05)	-	13	4	ns	62

Weed control and crop response to various rates of metribuzin, sulfentrazone, and flufenacet applied preemergence alone or in tank mixtures. Pamela J.S. Hutchinson, Brent R. Beutler, and Felix E. Fletcher. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210). This experiment was designed to evaluate the efficacy of rate ranges of metribuzin, sulfentrazone, and flufenacet alone and as tank mix partners applied preemergence. A weedy check and a weed-free control were included in the trial. The trial area was infested with 20 redroot pigweed (AMARE), 5 common lambsquarters (CHEAL), 40 kochia (KCHSC), 10 hairy nightshade (SOLSA), and 90 volunteer oat (AVESA)/m^2.

The experimental area was fertilized with 100 lb N, 150 lb P_2O_5, 100 lb K_2O, and 7 lb Zn/A before planting 'Russet Burbank' potatoes on May 8, 2002. Potatoes were planted 5 inches deep at 12-inch intervals in rows spaced 36 inches apart in a Declo loam soil with 1.2% organic matter and pH 8.1 at the Aberdeen Research and Extension Center, ID. The experimental design was a randomized complete block with three replications. Plot size was 12 by 30 feet.

Potatoes were hilled and 0.27 lb/A imidacloprid was applied on May 31, 2002, just prior to potato emergence. Herbicide treatments were applied June 4, 2002 with a CO_2-pressurized backpack sprayer that delivered 17.5 gpa at 30 psi. Herbicides were incorporated by 0.60-inch sprinkler irrigation immediately after application. No potato or weed plants were exposed at time of application.

Potatoes were sprinkler irrigated as needed throughout the growing season, and received additional N and P_2O_5, based on petiole test results, through the irrigation system. Mancozeb (1.5 lb/A) was applied through the irrigation system July 18, 2002. Potato vines were desiccated with 0.375 lb/A diquat September 12, 2002. Tubers were harvested from 20 feet of each of the two center rows in each plot using a single-row mechanical harvester on Oct. 3, 2002, and graded according to USDA standards.

Weed control was rated at row closure approximately 5 weeks after treatment. Flufenacet at 0.525 or 0.6 lb/A provided less broadleaf weed control than all other herbicide treatments (Table). Combinations of sulfentrazone at 0.047 lb/A with metribuzin at 0.375 or 0.5 lb/A, or flufenacet at 0.6 lb/A improved control of all weeds compared to sulfentrazone at 0.047 lb/A applied alone, while sulfentrazone at 0.07 or 0.094 lb/A applied alone provided broadleaf weed control similar to either metribuzin rate applied alone, or combinations of any sulfentrazone rate with either metribuzin or flufenacet rate. SOLSA control was <90% with metribuzin at 0.375 or 0.5 lb/A, or sulfentrazone at 0.047 or 0.07 lb/A applied alone, or flufenacet at 0.525 lb/A combined with 0.0235 or 0.047 lb/A sulfentrazone. Sulfentrazone at 0.094 lb/A, and all other tank mixture treatments provided $\geq$90% SOLSA control. Metribuzin or flufenacet alone, and all tank mixture treatments resulted in greater AVESA control than any sulfentrazone rate applied alone. No crop injury was visible during the growing season, and there were no tuber yield differences between treatments including the weedy and weed-free checks.

Table. Weed control and crop response with metribuzin, sulfentrazone, and flufenacet applied preemergence at Aberdeen, ID.

		Weed control[1]					Crop response	
Treatment	Rate	AMARE 7/12	CHEAL 7/12	KCHSC 7/12	SOLSA 7/12	AVESA 7/12	U.S. No. 1	Total tuber
	lb/A	---%					---cwt/A---	
Weedy check		0	0	0	0	0	179	283
Weed-free control		100	100	100	100	100	226	415
Metribuzin	0.375	93	93	98	85	92	242	427
Metribuzin	0.5	98	98	100	85	98	227	408
Sulfentrazone	0.047	77	77	80	75	10	192	337
Sulfentrazone	0.07	88	92	95	87	13	177	300
Sulfentrazone	0.094	98	98	100	92	50	223	344
Metribuzin + sulfentrazone	0.375 + 0.047	97	97	98	93	95	238	415
Metribuzin + sulfentrazone	0.375 + 0.07	97	98	98	90	92	280	434
Metribuzin + sulfentrazone	0.375 + 0.094	100	100	100	97	93	208	379
Metribuzin + sulfentrazone	0.5 + 0.047	100	100	100	95	98	198	403
Metribuzin + sulfentrazone	0.5 + 0.07	100	100	100	93	96	216	421
Metribuzin + sulfentrazone	0.5 + 0.094	100	100	100	99	99	186	387
Flufenacet	0.525	0	0	0	0	91	226	369
Flufenacet	0.6	33	33	33	33	95	234	366
Flufenacet + sulfentrazone	0.525 + 0.0235	90	90	90	87	92	217	384
Flufenacet + sulfentrazone	0.525 + 0.047	88	88	90	86	93	245	393
Flufenacet + sulfentrazone	0.525 + 0.094	100	100	100	95	98	229	421
Flufenacet + sulfentrazone	0.6 + 0.0235	97	100	93	93	98	241	420
Flufenacet + sulfentrazone	0.6 + 0.047	100	100	100	97	96	240	403
Flufenacet + sulfentrazone	0.6 + 0.094	100	100	100	99	97	212	380
LSD (0.05)	-	16	15	16	15	14	ns	ns

[1] AMARE redroot pigweed; CHEAL common lambsquarters; KCHSC kochia; SOLSA hairy nightshade; AVESA tame oat.

Efficacy of standard and new preemergence herbicides: alone, in tank mixtures, and applied preemergence followed by postemergence rimsulfuron. Pamela J.S. Hutchinson, Brent R. Beutler, and Felix E. Fletcher. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210). The objective of this trial was to compare weed control with dimethenamid-p, flumioxazin, sulfentrazone, and their tank mixtures with standard potato herbicides. The Aberdeen Research and Extension trial area was infested with 90 hairy nightshade (SOLSA), 10 common lambsquarters (CHEAL), 60 redroot pigweed (AMARE), 10 volunteer oat (AVESA), and 10 kochia (KCHSC)/m^2.

The experimental area was fertilized with 70 lb N, based on soil tests, before planting 'Russet Burbank' potatoes on April 30, 2002. Potatoes were planted 5 inches deep at 12-inch intervals in rows spaced 36 inches apart in a Declo loam soil with 1.5% organic matter and pH 7.9. The experimental design was a randomized complete block with three replications and 12 by 30 foot plots.

Potatoes were hilled and 0.27 lb/A imidacloprid was applied on May 20, 2002, just prior to potato emergence. Preemergence (PRE) herbicide treatments were applied May 23, 2002 and postemergence (POST) treatments June 21, 2002, with a CO_2-pressurized backpack sprayer that delivered 17.5 gpa at 25 psi. PRE treatments were incorporated by 0.6-inch sprinkler irrigation immediately after application. No potato or weed plants were exposed at time of the PRE application.

Potatoes were sprinkler irrigated as needed throughout the growing season and received additional N and P_2O_5, based on petiole test results, through the irrigation system. Mancozeb (1.5 lb/A) was applied through the irrigation system July 18, 2002. Potato vines were desiccated with 0.375 lb/A diquat September 3, 2002. Tubers were harvested from 20 feet of each of the two center rows in each plot using a single-row mechanical harvester on Sept. 16, 2002, and graded according to USDA standards.

Visual weed control ratings were conducted mid-season July 24, 2002, 8 weeks after the PRE treatments/2 weeks after the POST treatments, and late-season, September 9, 2002. Flufenacet PRE alone provided less control of all broadleaf weeds present compared to all other treatments (Table 1). Combining dimethenamid-p PRE with metribuzin, rimsulfuron, EPTC, flufenacet, pendimethalin, flumioxazin, or sulfentrazone PRE, or dimethenamid-p PRE followed by (fb) rimsulfuron POST, improved mid- and late-season AMARE and CHEAL control, and mid-season KCHSC control compared to dimethenamid-p applied PRE alone. Late-season KCHSC control with dimethenamid-p PRE alone was less than with dimethenamid-p PRE plus metribuzin, flumioxazin, or sulfentrazone, or fb rimsulfuron POST. SOLSA control was improved when dimethenamid-p PRE was combined with all tank mix partners except pendimethalin (mid-and late-season), and EPTC (mid-season), or fb rimsulfuron POST, compared to dimethenamid-p applied PRE alone. Dimethenamid-p alone PRE generally provided greater AMARE or KCHSC control than any tank mix partner applied PRE alone with the exception of rimsulfuron, metribuzin, or sulfentrazone, and greater SOLSA control than any tank mix partner applied alone except rimsulfuron or sulfentrazone. All tank mix partners except EPTC (3 lb/A), s-metolachlor, or flumioxazin provided greater mid-season CHEAL control compared to dimethenamid-p alone, while only metribuzin or sulfentrazone alone resulted in greater late-season CHEAL control than dimethenamid-p alone. Dimethenamid-p PRE plus all tank mix partners except EPTC or sulfentrazone, improved AVESA control compared to dimethenamid-p alone, while dimethenamid-p alone provided greater AVESA control than EPTC (3 lb/A), flumioxazin, or sulfentrazone PRE alone.

Flumioxazin PRE at 0.125 lb/A resulted in greater mid-season KCHSC and SOLSA control than flumioxazin PRE at 0.094 lb/A (Table 1). Combining flumioxazin with all tank mix partners PRE, or applying flumioxazin PRE fb rimsulfuron POST improved control of all weeds present in the trial compared to flumioxazin at 0.094 lb/A PRE applied alone. Sulfentrazone at all rates applied PRE alone provided comparable broadleaf control to sulfentrazone at 0.094 lb/A plus all tank mix partners, while sulfentrazone at 0.094 lb/A alone resulted in less AVESA control than sulfentrazone plus all tank mix partners (Table 1).

No crop injury was observed during the growing season. Tuber yields in herbicide treated plots, except flufenacet or pendimethalin PRE applied alone, were greater than in the weedy check plots (Table 2). All tank mix partners applied alone, except metribuzin or rimsulfuron, resulted in less U.S. No.1 tuber yields than the weed-free, untreated check. Dimethenamid-p plus EPTC or flufenacet; flumioxazin alone or plus metribuzin, EPTC, or pendimethalin; or sulfentrazone at 0.094 lb/A alone or plus metribuzin or EPTC resulted in less U.S. No. 1 tuber yields than the weed-free check. All tank mix partners applied alone except metribuzin or rimsulfuron; dimethenamid-p alone or plus flufenacet; or flumioxazin alone resulted in less total tuber yields than the weed-free check. Dimethenamid-p PRE alone resulted in U.S. No. 1 and total tuber yields comparable to dimethenamid-p PRE plus all tank mix partners, or fb rimsulfuron POST (Table 2). Sulfentrazone alone resulted in U.S. No. 1 and total tuber yields comparable to sulfentrazone PRE plus all tank mix partners, or fb rimsulfuron POST. Flumioxazin alone resulted in less U.S. No. 1 and total tuber yields than flumioxazin PRE fb rimsulfuron POST, or flumioxazin PRE plus all tank mix partners except pendimethalin.

Table 1. Season-long weed control with preemergence applications of dimethenamid-p, flumioxazin, or sulfentrazone alone, preemergence followed by postemergence rimsulfuron, or in preemergence tank mixtures with standard potato herbicides at Aberdeen, ID in 2002.

			Weed control[1]									
		Appl	AMARE		CHEAL		KCHSC		SOLSA		AVESA	
Treatment	Rate	Timing[2]	7/24	9/9	7/24	9/9	7/24	9/9	7/24	9/9	7/24	9/9
	lb/A		%									
Metribuzin + rimsulfuron	0.5 +0.023	PRE PRE	99	99	99	99	90	98	96	99	98	96.3
Metribuzin + rimsulfuron	0.5 +0.023	PRE POST	99	99	99	99	88	99	88	99	96	95
Metribuzin	0.5	PRE	98	96	93	95	99	98	63	47	90	90
Rimsulfuron	0.023	PRE	99	96	88	82	88	78	92	85	88	88
EPTC	3	PRE	82	70	82	80	88	60	87	73	75	80
EPTC	3.9	PRE	85	75	90	85	82	78	98	85	88	83
Flufenacet	0.6	PRE	27	27	33	37	57	53	0	0	95	96
S-metolachlor	1.34	PRE	75	68	82	85	70	60	67	72	88	85
Pendimethalin	1	PRE	53	53	83	83	90	87	20	13	85	85
Dimethenamid-p	0.64	PRE	88	83	78	82	88	85	92	88	88	88
Dimethenamid-p		PRE										
+ metribuzin	0.64 + 0.5	PRE	99	95	99	99	99	99	96	99	96	96
+ rimsulfuron	0.64 + 0.023	PRE	98	95	96	90	96	91	96	97	95	95
+ EPTC	0.64 + 3	PRE	96	95	92	88	96	87	93	96	93	93
+ flufenacet	0.64 + 0.6	PRE	95	93	92	92	93	93	96	98	98	98
+ pendimethalin	0.64 + 1	PRE	96	95	99	99	98	93	93	90	95	95
+ flumioxazin	0.64 + 0.094	PRE	99	99	99	99	99	99	98	99	95	95
+ sulfentrazone	0.64 + 0.094	PRE	99	99	99	99	99	99	98	99	93	93
+ rimsulfuron	0.64 + 0.023	POST	99	99	99	99	99	95	96	99	96	96
Flumioxazin + rimsulfuron	0.078 +0.023	PRE POST	99	98	99	95	96	88	92	98	95	93
Flumioxazin	0.094	PRE	47	47	80	73	75	85	83	78	73	68
Flumioxazin	0.125	PRE	47	43	88	75	92	85	90	83	73	67
Flumioxazin		PRE										
+ metribuzin	0.094 + 0.5	PRE	99	99	99	99	99	99	98	99	95	95
+ rimsulfuron	0.094 + 0.023	PRE	99	99	99	99	99	99	99	99	95	92
+ EPTC	0.094 + 3	PRE	99	99	99	99	99	99	99	99	95	92
+ flufenacet	0.094 + 0.6	PRE	99	99	99	99	99	99	99	99	95	96
+ s-metolachlor	0.094 + 1.34	PRE	99	99	99	99	99	99	99	99	95	93
+ pendimethalin	0.094 + 1	PRE	99	99	99	99	99	99	98	99	90	88
Sulfentrazone	0.063	PRE	98	96	99	99	99	99	99	98	73	73
Sulfentrazone	0.094	PRE	99	99	99	99	99	99	99	99	78	80
Sulfentrazone	0.125	PRE	99	99	99	99	99	99	99	99	80	80
Sulfentrazone		PRE										
+ metribuzin	0.094 + 0.5	PRE	99	99	99	99	99	99	99	99	96	96
+ rimsulfuron	0.094 + 0.023	PRE	99	99	99	99	99	99	99	99	95	93
+ EPTC	0.094 + 3	PRE	99	99	99	99	99	99	99	99	95	93
+ flufenacet	0.094 + 0.6	PRE	98	99	99	99	99	99	99	99	98	98
+ s-metolachlor	0.094 + 1.34	PRE	98	99	99	99	99	99	99	99	90	90
+ pendimethalin	0.094 + 1	PRE	99	96	99	99	99	99	99	99	93	92
+ rimsulfuron	0.094 + 0.023	POST	99	99	99	99	99	99	99	99	95	96
LSD (0.05)	-	-	5	9	4	6	5	9	4	6	7	5

[1] AMARE redroot pigweed; CHEAL common lambsquarters; KCHSC kochia; SOLSA hairy nightshade; AVESA tame oat.

[2] Post-applied treatments included MSO at 1% v/v.

Table 2. Potato crop response to preemergence applications of dimethenamid-p, flumioxazin, or sulfentrazone alone, preemergence followed by postemergence rimsulfuron, or in preemergence tank mixtures with standard potato herbicides at Aberdeen, ID in 2002.

Treatment	Rate	Application timing[1]	U.S. No. 1	Total Tuber
	lb/A		------------cwt/A-----------	
Weedy Check	-	-	74	124
Weed-free Control	-	-	375	475
Metribuzin	0.5	PRE	364	497
+ rimsulfuron	+0.023	PRE		
Metribuzin	0.5	PRE	289	386
+ rimsulfuron	+0.023	POST		
Metribuzin	0.5	PRE	318	452
Rimsulfuron	0.023	PRE	288	421
EPTC	3	PRE	255	334
EPTC	3.9	PRE	279	359
Flufenacet	0.6	PRE	119	175
S-metolachlor	1.34	PRE	223	294
Pendimethalin	1	PRE	93	139
Dimethenamid-p	0.64	PRE	290	373
Dimethenamid-p		PRE		
+ metribuzin	0.64 + 0.5	PRE	301	460
+ rimsulfuron	0.64 + 0.023	PRE	357	481
+ EPTC	0.64 + 3	PRE	268	398
+ flufenacet	0.64 + 0.6	PRE	207	303
+ pendimethalin	0.64 + 1	PRE	364	464
+ flumioxazin	0.64 + 0.094	PRE	304	436
+ sulfentrazone	0.64 + 0.094	PRE	295	456
+ rimsulfuron	0.64 + 0.023	POST	314	455
Flumioxazin	0.078	PRE	366	497
+rimsulfuron	+0.023	POST		
Flumioxazin	0.094	PRE	174	240
Flumioxazin	0.125	PRE	165	223
Flumioxazin		PRE		
+ metribuzin	0.094 + 0.5	PRE	261	415
+ rimsulfuron	0.094 + 0.023	PRE	345	506
+ EPTC	0.094 + 3	PRE	263	475
+ flufenacet	0.094 + 0.6	PRE	328	472
+ s-metolachlor	0.094 + 1.34	PRE	296	446
+ pendimethalin	0.094 + 1	PRE	246	458
Sulfentrazone	0.063	PRE	366	518
Sulfentrazone	0.094	PRE	260	426
Sulfentrazone	0.125	PRE	316	452
Sulfentrazone		PRE		
+ metribuzin	0.094 + 0.5	PRE	255	406
+ rimsulfuron	0.094 + 0.023	PRE	292	480
+ EPTC	0.094 + 3	PRE	242	428
+ flufenacet	0.094 + 0.6	PRE	314	467
+ s-metolachlor	0.094 + 1.34	PRE	331	472
+ pendimethalin	0.094 + 1	PRE	292	444
+ rimsulfuron	0.094 + 0.023	POST	328	502
LSD (0.05)	-	-	87	81

[1] Post-applied treatments included MSO at 1% v/v.

Weed control in potatoes with preemergence herbicides: two- and three-way tank mixtures. Pamela J.S. Hutchinson, Brent R. Beutler, and Felix E. Fletcher. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210). The objective of this trial was to compare standard preemergence two- and three-way tank mixtures including dimethenamid-p, EPTC, ethalfluralin, metribuzin, pendimethalin, rimsulfuron; and s-metolachlor. The trial area was infested with 50 redroot pigweed (AMARE), 10 common lambsquarters (CHEAL), 10 kochia (KCHSC), 30 hairy nightshade (SOLSA), 15 green foxtail (SETVI), and 15 volunteer oat (AVESA)/m^2.

The experimental area was fertilized with 70 lb N, based on soil tests, before planting. 'Russet Burbank' potatoes were planted 5 inches deep at 12-inch intervals in rows spaced 36 inches apart on April 30, 2002 in a Declo loam soil with 1.5% organic matter and pH 7.9. The experimental design was a randomized complete block with three replications. Plot size was 12 by 30 feet.

Potatoes were hilled, and 0.27 lb/A imidacloprid was applied on May 20, 2002. Herbicide treatments were applied after hilling and just prior to potato emergence on May 24, 2002, with a CO_2-pressurized backpack sprayer that delivered 17.5 gpa at 25 psi. Herbicides were incorporated by 0.60-inch sprinkler irrigation immediately after application. No potato or weed plants were exposed at time of application.

Potatoes were sprinkler irrigated as needed throughout the growing season, and received additional N and P_2O_5, based on petiole test results through the irrigation system. Mancozeb (1.5 lb/A) was applied through the irrigation system July 18, 2002. Potato vines were desiccated with 0.375 lb/A diquat September 3, 2002. Tubers were harvested from 20 feet of each of the two center rows in each plot using a single-row mechanical harvester on Sept. 16, 2002 and graded according to USDA standards.

Weed control ratings were performed periodically during the growing season. Late-season ratings were conducted on September 9, 2002 and are shown in Table 1. Arcsine transformed weed control data were used for ANOVA and LSD calculations, and non-transformed data are shown in the table. All three-way tank mixtures provided >90% AMARE and CHEAL control except pendimethalin combined with s-metolachlor plus EPTC. In general, the two- and three-way tank mixtures including EPTC, except ethalfluralin or pendimethalin combined with metribuzin plus EPTC, resulted in less AMARE control than the other treatments. All two-way combinations including EPTC, except EPTC plus metribuzin resulted in less CHEAL control than all three-way tank mixtures, except pendimethalin combined with s-metolachlor plus EPTC. S-metolachlor plus rimsulfuron, and any two-way combination including metribuzin controlled CHEAL greater than any other two-way tank mixture.

All treatments except s-metolachlor plus rimsulfuron or EPTC, or rimsulfuron plus EPTC, provided ≥90% KCHSC control (Table 1). All two- and three-way tank mixtures including metribuzin, except EPTC combined with rimsulfuron plus metribuzin, resulted in greater KCHSC control than other treatments not including metribuzin. All three-way tank mixtures, except pendimethalin combined with s-metolachlor plus EPTC resulted in >90% SOLSA control. Pendimethalin combined with s-metolachlor, pendimethalin combined with metribuzin, and all two-way tank mixtures including EPTC, except rimsulfuron plus EPTC resulted in less SOLSA control than all other treatments. SETVI and AVESA control by all treatments was >90%.

No crop injury was observed during the growing season. Total tuber yields in all herbicide treated plots, except ethalfluralin plus EPTC, and U.S. No. 1 tuber yields in all herbicide treated plots, except ethalfluralin plus EPTC, or pendimethalin combined with s-metolachlor plus EPTC, were greater than tuber yields in the weedy check plots (Table 2). EPTC combined with ethalfluralin, or EPTC combined with pendimethalin plus s-metolachlor resulted in less U.S. No. 1 tuber yields than the weed-free control. EPTC combined with pendimethalin, s-metolachlor, or ethalfluralin, or pendimethalin plus s-metolachlor resulted in reduced total tuber yields compared to the weed-free control. The two-way tank mixtures including metribuzin resulted in reduced tuber yields compared to two-way tank mixtures including EPTC (except metribuzin plus EPTC). Similarly, the two-way tank mixtures including rimsulfuron resulted in greater total tuber yields than two-way tank mixtures including EPTC, except s-metolachlor plus EPTC.

Table 1. Season-long weed control with preemergence two- and three-way tank mixtures in 2002 at Aberdeen, ID.

		Weed control[1]					
		AMARE	CHEAL	KCHSC	SOLSA	SETVI	AVESA
Treatment	Rate	9/9	9/9	9/9	9/9	9/9	9/9
	lb/A	%					
Metribuzin							
+ rimsulfuron	0.5 + 0.023	96 abc[2]	96 ab	98 ab	96 bc	93 bc	98 a
+ pendimethalin	0.5 + 1	98 ab	98 ab	98 ab	72 e	99 a	99 a
+ s-metolachlor	0.5 + 1.34	92 de	95 bc	98 ab	82 d	95 b	95 b
+ ethalfluralin	0.5 + 0.94	98 ab	98 ab	98 ab	93 c	93 bc	98 a
+ EPTC	0.5 + 3	92 de	95 bc	98 ab	87 d	90 c	95 b
Rimsulfuron							
+ pendimethalin	0.023 + 1	96 abc	88 de	92 cd	93 c	92 bc	92 bc
+ s-metolachlor	0.023 + 1.34	98 ab	96 ab	85 ef	93 c	92 bc	92 bc
+ ethalfluralin	0.023 + 0.94	77 gh	72 f	90 de	93 c	90 c	92 bc
+ EPTC	0.023 + 3	95 bcd	72 f	70 g	93 c	93 bc	93 bc
EPTC							
+ pendimethalin	3 + 1	72 h	83 e	92 cd	73 e	90 c	90 c
+ s-metolachlor	3 + 1.34	82 fg	75 f	83 f	83 d	90 c	90 c
+ ethalfluralin	3 + 0.94	80 fg	83 e	90 de	82 d	90 c	90 c
Metribuzin + Rimsulfuron							
+ pendimethalin	0.5 + 0.023 + 0.75	99 a	99 a	99 a	98 ab	99 a	99 a
+ s-metolachlor	0.5 + 0.023 + 1	99 a	98 ab	98 ab	99 a	98 a	98 a
+ ethalfluralin	0.5 + 0.023 + 0.94	99 a	99 a	99 a	98 ab	99 a	99 a
+ EPTC	0.5 + 0.023 + 3	92 de	92 cd	90 de	93 c	93 bc	92 bc
Metribuzin + EPTC							
+ pendimethalin	0.5 + 3 + 0.75	98 ab	99 a	99 a	93 c	98 a	98 a
+ s-metolachlor	0.5 + 3 + 1	93 cd	99 a	99 a	93 c	99 a	99 a
+ ethalfluralin	0.5 + 3 + 0.94	99 a	98 ab	98 ab	96 bc	95 b	95 b
Pendimethalin+ S-metolachlor							
+ metribuzin	0.75 + 1 + 0.5	99 a	98 ab	98 ab	93 c	98 a	98 a
+ rimsulfuron	0.75 + 1 + 0.023	98 ab	98 ab	95 bc	96 bc	95 b	95 b
+ EPTC	0.75 + 1 + 3	87 ef	87 de	95 bc	85 d	90 c	90 c
Pendimethalin+ Dimethenamid-p							
+metribuzin	0.75 + 0.64 + 0.5	99 a	99 a	99 a	99 a	99 a	99 a
+EPTC	0.75 + 0.64 + 3	92 de	98 ab	92 cd	98 ab	95 b	95 b

[1] AMARE redroot pigweed; CHEAL common lambsquarters; KCHSC kochia; SOLSA hairy nightshade; SETVI green foxtail; AVESA tame oat.

[2] Means within a column followed by the same letter were not significantly different at the 5% level according to LSD tests performed on arcsine-transformed data.

Table 2. Potato crop response to preemergence two- and three-way tank mixtures in 2002 at Aberdeen, ID.

Treatment	Rate	U.S. No. 1	Total Tuber
	lb/A	-------------cwt/A------------	
Weedy check	-	130	194
Weed-free control	-	304	418
Metribuzin			
+ rimsulfuron	0.5 + 0.023	292	425
+ pendimethalin	0.5 + 1	306	420
+ s-metolachlor	0.5 + 1.34	339	448
+ ethalfluralin	0.5 + 0.94	313	429
+ EPTC	0.5 + 3	306	417
Rimsulfuron			
+ pendimethalin	0.023 + 1	279	393
+ s-metolachlor	0.023 + 1.34	290	409
+ ethalfluralin	0.023 + 0.94	255	396
+ EPTC	0.023 + 3	316	396
EPTC			
+ pendimethalin	3 + 1	219	309
+ s-metolachlor	3+ 1.34	240	333
+ ethalfluralin	3 + 0.94	204	260
Metribuzin + Rimsulfuron			
+ pendimethalin	0.5 + 0.023 + 0.75	305	411
+ s-metolachlor	0.5 + 0.023 + 1	302	450
+ ethalfluralin	0.5 + 0.023 + 0.94	286	433
+ EPTC	0.5 + 0.023 + 3	307	431
Metribuzin + EPTC			
+ pendimethalin	0.5 + 3 + 0.75	292	441
+ s-metolachlor	0.5 + 3 + 1	329	437
+ ethalfluralin	0.5 + 3 + 0.94	347	467
Pendimethalin + S-metolachlor			
+ metribuzin	0.75 + 1 + 0.5	300	435
+ rimsulfuron	0.75 + 1 + 0.023	288	426
+ EPTC	0.75 + 1 + 3	206	301
Pendimethalin + Dimethenamid-p			
+metribuzin	0.75 + 0.64 + 0.5	342	462
+EPTC	0.75 + 0.64 + 3	282	353
LSD (0.05)	-	85	74

Weed control in potatoes with standard and developmental preemergence herbicides at three Idaho locations in 2002. Pamela J.S. Hutchinson, Brent R. Beutler, Felix E. Fletcher, Don W. Morishita, and W. Mack Thompson, and Gale W. Harding. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210; Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303; Parma Research and Extension Center, University of Idaho, Parma, ID 83660; and Madison County Extension Office, Rexburg, ID 83441). The objective of this trial was to evaluate weed control with preemergence applications of sulfentrazone, flumioxazin, or dimethenamid-p applied in two-way tank mixtures with standard herbicides compared to rimsulfuron plus metribuzin, and standard three-way tank mixtures in trials located near Kimberly, Parma, and Rexburg, ID.

'Russet Burbank' potatoes were hilled just prior to emergence at all locations and herbicides were applied preemergence. Treatments were sprinkler or mechanically incorporated immediately after application. Applications were made June 5, 2002 in Rexburg, May 11, 2002 in Parma, and May 30, 2002 in Kimberly. Redroot pigweed (AMARE) and wild oat (AVEFA) were present at Rexburg at populations of 20 and 80/m^2, respectively. Kimberly had infestations of 10 AMARE, 30 common lambsquarters (CHEAL), 20 hairy nightshade (SOLSA), and 20 barnyardgrass (ECHCG)/ m^2. Parma had light infestations of AMARE, kochia (KCHSC), ECHCG, common mallow (MALNE), and common purslane (POROL). Yield data were not collected at any location.

Weed control ratings were conducted just prior to row closure at all locations, approximately 4 to 6 weeks after application. With a few exceptions, all weed present at Kimberly and Parma at a lighter density than at Rexburg, were controlled $\geq$90% by all treatments (Table). AMARE was controlled $\geq$90% with the three-way tank mixtures, sulfentrazone plus pendimethalin, EPTC, or metribuzin, or dimethenamid-p plus metribuzin at Rexburg. AVEFA was controlled $\geq$90% at Rexburg by all treatments with the exception of 88% control with flumioxazin plus s-metolachlor. In general, regardless of location or weed, the two-way tank mixtures of rimsulfuron plus metribuzin, sulfentrazone, flumioxazin, or dimethenamid-p plus metribuzin, pendimethalin, or EPTC, or sulfentrazone or flumioxazin plus s-metolachlor provided comparable weed control to the three-way tank mixtures of pendimethalin or s-metolachlor combined with EPTC plus metribuzin, or pendimethalin combined with EPTC plus dimethenamid-p or rimsulfuron.

Table. Weed control at three Idaho locations with preemergence herbicides and tank-mixtures in 2002.

		Weed control[1]										
		Rexburg		Kimberly				Parma				
Treatment	Rate	AMARE	AVEFA	AMARE	CHEAL	SOLSA	ECHCG	AMARE	KCHSC	ECHCG	MALNE	POROL
	lb/A	%										
Rimsulfuron + metribuzin	0.023+ 0.5	85	92	100	100	93	98	100	100	95	99	100
Pendimethalin + EPTC + metribuzin	0.75+ 3+ 0.5	92	98	100	100	99	100	100	100	100	100	100
S-metolachlor + EPTC + metribuzin	1+ 3+ 0.5	90	93	100	97	100	100	100	100	100	100	100
Pendimethalin + EPTC + dimethenamid-p	0.75+ 3+ 0.64	93	9	98	100	97	100	100	100	100	98	99
Pendimethalin + EPTC + rimsulfuron	0.75+ 3+ 0.023	90	99	100	98	100	100	100	100	99	97	99
Sulfentrazone + pendimethalin	0.094 1	92	98	100	100	98	92	100	100	90	97	98
Flumioxazin + pendimethalin	0.094 1	83	90	100	100	95	93	99	100	90	96	93
Dimethenamid-p + pendimethalin	0.64 1	90	95	100	93	99	100	100	100	99	89	98
Sulfentrazone + s-metolachlor	0.094 1.34	82	93	98	96	98	98	100	100	99	98	100
Flumioxazin + s-metolachlor	0.094 1.34	82	88	100	100	98	100	100	100	96	99	99
Sulfentrazone + EPTC	0.094 3	92	93	97	97	98	98	100	100	95	95	81
Flumioxazin + EPTC	0.094 3	85	96	97	95	95	92	100	99	94	100	100
Dimethenamid-p + EPTC	0.64 3	87	95	98	90	98	98	100	100	100	96	100
Dimethenamid-p + metribuzin	0.64 0.5	92	96	98	98	98	100	100	100	99	100	100
Sulfentrazone + metribuzin	0.094 0.5	94	99	100	100	85	90	100	100	99	100	100
Flumioxazin + metribuzin	0.094 0.5	78	93	-	-	-	-	-	-	-	-	-
LSD(0.05)	-	ns	ns	ns	ns	8	ns	ns	ns	5	4	9

[1] AMARE redroot pigweed; AVEFA wild oat; CHEAL common lambsquarters; SOLSA hairy nightshade; ECHCG barnyardgrass; KCHSC kochia; MALNE common mallow; POROL common purslane.

Evaluation of preemergence herbicides in spinach. Kai Umeda. (University of Arizona Cooperative Extension, 4341 E. Broadway Rd., Phoenix, AZ 85040) A small plot experiment was conducted at the University of Arizona Maricopa Agricultural Center, Maricopa, AZ. Spinach cv. Bejo-2521 was direct seeded on 22 October 2002 in two rows on raised and shaped 40-inch beds. Each plot consisted of two beds measuring 50 ft in length. Herbicide treatments were replicated three times in a randomized complete block design. All preemergence herbicide treatments were made using a backpack CO2 sprayer equipped with a hand-held boom consisting of four flat fan 8004 nozzles spaced 20-inches apart. Treatments were applied in 22 gpa of water at 20 psi. Preemergence herbicides were applied on 22 October and furrow irrigation applied immediately after and the beds were sub-irrigated to wet the soil surface across the bed top to activate the herbicides. At the time of herbicide applications, the temperature was 82EF, partly cloudy, and there was a slight breeze. The soil was dry and the surface temperature was 80EF. At four weeks after the first water date and herbicide applications, spinach stand counts were assessed by counting the number of plants in 3 ft of row in each of the two seedlines on the beds and crop injury was assessed with visual ratings.

Spinach exhibited progressively increased injury and crop stand reduction with increasing rates of *s*-metolachlor and dimethenamid-*p*. At the lowest rate applied, *s*-metolachlor at 0.38 lb ai/A caused minimal injury and slight stand reduction compared to the untreated check. At rates of 0.5 lb ai/A or greater, spinach injury was not acceptable at 27% or greater. Dimethenamid-*p* injured spinach at the lowest rate applied and significant stand reduction was observed at 0.5 lb ai/A or greater.

Table. Preemergence herbicide injury on spinach.

		Spinach	
Treatment	Rate	Injury	Stand reduction
	lb ai/A	%	no. of plants[1]
Untreated check		0	28.0
s-metolachlor	0.38	10	26.3
s-metolachlor	0.5	27	23.8
s-metolachlor	0.75	43	21.5
s-metolachlor	1.0	47	18.2
Dimethenamid-*p*	0.38	25	25.2
Dimethenamid-*p*	0.5	38	18.5
Dimethenamid-*p*	0.75	67	17.5
Dimethenamid-*p*	1.0	78	14.8
LSD (p=0.05)		16.4	6.43

Herbicides applied on 22 October 2002.
Assessments made on 11 November.
[1] No. of plants are average of 3 ft of row of 2 lines per bed.

Evaluation of promising weed control strategies in newly established strawberries. Diane Kaufman, Ed Peachey, and Judy Kowalski. (North Willamette Research and Extension Center, Oregon State University, Aurora, OR 97002). A study was established in newly planted 'Totem' strawberry to evaluate quality of weed control and effect on plant growth with selected chemical herbicides, organic herbicides, and/or cultural practices. 'Totem' strawberry plants were planted on raised beds in a Quatama silt loam soil with 4% organic matter at the North Willamette Research and Extension Center (NWREC) on May 28, 2003. Treatments were applied over the tops of plants on May 30, 2003 and irrigated in the same day with 1 inch of water. Plots 4 rows wide (13.3 feet) by 25 feet long were arranged in a randomized complete block design with four replications. Chemical herbicides were applied using a CO_2 pressurized backpack sprayer with a 4-nozzle boom (TeeJet 8002, flat fan) set at 40 psi and a rate of 20 gallons of spray per acre. In the organically managed plots, high glucosinilate mustard seed meal was applied by hand over the tops of plants on May 30, 2003. Subsequent weed control in these plots was accomplished through a combination of cultivation, hand weeding, and post-emergence applications of vinegar, as needed. The effects of experimental herbicides on strawberry plant growth and quality of weed control were monitored through September, 2003.

Table 1. Treatments and herbicide rates.

Treatment	Rate
	(lb ai/A)
Imazapic	0.062, 0.124 and 0.248
Mesotrione	0.1875[1]
Mesotrione+ pendimethalin	0.1875+1.24
Dimethenamid-P	0.65 and 0.84
Sulfentrazone[2]	0.15
Sulfentrazone + pendimethalin	0.15 +1.24
Hand weeded control	- - - -
Weedy control	- - - -
Mustard seed meal[3]	Broadcast rate: 480 lbs/A

[1] Because of injury from the 0.1875 lb ai rate, Mesotrione was also applied to plants in border rows at 0.094 and 0.047 lb ai/A on June 4, 2003.

[2] Two identical sets of plots were established for sulfentrazone with the intention of dividing these plots into two different cultural practices (runners tucked into the berry row or runners allowed to fill in the area between rows) later in the experiment.

[3] Rows treated with high glucosinilate mustard seed meal were beside experimental plots and, therefore, not within the experimental design.

Evaluations of herbicide phytotoxicity to strawberry plants began on June 4, 2003, five days after treatment (DAT). Phytotoxicity ratings are based on a scale of 0 to 5 with 0 = no observable negative effects and 5 = plants dead.

Table 2. Ratings of phytotoxicity, June 4 (5 DAT) and 18 (20 DAT), 2003.

Treatment	Phytotoxicity rating , June 4	Phytotoxicity rating, June, 18
Imazapic 0.062	1.2	3.9
Imazapic 0.124	1.7	3.9
Imazapic 0.248	0.9	3.7
Mesotrione 0.1875	3.4	5.0
Mesotrione+pendimethalin	4.0	5.0
Dimethenamid-P 0.65	0.2	0
Dimethenamid-P	0.7	0
Sulfentrazone 0.15 (8 plots)	0.6	0
Sulfentrazone+pendimethalin	0.9	0
LSD (0.05)	0.3	0.3
Mustard seed meal	0.1	1.5
Mesotrione 0.094	- - -	3.0
Mesotrione 0.047	- -	2.2

Mesotrione applied at the 0.1875 lb ai rate resulted in severe yellowing and stunting of new plant growth within days of application. All plants treated with this rate of mesotrione were dead by mid-June. Mesotrione applied in early June at reduced rates also caused unacceptable damage. Because imazapic provided excellent weed control without damage when applied to second year strawberries in a previous trial, another objective was to see how early it could be used in a strawberry planting. By June 4, 2003, plants treated with imazapic were slightly stunted with a yellow discoloration on new leaves. By June 18, imazapic-treated plants were severely stunted with yellow leaves and red mid-veins. All imazapic-treated plants were dead by the end of June. Because imazapic performed well in established strawberry plants, we will apply it again during winter dormancy to extra plots previously treated with sulfentrazone + pendimethalin (the industry standard application at planting).

Strawberry plant growth in surviving treatments was measured on July 23, 2003, 55 DAT. There were no differences among treatments in number of leaves per plant (mean 10.85), number of runners per plant (mean 1.82), or plant size (mean 30.60 cm).

Broadleaf weed control was excellent among all treatments during June and July, 2003. However, there was great pressure from barnyardgrass in June, large crabgrass during July through September, and annual bluegrass in late August through September. Plots treated with sulfentrazone alone were completely overrun by barnyardgrass and crabgrass throughout the summer. Quality of weed control was evaluated on August 1 (62 DAT) and 25 (86 DAT), 2003.

Table 3. Annual broadleaf and grass weed control, expressed as percent control compared to weedy check plots.

Treatment	Broadleaf weeds[1] 8/1/03	Broadleaf weeds 8/25/03	Grass weeds [2] 8/1/03	Grass weeds 8/25/03
Dimethenamid-P 0.65 lb ai	93	88.75	96.25	77.50
Dimethenamid-P 0.84 lb ai	96	82.50	93.75	91.25
Sulfentrazone – 1[3]	100	98.25	10.00	55.00
Sulfentrazone - 2	100	99.50	7.50	38.75
Sulfentrazone+ pendimethalin	99	97.75	88.75	95.37
LSD (0.05)	3.92	8.83	9.61	26.57
Mustard seed meal	- - -	88.75	- - -	80.00

[1] Primary broadleaf weeds 8/1 and 8/25/03: redroot pigweed, annual sowthistle, common groundsel, bristly hawksbeard.

[2] Primary grass weeds 8/1: barnyardgrass and crabgrass. 8/25: barnyardgrass, crabgrass, annual bluegrass.

[3] Sulfentrazone plots were divided so that 1 = runners tucked in to row, some hoeing; 2 = runners not managed, no hoeing.

Both rates of dimethenamid-P provided excellent (90 –100%) control of annual weeds through July and good (80-89%) control of broadleaf weeds through August. By August 25, grass weed control was fair (70-79%) at the lower rate of dimethenamid-P and still excellent, though statistically similar, at the higher rate. Although sulfentrazone alone provided excellent control of annual broadleaf weeds through August, it provided no control of barnyardgrass or crabgrass. During the month of August, the eight sulfentrazone plots were divided based on handling of runners. In the four plots where runners were tucked into the strawberry row as they grew (sulfentrazone – 1), some hoeing was also done. In the remaining four plots (sulfentrazone –2), runners were allowed to fill in the space between rows and no hoeing was done. The purpose of this is to evaluate the effect of runners between rows on weed populations and strawberry yield. Although control of grasses with sulfentrazone was poor all season, it was more effective against annual bluegrass than barnyard or crabgrass. The mixture of sulfentrazone + pendimethalin provided excellent to good weed control through August.

The combination of high glucosinilate mustard seed meal and vinegar in plant rows, cultivation between rows, and hand-pulling of weeds provided good weed control in the organically managed plots. To achieve this level of control, plots were cultivated four times (June 20, July 7 and 29, and August 26, 2003); plots were hand-weeded three times (July 10 and 25 and August 6, 2003); and vinegar (acetic acid) was applied as a directed spray to in-row weeds five times (July 8, 14, and 20, and August 5 and 13, 2003). Although the 20% concentration of acetic acid was somewhat more effective than the 5% concentration, both concentrations were effective at burning back small weeds. The vinegar caused a slight burn on the margins of strawberry leaves it contacted, but there was no effect on subsequent growth or unsprayed leaves.

A final weed evaluation was conducted on September 29, 2003.

Table 4. Annual broadleaf and grass weed control, expressed as percent control compared to weedy check plots, 121 DAT.

Treatment	Broadleaf annuals[1]	Grasses[2]	Overall weed control
Dimethenamid-P 0.65	22.50	52.50	45.00
Dimethenamid-P 0.84	22.50	61.25	40.00
Sultfentrazone – 1	90.00	51.25	68.75
Sulfentrazone - 2	95.00	30.00	38.75
Sulfentrazone+pendimethalin	82.50	61.25	62.50
LSD (0.05)	25.53	18.06	NS

[1] Primary broadleaf weeds: annual sowthistle, redroot pigweed, common groundsel. Weed pressure: high.

[2] Primary grass weeds: barnyardgrass, crabgrass, annual bluegrass. Weed pressure: high.

Although the quality of grass weed control was better with dimethenamid-P than the quality of broadleaf weed control, overall weed control with dimethenamid-P was poor in September. Sulfentrazone alone continued to provide excellent control of broadleaf weeds and poor control of grasses. Although the mixture of sulfentrazone + pendimethalin provided good control of broadleaf weeds during September, quality of grass weed control had deteriorated.

All plots were hand hoed on October 1 and 2, 2003 and fall herbicides were applied on October 3, 2003 (except in organically managed plots). With the exception of the eight sulfentrazone plots, all living plots were treated with simazine at 1 lb ai/A (industry standard). Sulfentrazone plots were treated with metolachlor at 1 lb ai/A. Bark mulch was applied to the area between strawberry rows to provide weed control over winter in the organically managed plots. Experimental herbicides will be re-applied during the winter of 2003/2004. Plant growth and quality of weed control will be monitored during spring, 2004 and yield data will be collected in June.

Post-bloom applications for late-season weed control in tulip. Timothy W. Miller and Robert K. Peterson. (Washington State University, Mount Vernon, WA 98273) Tulip bulb production in northwestern Washington is made more difficult by the inability of dormant-season herbicides, usually applied in October or November, to maintain weed control through the July bulb harvest. Postemergence herbicides are not currently available for over-the-top use due to injury potential to bulb foliage. If postemergence products could be applied using a shielded sprayer, however, perhaps weed control could be accomplished in mid-spring with minimal crop injury. 'Negrita' and 'Preludium' tulip bulbs were planted in October, 2002 at WSU Mount Vernon into 3- by 10-ft plots. All plots were treated with either dimethenamid-p or s-metolachlor plus glyphosate December 6, 2002. Nine postemergence herbicides were then applied post-bloom (May 6, 2003) using a CO_2-pressurized, backpack sprayer delivering 21 gpa at 19 psi and equipped with one shielded nozzle (XR8002VS). Herbicides tested were glyphosate, glufosinate, diquat, paraquat, flumioxazin, bentazon, sulfentrazone, chloransulam, and carfentrazone. Glyphosate and glufosinate treatments were not mixed with surfactant, bentazon was applied with crop oil concentrate at 1% (v/v), and all other herbicides were applied with nonionic surfactant at 0.25% (v/v). Flower height and number were measured at full bloom (April 4, 2003 for 'Negrita' and April 14, 2003 for 'Preludium'). Crop injury and weed control were rated May 8, 13, and 27, 2003 (0 = no injury or control, 100 = dead plants; 2, 7 and 21 days after treatment (DAT), respectively). Primary weed species in this trial was shepherd's-purse, pale smartweed, and ladysthumb. Bulbs were harvested in July, then washed, sorted, and weighed. The statistical design for this trial was an RCB with four replicates. Means were separated using Fisher=s Protected LSD (P = 0.05). Application data are presented in Table 1, and results in Tables 2 through 4.

Table 1. Herbicide application data.

12:45 p.m., December 6, 2002	2:00 p.m., May 6, 2003
Broadcast, PRE	Broadcast, POST
40% cloud cover	50% cloud cover
Winds 3 to 4 mph, from N	Winds 4 to 6 mph, from W
Air temp. = 48 F; soil temp (4") = 43 F	Air temp. = 58 F; soil temp (4") = 55 F
Relative humidity = 41%	Relative humidity = 50%
Soil surface was moist	Soil surface was dry, no dew present
No weeds present	Weeds 4 to 6 inches

Preemergence products. Although both s-metolachlor and dimethenamid-p were applied at the same rate of active ingredient, dimethenamid-p was the more active product (Table 2). Weed control from either s-metolachlor or dimethenamid-p + glyphosate was excellent through flowering (85 and 97%, respectively). These preemergence products only caused slight foliar injury to tulip (4 to 6%) and dimethenamid-p also slightly reduced flower height. Treatment with dimethenamid-p resulted in greater total bulb weight and number compared to s-metolachlor treatment, although dimethenamid-p reduced average bulb size significantly. Based on these results, it appears that both these products are good herbicides for use in tulips. A dimethenamid-p rate of 2.48 lb ai/a, however, is probably too high.

Table 2. Weed control, injury, and bulb yield after preemergence winter herbicide applications to tulip plots[1].

		Foliar	Weed	Flower	Flower	Bulb yield		
Treatment	Rate	injury	control[2]	height	Number	Total wt.	Total no.	Avg. wt
	lb ai/a	%	%	cm	no./plot	g/plot	no./plot	g/bulb
s-metolachlor	2.48	4 b	85 b	41.2 a	36 a	1249 b	122 b	10.3 a
dimethenamid-p	2.48	6 a	97 a	38.7 b	35 a	1371 a	170 a	8.1 b

[1]Data averaged across both tulip varieties.

[2]Weed control rated May 8, 2003.

Means followed by the same letter are not significantly different.

Postemergence products. Tulip foliage was severely injured by diquat and paraquat, despite shielding (Table 3). Injury was apparent at 2 DAT and was still excessively high through 21 DAT. No other treatment resulted in significant foliar injury at 21 DAT (0 to 6%). Weed control was equally rapid with diquat and paraquat (99 and 100% control at 2 DAT, respectively). Weed control with carfentrazone, sulfentrazone, and flumioxazin had improved to 80 to 86% by 7 DAT, while other products were slower in their activity. By 21 DAT, all treatments had resulted in total weed control of 85% or greater. All bulb yield parameters were severely reduced by diquat and paraquat treatments (Table 4). Chloransulam also reduced total bulb weight and number, as well as slightly reducing marketable bulb weight and number. Bentazon reduced production of large bulbs. Based on these data, diquat and paraquat caused excessive injury to tulip foliage and reduced bulb yield, necessitating changes in the system or herbicide rates to achieve acceptable crop safety; chloransulam also was probably too injurious to tulip for this type of use.

Table 3. Tulip foliar injury and weed control after directed postemergence applications of various herbicides[1].

		Foliar injury			Weed control[2]		
Treatment	Rate	2 DAT	7 DAT	21 DAT	2 DAT	7 DAT	21 DAT
	lb ai/a	%	%	%	%	%	%
glyphosate	0.5	0 c	0 c	6 c	11 cd	50 e	99 ab
glufosinate	0.5	0 c	2 c	4 c	24 c	68 d	88 abc
diquat	0.5	26 a	39 a	47 a	99 a	98 a	98 ab
paraquat	0.5	21 b	30 b	34 b	100 a	95 ab	100 a
flumioxazin	0.07	3 c	2 c	5 c	64 b	80 c	85 bc
bentazon	0.75	0 c	1 c	0 c	6 d	49 e	94 ab
sulfentrazone	0.25	0 c	1 c	3 c	64 b	83 c	97 ab
chloransulam	0.032	0 c	0 c	3 c	4 d	36 f	96 ab
carfentrazone	0.075	0 c	1 c	3 c	67 b	86 bc	96 ab

[1] Data averaged across both tulip varieties.

[2] Weed control at 2 and 7 DAT from postemergence treatment alone (herbicide burn).

Means followed by the same letter are not significantly different; DAT = days after treatment.

Table 4. Tulip bulb yield after directed postemergence applications of various herbicides[1].

		Total yield (all sizes)			Yield (#7 bulbs)		Yield (#10+ bulbs)	
Treatment	Rate	Weight	Number	Avg. wt.	Weight	Number	Weight	Number
	lb ai/a	g/plot	no./plot	g/bulb	g/plot	no./plot	g/plot	no./plot
glyphosate	0.5	1245 ab	145 a	8.8 a	312 abc	33 abc	722 abc	26 a
glufosinate	0.5	1252 ab	145 a	8.9 a	332 a	35 ab	707 abc	26 a
diquat	0.5	766 c	116 c	6.8 b	249 d	27 d	331 d	15 b
paraquat	0.5	903 c	130 b	7.0 b	276 cd	31 cd	439 d	18 b
flumioxazin	0.07	1307 a	148 a	9.3 a	335 a	37 a	721 abc	27 a
bentazon	0.75	1232 ab	148 a	8.6 a	335 a	36 a	675 bc	26 a
sulfentrazone	0.25	1342 a	154 a	9.0 a	323 ab	34 abc	797 a	29 a
chloransulam	0.032	1116 b	130 b	8.7 a	289 bc	31 bc	656 c	26 a
carfentrazone	0.075	1315 a	151 a	8.9 a	333 a	35 ab	766 ab	28 a
none	---	1286 a	148 a	8.9 a	309 abc	33 abc	768 ab	28 a

[1] Data averaged across both tulip varieties.

Means followed by the same letter are not significantly different.

Broadleaf weed control in spring-seeded alfalfa. Richard N. Arnold, Michael K. O'Neill and Dan Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 14, 2003 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of spring-seeded alfalfa (var. WL 325) and annual broadleaf weeds to postemergence application of imazamox and imazethapyr applied alone or in combination. Soil type was a Wall sandy loam with a pH of 7.8 and an organic matter content of less than 1%. The experimental design was a randomized complete block with three replications. Individual plots were 10 by 30 ft in size. Treatments were applied with a compressed air backpack sprayer calibrated to deliver 30 gal/A at 30 psi. Treatments were applied on June 5 when alfalfa was in the second trifoliolate leaf stage and weeds were small. A crop oil concentrate and 32-0-0 was added at 0.5 and 1.0 percent v/v to the spray mixture. Black nightshade, redroot and prostrate pigweed, and common lambsquarters infestations were heavy and Russian thistle infestations were moderate throughout the experimental area. Plots were evaluated on July 9. Alfalfa was harvested on August 4, using a self-propelled Almaco plot harvester.

Imazamox applied at 0.063 lb ai/A had an injury rating of 13 (data not shown). All treatments except the weedy check gave good to excellent control of prostrate and redroot pigweed, black nightshade, and common lambsquarters. Imazamox applied at 0.032, 0.04 and 0.047 lb ai/A in combination with buctril applied at 0.25 lb ai/A gave excellent control of Russian thistle. The weedy check had significantly higher yields as compared to other treatments. This is possibly attributed to the high weed content when harvested.

Table. Broadleaf weed control in spring-seeded alfalfa.

		Weed control					Alfalfa
Treatments[1]	Rate	AMABL	AMARE	SOLNI	SASKR	CHEAL	yield
	lb ai/A			%			t/A
Imazamox	0.032	97	98	96	88	97	2.3
Imazamox	0.04	98	98	99	91	99	2.3
Imazamox	0.047	100	100	100	92	98	2.2
Imazamox + imazethapyr	0.024+0.024	100	100	96	85	95	2.6
Imazamox + imazethapyr	0.032+0.032	99	100	100	89	96	2.3
Imazamox[2]	0.063	99	100	100	93	98	2.0
Imazamox + bromoxynil	0.032+0.25	100	99	99	99	99	2.1
Imazamox + bromoxynil	0.04+0.25	100	100	100	100	99	2.0
Imazamox + bromoxynil	0.047+0.25	100	100	100	100	100	2.0
Imazamox + clethodim	0.032+0.094	98	99	96	88	98	2.2
Imazamox + clethodim	0.04+0.094	99	100	99	90	98	2.4
Imazamox + clethodim	0.047+0.094	100	99	100	91	97	1.9
Imazethapyr	0.047	100	98	98	84	96	2.5
Imazethapyr	0.063	100	99	99	88	98	2.2
Imazethapyr + clethodim	0.063+0.094	100	100	99	89	98	2.4
Weedy check		0	0	0	0	0	3.5
LSD 0.05							0.3

[1] Treatments were applied with a COC and AMS at 0.5% and 1.0% v/v.

[2] Treatment had an injury rating of 13.

Preplant quizalofop and glyphosate application time affects spring wheat and barley. Joan Campbell and Donn Thill. (Crop and Weed Science Division, University of Idaho, Moscow, Idaho 83844-2339) Glyphosate is the major herbicide used to control volunteer wheat before planting a spring crop, especially in direct seed systems. An alternate herbicide would be required if a glyphosate-resistant crop was planted in a previous season. Crop injury can result when cereal crops are planted before volunteer wheat is completely killed (greenbridge effect). Quizalofop may not kill the plants as rapidly as glyphosate and thus extend the greenbridge. Also, there may be a possibility of wheat or barley injury due to quizalofop residue in the soil. An experiment was established near Moscow, Idaho to determine effects of two application times of preplant quizalofop and glyphosate comparing direct seed with tillage. Winter wheat was direct seeded at 50 lb/A with a Haybuster no-till drill October 2002 to simulate a uniform stand of volunteer wheat. Herbicides were applied with a CO_2 pressurized backpack sprayer delivering 10 gpa at 3 mph and 32 psi (Table 1). Soil pH, organic matter, CEC and texture were 5.2, 2.7%, 20 cmol/kg, and silt loam, respectively. The experimental design was a randomized complete block, split block with main plots arranged as factorial of herbicide and application timing, and sub plots were direct seed or tillage. Experimental units were 10 by 24 ft and treatments were replicated four times. Tillage treatment was two passes with a field cultivator/harrow on May 8, 2003. "Zak" wheat and "Baronesse" barley were planted with a Haybuster no-till drill on May 9, 2003. The entire experiment was treated with glyphosate at 0.5 lb ai/A on May 10, 2003. Wheat and barley injury was evaluated visually throughout the growing season and wheat grain was harvested at maturity.

Table 1. Application weather data and wheat growth stage.

Application date	April 4, 2003 (4 WBP)	May 1, 2003 (1 WBP)
Volunteer wheat growth stage	3 leaf to 1 tiller	8 inch, 2 to 3 tillers
Volunteer wheat dry biomass (g/m^2)	13	66
Air temperature (F)	41	63
Soil temperature (F)	51	48
Relative humidity (%)	64	65
Cloud cover (%)	85	100
Soil moisture	high	high

Barley injury, yield, and test weight were not affected by tillage system and there was no effect of herbicide by application timing by tillage (Table 2). Barley was injured more when herbicides were applied 1 WBP than 4 WBP and barley injury was highest (51%) with glyphosate applied 1 WBP (Table 3). Barley grain yield was best (mean 3644 lb/A) with all the treatments applied 4 WBP, and grain yield was lowest (1903 lb/A) with glyphosate applied 1 WBP. Barley test weight was best (51.0 and 51.1 lb/bu) with quizalofop at 0.068 lb ai/A and glyphosate applied 4 WBP. Barley test weight was lowest (mean 47.7 lb/bu) with glyphosate applied 1 WBP. This may be due to the winter wheat dying faster in the glyphosate treated plots compared to the quizalofop treated plots which results in higher pathogen load to attack the emerging barley seedlings. Volunteer wheat treated with quizalofop 1 WBP would have reached the same stage of death when the barley plants were larger which resulted in less barley injury compared to glyphosate 1WBP.

Wheat grain yield was not affected by any treatments (Table 4). Wheat test weight was higher in the tilled plots (62.0 lb/bu) compared to the direct seed plots (61.5 lb/bu).

Table 2. Spring barley injury, grain yield, and test weight.

Herbicide[1]	Rate	Application	Tillage	Barley injury	Grain yield	Test weight
	lb ai/A	WBP		% stunted	lb/A	lb/bu
Quizalofop	0.034	4	Direct seed	5	3406	50.0
			Tilled	2	3610	49.2
Quizalofop	0.068	4	Direct seed	4	3679	50.8
			Tilled	2	3771	51.1
Glyphosate	0.75	4	Direct seed	0	3754	51.2
			Tilled	--	3641	51.0
Quizalofop	0.034	1	Direct seed	31	2504	49.4
			Tilled	14	2917	49.6
Quizalofop	0.068	1	Direct seed	49	2690	49.6
			Tilled	22	2664	48.8
Glyphosate	0.75	1	Direct seed	54	2046	48.0
			Tilled	49	1761	47.4
			Treatment by application by tillage interaction NS			

[1] Urea ammonium nitrate at 4 qt/A and crop oil concentrate (Moract) at 1% v/v were added to all quizalofop treatments. Ammonium sulfate (Bronc) at 8.5 lb/100 gal was added to glyphosate treatments.

Table 3. Effect of treatment and application timing on barley grain yield and test weight.

Treatment		Application	Barley	Barley grain yield		Test weight	
Herbicide[1]	Rate	timing	injury	Treatment x timing	Application timing mean	Treatment x timing	Application timing mean
	lb ai/A	WBP	%	----------- lb/A -----------		---------- lb/bu ---------	
Quizalofop	0.034	4	4 a	3508 a		49.6 bc	
Quizalofop	0.068	4	3 a	3725 a		51.0 a	
Glyphosate	0.75	4	0 a	3698 a	3644 a	51.1 a	50.6 a
Quizalofop	0.034	1	22 b	2711 b		49.5 c	
Quizalofop	0.068	1	36 c	2677 b		49.2 c	
Glyphosate	0.75	1	51 d	1903 c	2430 b	47.7 d	48.1 b
P > F			<0.01	0.08	<0.01	<0.01	<0.01

[1] Urea ammonium nitrate at 4 qt/A and crop oil concentrate (Moract) at 1% v/v were added to all quizalofop treatments. Ammonium sulfate (Bronc) at 8.5 lb/100 gal was added to glyphosate treatments.

Table 4. Spring wheat injury, grain yield, and test weight.

Treatment				Wheat		
Herbicide[1]	Rate	Application	Tillage	Injury	Grain yield	Test weight
	lb ai/A	WBP		% stunted	lb/A	lb/bu
Quizalofop	0.034	4	Direct seed	0	3348	61.4
			Tilled	0	3604	61.9
Quizalofop	0.068	4	Direct seed	0	4020	61.7
			Tilled	0	3697	62.6
Glyphosate	0.75	4	Direct seed	0	3623	61.6
			Tilled	-	3810	62.0
Quizalofop	0.034	1	Direct seed	0	3144	61.2
			Tilled	0	3395	61.5
Quizalofop	0.068	1	Direct seed	0	2735	61.2
			Tilled	0	3052	62.2
Glyphosate	0.75	1	Direct seed	1	2863	61.8
			Tilled	1	3173	61.5
			Treatment by application by tillage interaction NS			

[1] Urea ammonium nitrate at 4 qt/A and crop oil concentrate (Moract) at 1 %v/v were added to all quizalofop treatments. Ammonium sulfate (Bronc) at 8.5 lb/100 gal was added to glyphosate treatments.

Downy brome control in winter malting barley. Larry H. Bennett, Sandra M. Frost, and Daniel A. Ball. (Columbia Basin Agricultural Research Center, Oregon State University, Pendleton, OR 97801) A study was established in 'Stab 7' fall-seeded malting barley to examine possible herbicide candidates for control of downy brome. Barley was seeded on October 2, 2002. Plots were 9 by 30 ft arranged in a randomized complete block design with four replications. Granular preplant incorporated (PPI) treatments were applied with a 'Gandy' drop spreader. All other treatments were applied with a CO_2-pressurized backpack sprayer calibrated to deliver 16 gpa at 30 psi (Table 1). Barley stand counts were taken on January 3, 2003 by counting the number of plants/meter in two locations per plot. Barley injury and downy brome control were evaluated visually on March 13 and April 11, 2003. Barley was harvested with a small-plot combine on June 27, 2003.

Table 1. Application and soil data.

Location	Pendleton, OR			
Application date	Oct 1, 2002	Oct 2, 2002	Feb 23, 2003	Mar 17, 2003
Application timing	Preplant (PPI)	Preemergence (PRE)	Early post (EPOST)	Late post (LPOST)
Barley growth stage	preplant	preemergence	4-5 leaf	2-4 tiller
Downy brome growth stage	preemergence	preemergence	2-4 leaf	1-3 tiller
Air temperature (F)	59	61	41	42
Relative humidity (%)	52	45	69	70
Wind (mph)	2	3	5	2
Cloud cover (%)	10	0	60	90
Soil temperature at 2 in (F)	68	62	42	39
pH	5.4			
OM (%)	2.2			
Texture	silt loam			

Treatments containing diclofop-methyl caused significant stand reduction and visible crop injury when stand counts and injury ratings were taken. (Table 2). Triallate + trifluralin also caused some crop injury. All other treatments showed little or no crop injury. Downy brome control with flufenacet + metribuzin was excellent (91 to 94%). Dicoflop-methyl + triallate applied preplant incorporated and followed by metribuzin applied early postemergence also gave 90% control of downy brome, however, crop injury was unacceptable with this combination. Barley yields were correlated with crop injury and downy brome control. Plots with good downy brome control and little crop injury had the highest barley yields (103 to 115 bu/A); whereas treatments with little or no crop injury and poor downy brome control had decreased yields (88 to 92 bu/A). The lowest yields were in plots that had substantial crop injury and poor downy brome control combined (57 to 64 bu/A). At the present time, triallate and metribuzin are the only products in this trial currently registered for use in winter barley. Triallate is no longer being produced and will not be available once present stocks are used. Metribuzin is safe to use on barley, but control of downy brome is generally not acceptable. Efforts are being made to get flufenacet registered on barley as crop safety and downy brome control is excellent when this product is mixed with metribuzin. Current research is evaluating flufenacet for downy brome control in barley with and without metribuzin.

Table 2. Crop injury, weed control, and barley yields with various herbicides near Pendleton, Oregon in 2003

Treatment[1]	Rate	Application timing	Barley stand Jan 24, 2003	Barley injury Apr 11, 2003	Downy brome control Apr 11, 2003	Barley yield
	lb ai/A		Plants/meter	---------------%---------------		Bu/A
Diclofop-methyl	1.0	PPI	16	73	48	57
Triallate	1.5	PPI	32	1	38	92
Diclofop-methyl + triallate	1.0 + 1.5	PPI	18	71	68	63
Triallate +trifluralin	1.5 +0.45	PPI	21	29	61	94
Metribuzin	0.187	PRE	32	3	23	88
Metribuzin	0.187	EPOST	32	1	33	99
Triallate/metribuzin	1.5/0.187	PPI/EPOST	27	5	74	103
Diclofop-methyl + triallate / metribuzin	1.0 + 1.5/0.187	PPI + PPI/ EPOST	16	91	90	64
Triallate + trifluralin/ metribuzin	1.5 + 0.45/ 0.187	PPI/ EPOST	24	38	84	103
Metribuzin / metribuzin	0.187/ 0.187	EPOST/ LPOST	33	5	33	115
Flufenacet + metribuzin	0.34 + 0.085	PRE	34	0	94	107
Flufenacet + metribuzin+ metribuzin	0.34 + .085/ 0.187	PRE PRE	34	4	91	103
Flufenacet + metribuzin/ metribuzin	0.34 + .085/ 0.187	PRE EPOST	27	9	91	115
Untreated control			30	0	0	90
LSD (0.05)			6	14	18	15

[1] 90% nonionic surfactant (R-11) at 0.25% v/v was added to the EPOST and LPOST metribuzin treatments.

Evaluation of dimethenamid-P application timing on sugar beets. Robyn C. Walton, Don W. Morishita, and Michael P. Quinn. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to determine the effectiveness of different timings of dimethenamid-P applications. Experimental design was a randomized complete block with four replications. Individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (17.9% sand, 61.8% silt, and 20.3% clay) with a pH of 8.1, 1.6% organic matter, and CEC of 16-meq/100 g soil. HM 2984RZ' sugar beet was planted April 16, 2003, in 22-inch rows at a rate of 57,024 seed/A. Kochia, redroot pigweed, common lambsquarters, annual sowthistle, common mallow, common barnyardgrass, and green foxtail were the major weed species present. Herbicides were broadcast-applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 8001 flat fan nozzles. Additional environmental and application information is given in Table 1. Crop injury and weed control were evaluated visually 46 days after the last herbicide treatment (DALT) on July 15. The two center rows of each plot were harvested mechanically September 29.

Table 1. Environmental conditions at application and weed species densities.

Application date	May 2	May 13	May 21	May 30
Application timing	Cotyledon	7 d later	2-4 lf	6 lf
Air temperature (F)	51	45	71	66
Soil temperature (F)	43	40	64	62
Relative humidity (%)	61	89	22	72
Wind velocity (mph)	4	2	5	5
Cloud cover (%)	100	1	35	90
Weed species (plant/ft^2)				
kochia			17	17
pigweed, redroot			26	64
lambsquarters, common			2	2
sowthistle, annual			16	10
mallow, common			5	6
grasses			8	11

The herbicide treatments caused 19 to 39% injury to the sugar beets 46 DALT but did not differ from each other (Table 2). Kochia (KCHSC) control ranged from 72 to 88%, common lambsquarters (CHEAL) control ranged from 81 to 89 %, annual sowthistle (SONOL) control ranged from 82 to 87%, common mallow (MALNE) control ranged from 77 to 90 %, green foxtail (SETVI) control ranged from 96 to 99%, and barnyardgrass (ECHCG) control ranged from 95 to 99% with no significant difference between the treatments. Redroot pigweed AMARE control ranged from 61 to 89% control. The latest application of dimethenamid-P had the best control and the earliest had the worst control. There were also no significant differences in the root yield or the amount of extractable sugar.

Table 2. Crop injury, weed control, and sugar beet yield response to different timing of applications of dimethenamid-P near Kimberly, Idaho.

Treatment[2]	Rate	Application date	Crop injury	Weed control[1]							Root yield	Extractable sugar
				KCHSC	CHEAL	AMARE	SONOL	MALNE	SETVI	ECHCG		
	lb ai/A		%								ton/A	lb/A
Check	-										5	1105
Efs&dmp&pmp + triflusulfuron + dimethenamid-P	0.25 + 0.0156 + 0.75	5/2	39	88	82	61	82	77	98	95	18	4045
Efs&dmp&pmp + triflusulfuron	0.25 + 0.0156	5/13										
Efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.0156 + 0.094	5/21 & 5/30										
Efs&dmp&pmp + triflusulfuron	0.25 + 0.0156	5/2	20	79	81	75	83	83	96	96	33	7545
Efs&dmp&pmp + triflusulfuron + dimethenamid-P	0.25 + 0.0156 + 0.75	5/13										
Efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.0156 + 0.094	5/21 & 5/30										
Efs&dmp&pmp + triflusulfuron	0.25 + 0.0156	5/2, 5/13 & 5/21	20	72	85	81	87	90	98	99	27	6155
Efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.0156 + 0.094											
Efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.0156 + 0.094	5/30										
Efs&dmp&pmp + triflusulfuron	0.25 + 0.0156	5/2, 5/13 & 5/21	19	75	89	89	87	78	99	99	33	7690
Efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.0156 + 0.094											
Efs&dmp&pmp + triflusulfuron+ clopyralid+ dimethenamid-P	0.25 + 0.0156 + 0.094 + 0.75	5/30										
LSD (0.05)			ns	ns	ns	18	ns	ns	ns	ns	18	4075

[1] Weeds evaluated for control were kochia (KCHSC), common lambsquarters (CHEAL), redroot pigweed (AMARE), annual sowthistle (SONOL), common mallow (MALNE), green foxtail (SETVI), and barnyardgrass (ECHCG).

[2] Efs&dmp&pmp is a commercial formulation of a 1:1:1 mixture of ethofumesate, desmedipham, and phenmedipham.

Increasing herbicide rates for weed control in sugar beet. Robyn C Walton, Don W Morishita, and Michael P. Quinn. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to evaluate the effect of increasing triflusulfuron or ethofumesate & desmedipham & phenmedipham (efs&dmp&pmp) rates for weed control in sugar beet. Experimental design was a randomized complete block with four replications. Individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (17.9% sand, 61.8% silt, and 20.3% clay) with a pH of 8.1, 1.6% organic matter, and CEC of 16-meq/100 g soil. HM 2984RZ' sugar beet was planted April 16, 2003, in 22-inch rows at a rate of 57,024 seed/A. Kochia, redroot pigweed, common lambsquarters, annual sowthistle, barnyardgrass, and green foxtail were the major weed species present. Herbicides were broadcast-applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 8001 flat fan nozzles. Additional environmental and application information is given in Table 1. Crop injury and weed control were evaluated visually 42 days after the last herbicide treatment on July 18. The two center rows of each plot were harvested mechanically September 30.

Table 1. Environmental conditions at application and weed species densities.

Application date	May 2	May 13	May 21	May 31	June 6
Application timing	Pre	Cotyledon	2 lf	6 lf	7 d later
Air temperature (F)	59	58	76	62	73
Soil temperature (F)	44	40	68	60	63
Relative humidity (%)	32	42	17	70	17
Wind velocity (mph)	2	1	5.8	5	2.3
Cloud cover (%)	100	1	75	0	0
Weed species (plants/ft^2)					
kochia			1	1	1
pigweed, redroot			12	9	9
lambsquarters, common			3	1	9
sowthistle, annual			7	32	15
grasses			28	69	70

Crop injury ranged from 0 to 8%, but there were no differences among herbicide treatments (Table 2). Kochia (KCHSC) control ranged from 64 to 95%. Among the treatments that controlled kochia ≥93% were ethofumesate applied preemergence (PRE) followed by efs&dmp&pmp + triflusulfuron + clopyralid + MSO postemergence (POST) with or without dimethenamid-P applied with the third application. Common lambsquarters (CHEAL) control ranged from 64 to 99%. There was a 14 to 24 % increase in control when ethofumesate was included in the POST applications. Redroot pigweed (AMARE) control ranged from 81 to 100 % control with no significant difference among the treatments. Annual sowthistle (SONOL) control ranged from 93 to 100% and although a statistical difference was observed, the difference in control among treatments was not biologically significant. Green foxtail (SETVI) control ranged from 64 to 100%. Efs&dmp&pmp + triflusulfuron + clopyralid + clethodim + In-place had the poorest control (64%). Adding MSO to this same tank mixture increased SETVI control to 90%. Barnyardgrass (ECHCG) control ranged from 95 to 100%. The majority of treatments that included ethofumesate applied PRE had better control. Sugar beet root yield ranged from 13 to 46 ton/A. The untreated check yield was significantly lower than all herbicide treatments. Among the highest yielding treatments was ethofumesate at 1.125 lb ai/A applied PRE followed by micro rate POST applications of efs&dmp&pmp + triflusulfuron + clopyralid + MSO or standard rate applications of the same herbicide combinations.

Table 2. Crop injury, weed control, and sugar beet root yield response to different application rates of triflusulfuron near Kimberly, Idaho.

Treatment[2]	Rate	Application date	Crop injury	Weed control[1]						Root yield
				KCHSC	CHEAL	AMARE	SONOL	SETVI	ECHCG	
	lb ai/A		%							ton/A
Check	-									13
Ethofumesate +	1.125 +	5/2	3	93	99	100	100	99	100	46
efs&dmp&pmp +	0.08 +	5/13								
triflusulfuron +	0.0052 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.163 +	5/21,								
triflusulfuron +	0.0078 +	5/31 &								
clopyralid +	0.0304 +	6/6								
MSO	1.5% v/v									
Ethofumesate +	1.125 +	5/2	1	70	96	98	97	99	98	33
efs&dmp&pmp +	0.08 +	5/13								
triflusulfuron +	0.0078 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.163 +	5/21								
triflusulfuron +	0.0078 +									
clopyralid +	0.0304 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.163 +	5/31 &								
triflusulfuron +	0.0104 +	6/6								
clopyralid +	0.0304 +									
MSO	1.5% v/v									
Ethofumesate +	1.125 +	5/2	0	81	99	100	97	100	100	37
efs&dmp&pmp +	0.08 +	5/13								
triflusulfuron +	0.0078 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.163 +	5/21								
triflusulfuron +	0.0078 +									
clopyralid +	0.0304 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.163 +	5/31								
triflusulfuron +	0.0104 +									
clopyralid +	0.0304 +									
dimethenamid-P +	0.75 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.163 +	6/6								
triflusulfuron +	0.0104 +									
clopyralid +	0.0304 +									
MSO	1.5% v/v									

Table 2. continued

Treatment[2]	Rate	Application date	Crop injury	Weed control[1]						Root yield
				KCHSC	CHEAL	AMARE	SONOL	SETVI	ECHCG	
	lb ai/A		%							ton/A
Efs&dmp&pmp +	0.08 +	5/13	1	86	90	90	99	96	100	37
triflusulfuron +	0.0078 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.163 +	5/21								
triflusulfuron +	0.0078 +									
clopyralid +	0.0304 +									
ethofumesate +	0.0937 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.163 +	5/31								
triflusulfuron +	0.0104 +									
clopyralid +	0.0304 +									
ethofumesate +	0.125 +									
dimethenamid-P +	0.75 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.163 +	6/6								
triflusulfuron +	0.0104 +									
clopyralid +	0.0304 +									
ethofumesate +	0.1875 +									
MSO	1.5% v/v									
Efs&dmp&pmp +	0.08 +	5/13	1	64	74	98	97	98	100	35
triflusulfuron +	0.0078 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.163 +	5/21								
triflusulfuron +	0.0078 +									
clopyralid +	0.0304 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.163 +	5/31								
triflusulfuron +	0.0104 +									
clopyralid +	0.0304 +									
dimethenamid-P +	0.75 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.163 +	6/6								
triflusulfuron +	0.0104 +									
clopyralid +	0.0304 +									
MSO	1.5% v/v									
Ethofumesate +	1.125 +	5/2	5	83	99	100	96	100	100	39
efs&dmp&pmp +	0.3375 +	5/13								
triflusulfuron	0.0234									

Table 2. continued

		Application	Crop	Weed control[1]						Root
Treatment[2]	Rate	date	injury	KCHSC	CHEAL	AMARE	SONOL	SETVI	ECHCG	yield
	lb ai/A		-----------------------------	-----------------------------	-----------------------------	---%---	-----------------------------	-----------------------------	-----------------------------	ton/A
efs&dmp&pmp +	0.5062 +	5/21								
triflusulfuron +	0.0234 +									
clopyralid +	0.0937 +									
dimethenamid-P	0.75									
efs&dmp&pmp +	0.675 +	5/31								
triflusulfuron +	0.0312 +									
clopyralid	0.0937									
Ethofumesate +	1.125 +	5/2	5	84	99	96	97	100	100	34
efs&dmp&pmp +	0.3375 +	5/13								
triflusulfuron +	0.0234 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.5062 +	5/21								
triflusulfuron +	0.0234 +									
clopyralid +	0.0937 +									
dimethenamid-P +	0.75 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.675 +	5/31								
triflusulfuron +	0.0312 +									
clopyralid +	0.0937 +									
MSO	1.5% v/v									
Ethofumesate +	1.125 +	5/2	0	95	99	98	96	100	100	36
efs&dmp&pmp +	0.2531 +	5/13								
triflusulfuron	0.0078									
efs&dmp&pmp +	0.3375 +	5/21								
triflusulfuron +	0.0078 +									
clopyralid +	0.0937 +									
dimethenamid-P	0.75									
efs&dmp&pmp +	0.4218 +	5/31								
triflusulfuron +	0.0078 +									
clopyralid	0.0937									
Ethofumesate +	1.125 +	5/2	8	95	96	100	96	100	100	34
efs&dmp&pmp+	0.3375 +	5/13								
triflusulfuron	0.0078									
efs&dmp&pmp +	0.5062 +	5/21								
triflusulfuron +	0.0078 +									
clopyralid +	0.0937 +									
dimethenamid-P	0.75									
efs&dmp&pmp +	0.675 +	5/31								
triflusulfuron +	0.0078 +									
clopyralid	0.0937									

Table 2. continued

Treatment[2]	Rate	Application date	Crop injury	Weed control[1]						Root yield
				KCHSC	CHEAL	AMARE	SONOL	SETVI	ECHCG	
	lb ai/A		---%							ton/A
Ethofumesate +	1.125 +	5/2	1	81	88	96	96	96	99	37
efs&dmp&pmp +	0.08 +	5/13 &								
triflusulfuron +	0.0052 +	5/21								
clopyralid +	0.0304 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.1125 +	5/31								
triflusulfuron +	0.0052 +									
clopyralid +	0.0304 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.1125 +	6/6								
triflusulfuron +	0.0052 +									
clopyralid +	0.0304 +									
MSO	1.5% v/v									
Ethofumesate +	1.125 +	5/2	3	86	96	99	99	100	100	36
efs&dmp&pmp +	0.08 +	5/13								
triflusulfuron +	0.0052 +									
clopyralid +	0.0304 +									
MSO	1.5% v/v									
efs&dmp&pmp +	0.1631 +	5/21,								
triflusulfuron +	0.0052 +	5/31 &								
clopyralid +	0.0304 +	6/6								
MSO	1.5% v/v									
Efs&dmp&pmp +	0.083 +	5/13,	0	73	65	94	96	64	95	32
triflusulfuron +	0.063 +	5/21,								
clopyralid +	0.0304 +	5/31 &								
clethodim +	0.0312 +	6/6								
In-Place	1.5 fl oz/A									
Efs&dmp&pmp +	0.083 +	5/13,	4	86	64	81	93	90	99	30
triflusulfuron +	0.063 +	5/21,								
clopyralid +	0.0304 +	5/31 &								
clethodim +	0.0312 +	6/6								
In-Place +	1.5 fl oz/A +									
MSO	1.5% v/v									
LSD (0.05)			ns	16[3]	9	ns	3	10	ns	8

[1] Weeds evaluated for control were kochia (KCHSC), common lambsquarters (CHEAL), redroot pigweed (AMARE), annual sowthistle (SONOL), green foxtail (SETVI), and barnyardgrass (ECHCG).

[2] MSO is methylated seed oil. In-Place is a spray deposition aid. Efs&dmp&pmp is a commercial formulation of a 1:1:1 mixture of ethofumesate, desmedipham, and phenmedipham.

[3] LSD value is calculated at a 90% significance level.

Weed control in glyphosate tolerant sugar beet. Michael P. Quinn, Don W. Morishita, and Robyn C. Walton (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho toevaluate glyphosate and glyphosate tank mix combinations for weed control inglyphosate tolerant sugar beet. Experimental design was a randomized complete block with four replications. Individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (17.9% sand, 61.8% silt, and 20.3% clay) with a pH of 8.1, 1.6% organic matter, and CEC of 16-meq/100 g soil. 'HM 2984RZ' sugar beet was planted April 16, 2003, in 22-inch rows at a rate of 57,024 seed/A. Kochia, redroot pigweed, common lambsquarters, annual sowthistle, barnyardgrass, and green foxtail were the major weed species present. Herbicides were applied broadcast with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 8001 flat fan nozzles. Additional environmental and application information is given in Table 1. Crop injury and weed control were evaluated visually 35 days after the last herbicide treatment on July 11. The two center rows of each plot were harvested mechanically September 29.

Table 1. Environmental conditions at application and weed species densities.

Application date	May 2	May 13	May 21	May 30	June 6
Application timing	Cotyledon	7 d later	7 d later	4 lf	7 d later
Air temperature (F)	48	45	71	64	70
Soil temperature (F)	40	40	64	62	62
Relative humidity (%)	64	89	24	77	21
Wind speed (mph)	5	2	5	2	2.4
Cloud cover (%)	80	1	35	85	0
Weed species/ft^2					
kochia			2	2	2
pigweed, redroot			1	1	2
lambsquarters, common			1	1	1
sowthistle, annual			1	1	3

The standard weed control treatment (ethofumesate & desmedipham & phenmedipham + triflusulfuron + clopyralid) injured the crop (9%) more than any of the glyphosate treatments (1 to 3%) (Table 2). All glyphosate treatments controlled kochia 97 to 100%, except those that were tank mixed with pyrazon (82%). Kochia (KCHSC) control with the standard weed control treatment averaged 76%. Common lambsquarters (CHEAL) control was 94% or greater with all glypohosate alone and glyphosate tank mix treatments except glyphosate + ethofumesate and glyphosate + pyrazon. Control of redroot pigweed (AMARE) and annual sowthistle (SONOL) ranged from 98 to 100% and did not differ among herbicide treatments. Sugar beet root yield among herbicide treatments ranged from 33 to 40 ton/A and was not from each other. Extractable sugar yield among herbicide treatments ranged from 9818 to 12187 lb/A and was not different between treatments. All rootand extractable sugar yields among the herbicide treatments were greater than the check.

Table 2. Crop injury, weed control, root yield, and extractable sugars in glyphosate tolerant sugar beet near Kimberly, Idaho.

Treatment[2]	Rate	Application date	Crop injury	Weed control[1]						Root yield	Extractable sugar
				KCHSC	CHEAL	AMARE	SONOL	SETVI	ECHCG		
	lb ai/A		%	%						ton/A	lb/A
Check	-			-	-	-	-	-	-	19	5835
Glyphosate	0.75	5/30	1	100	94	99	99	95	100	32	9818
Glyphosate	0.75	5/30 & 6/6	3	100	98	100	100	100	100	38	11494
Glyphosate	0.75	5/21, 5/30 & 6/6	0	100	100	100	100	97	100	38	11361
Glyphosate + ethofumesate	0.75 1.0	5/30	0	97	86	99	100	100	100	37	11067
Glyphosate + dimethenamid-P	0.75 0.75	5/30	0	100	95	100	100	100	100	39	11804
Glyphosate + dimethenamid-P	0.75 0.98	5/30	0	100	95	100	100	100	100	38	11466
Glyphosate + pyrazon	0.75 3.0	5/30	3	82	81	100	98	99	100	38	11438
Glyphosate+ metolachlor	0.75 1.27	5/30	0	99	96	100	100	100	100	40	12187
Efs&dmp&pmp + triflusulfuron + Efs&dmp&pmp + clopyralid	0.25 0.0156 0.33 0.094	5/2, 5/13, 5/21 & 5/30	9	76	97	100	100	91	93	33	9969
LSD (0.05)			5	11	12	ns	ns	6	11	5	1500

[1] Weeds evaluated for control were kochia (KCHSC), common lambsquarters (CHEAL), redroot pigweed (AMARE), annual sowthistle (SONOL), green foxtail (SETVI), and barnyardgrass (ECHCG).

[2] Efs&dmp&pmp is Progress a commercial formulation of a 1:1:1 mixture of ethofumesate, desmedipham, and phenmedipham.

Comparison of selected herbicides for micro rate weed control in sugar beet. Michael P. Quinn, Don W. Morishita, and Robyn C. Walton (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to assess the effectiveness of micro rates applied at three or four application timings. All of the micro rate treatments included ethofumesate & desmedipham & phenmedipham(efs&dmp&pmp) + triflusulfuron + clopyralid + clethodim + MSO. These herbicides were applied three or four times with and without ethofumesate, dimethenamid-P, or metolachlor. Experimental design was a randomized complete block with four replications. Individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (17.9% sand, 61.8% silt, and 20.3% clay) with a pH of 8.1, 1.6% organic matter, and CEC of 16-meq/100 g soil. HM 2984RZ' sugar beet was planted April 16, 2003, in 22-inch rows at a rate of 57,024 seed/A. Kochia, redroot pigweed, common lambsquarters, annual sowthistle, barnyardgrass, and green foxtail were the major weed species present. Herbicides were broadcast-applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 8001 flat fan nozzles. Additional environmental and application information is given in Table 1. Crop injury and weed control were evaluated visually 56 days after the last herbicide treatment on July 16. The two center rows of each plot were harvested mechanically on September 29.

Table 1. Environmental conditions at application and weed species densities.

Application date	May 2	May 8	May 15	May 21
Application timing	Cotyledon	7 d later	7 d later	7 d later
Air temperature (F)	51	51	53	76
Soil temperature (F)	43	48	50	68
Relative humidity (%)	61	52	80	17
Wind speed (mph)	4	5	5	5.8
Cloud cover (%)	100	100	10	75
Weed species/ft^2				
Kochia				2
pigweed, redroot				29
lambsquarters, common				6
sowthistle, annual				8

Crop injury ranged from 0 to 9%, but did not differ among herbicide treatments (Table 2). There was no difference in kochia (KCHSC), common lambsquarters (CHEAL), redroot pigweed (AMARE) or annual sowthistle (SONOL) control among any of the herbicide treatments. KCHSC control ranged from 50 to 71%, while CHEAL, AMARE,and SONOL control was generally better and ranged from 65 to 81% and 69 to 92%, and 95 to 99%, respectively. SETVI control ranged from 72 to 100%. The micro rate treatments that controlled SETVI and ECHCG best (≥98%) included dimethenamid-P or metolachlor applied with the above-mentioned herbicide combination applied three or four times. Ethofumesate tank mixed with the above-mentioned herbicide combination applied four times also controlled SETVI 97%. There was no difference in weed control or yield between three or four micro rate herbicide applications. Sugar beet root yields ranged from 5 to 42 ton/A. The highest yielding micro-rate treatments included efs&dmp&pmp + triflusulfuron + cloprylid + ethofumesate + MSO applied four times. Significant differences in yield only existed between the check and the herbicide treatments.

Table 2. Crop injury, weed control, and root yield in sugar beets using micro rates of selected herbicides.

Treatment[2]	Rate	Application date	Crop injury	Weed control[1]						Root Yield	Extractable Sugar
				KCHSC	CHEAL	AMARE	SONOL	SETVI	ECHCG		
	lb ai/A			------%					------	ton/A	lb/A
Check	-									5	1231
Efs&dmp&pmp +	0.083	5/15	0	64	66	69	96	59	73	29	6869
triflusulfuron +	0.063	5/2,									
clopyralid +	0.5	5/8 &									
cethodim +	2										
MSO	1.5										
Efs&dmp&pmp +	0.083	5/15 &	3	71	80	69	96	77	76	29	7018
triflusulfuron +	0.063	5/2,									
clopyralid +	0.5	5/8,									
clethodim +	2	5/21									
MSO	1.5										
Efs&dmp&pmp +	0.083	5/2 &	5	58	65	80	95	98	99	35	8354
triflusulfuron +	0.063	5/15									
clopyralid +	0.5										
clethodim +	2										
MSO	1.5										
Efs&dmp&pmp +	0.083	5/8									
triflusulfuron +	0.063										
clopyralid +	0.5										
clethodim +	2										
dimethenamid-P +	0.64										
MSO	1.5										
Efs&dmp&pmp +	0.083	5/2,	8	55	70	85	95	100	100	27	6449
triflusulfuron +	0.063	5/15 &									
clopyralid +	0.5	5/21									
clethodim +	2										
MSO	1.5										
Efs&dmp&pmp +	0.083	5/8									
triflusulfuron +	0.063										
clopyralid +	0.5										
clethodim +	2										
dimethenamid-P +	0.64										
MSO	1.5										
Efs&dmp&pmp +	0.083	5/2 &	4	58	70	81	95	100	100	32	7664
triflusulfuron +	0.063	5/15									
clopyralid +	0.5										
clethodim +	2										
MSO	1.5										
Efs&dmp&pmp +	0.083	5/8									
triflusulfuron +	0.063										
clopyralid +	0.5										
clethodim +	2										
metolachlor +	1.3										
MSO	1.5										

Table 2. Continued.

Treatment[2]	Rate	Application date	Crop injury	Weed control[1] KCHSC	CHEAL	AMARE	SONOL	SETVI	ECHCG	Root Yield	Extractable Sugar
	lb ai/A		%							ton/A	lb/A
Efs&dmp&pmp +	0.083	5/2,	4	50	81	92	95	100	100	31	7277
triflusulfuron +	0.063	5/15 &									
clopyralid +	0.5	5/21									
clethodim +	2										
MSO	1.5										
Efs&dmp&pmp +	0.083	5/8									
triflusulfuron +	0.063										
clopyralid +	0.5										
clethodim +	2										
metolachlor +	1.3										
MSO	1.5										
Efs&dmp&pmp +	0.083	5/2 &	1	63	74	83	99	84	78	30	7112
triflusulfuron +	0.063	5/15									
clopyralid +	0.5										
clethodim +	2										
MSO	1.5										
Efs&dmp&pmp +	0.083	5/8									
triflusulfuron +	0.063										
clopyralid +	0.5										
clethodim +	2										
ethofumesate +	1.0										
MSO	1.5										
Efs&dmp&pmp +	0.083	5/2,	9	54	81	80	95	97	90	42	10034
triflusulfuron +	0.063	5/15 &									
clopyralid +	0.5	5/21									
clethodim +	2										
MSO	1.5										
Efs&dmp&pmp +	0.083	5/8									
triflusulfuron +	0.063										
clopyralid +	0.5										
clethodim +	2										
ethofumesate +	1.0										
MSO	1.5										
Efs&dmp&pmp +	0.083	5/2 &	3	50	65	75	96	72	69	22	5240
triflusulfuron +	0.063	5/15									
clopyralid +	0.5										
Efs&dmp&pmp +	0.083	5/8									
triflusulfuron +	0.063										
clopyralid +	0.5										
clethodim +	2										
LSD (0.05)			ns	ns	ns	ns	ns	ns	18	13	12	2835

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[1] Weeds evaluated for control were kochia (KCHSC), common lambsquarters (CHEAL), redroot pigweed (AMARE), annual sowthistle (SONOL), green foxtail (SETVI), and barnyardgrass (ECHCG).

[2] MSO is methylated seed oil. Efs&dmp&pmp is a commercial formulation of a 1:1:1 mixture of ethofumesate, desmedipham, and phenmedipham.

Comparing ethofumesate, desmedipham, and phenmedipham formulations for weed control in sugar beet. Robyn C. Walton, Don W. Morishita, Michael P. Quinn. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to compare the effectiveness of commercial, and candidate formulations of desmedipham & phenmedipham (dmp&pmp) and ethofumesate & desmedipham & phenmedipham (efs&dmp&pmp) for weed control in sugar beet. Experimental design was a randomized complete block with four replications. Individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (17.9% sand, 61.8% silt, and 20.3% clay) with a pH of 8.1, 1.6% organic matter, and CEC of 16-meq/100 g soil. 'HM 2984RZ' sugar beet was planted April 16, 2003, in 22-inch rows at a rate of 57,024 seed/A. Kochia, redroot pigweed, common lambsquarters, annual sowthistle, barnyardgrass, and green foxtail were the major weed species present. Herbicides were broadcast-applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 8001 flat fan nozzles. Additional environmental and application information is given in Table 1. Crop injury and weed control were evaluated visually 27 days after the last herbicide treatment on July 3. The two center rows of each plot were harvested mechanically September 30.

Table 1. Environmental conditions at application and weed species densities.

Application date	May 8	Many 20	May 30	June 6
Application timing	Cotyledon	2 lf	6 lf	8 lf
Air temperature (F)	48	68	66	74
Soil temperature (F)	44	62	64	64
Relative humidity (%)	42	12	77	21
Wind velocity (mph)	2	2	8	4
Cloud cover (%)	100	10	25	0
Weed species (plants/ft^2)				
kochia		1	1	1
pigweed, redroot		11	6	5
lambsquarters, common		2	5	1
sowthistle, annual		5	8	13
grasses		1	1	1

None of the herbicide treatments injured the sugar beet crop more than 5%(Table 2). Kochia (KCHSC) control ranged from 60 to 95%, with the hand weeded check ranking among the highest. Tank mixing triflusulfuron + clopyralid with efs&dmp&pmp and dmp&pmp increased kochia control by as much as 20% or more. No differences in kochia control were observed between the different formulations. Common lambsquarters (CHEAL) control ranged from 64 to 90%. Dmp&pmp-1 + triflusulfuron + clopyralid + MSO did not control CHEAL as well as the new formulation (AE B038584 01 EC30 A3) or the generic dmp&pmp-2 in the same tank mix combinations (73 vs 88 vs 90%). Redroot pigweed (AMARE) control ranged from 78 to 100% control but there was no significant difference among treatments. Annual sowthistle (SONOL) control ranged from 54 to 100%. All treatments controlled SONOL >80% except AE B049913 EC39 A1 applied alone, efs&dmp&pmp-2 applied alone, and the hand weeded check. Barnyardgrass (ECHCG) control ranged from 70 to 97%. Dmp&pmp-2 and AE B038584 01 EC30 A3 increased ECHCG control when used in a tank mix with triflusulfuron + clopyralid + MSO. Green foxtail (SETVI) control ranged from 64 to 99%. Sugar beet yield ranged from 10 to 34 ton/A and all weed control treatments yielded higher than the untreated check. AE B038584 01 EC30 A3, efs&dmp&pmp-1, and efs&dmp&pmp-2 applied alone were among the lowest yielding herbicide treatments.

Table 2. Crop injury, weed control, and sugar beet root yield response to herbicide formulations of ethofumesate, desmedipham, and phenmedipham near Kimberly, Idaho.

		Application	Crop	Weed control[1]						Root	Extractable
Treatment[2]	Rate	date	injury	KCHSC	CHEAL	AMARE	SONOL	ECHCG	SETVI	yield	sugar
	lb ai/A		%							ton/A	lb/A
Check	-									10	2444
AE B049913 01 EC39 A1	0.25	5/8,	5	63	70	78	54	90	85	28	6875
AE B049913 01 EC39 A1	0.33	5/20,									
AE B049913 01 EC39 A1	0.33	5/30									
Efs&dmp&pmp-1	0.25	5/8,	2	65	75	90	84	81	64	25	6135
Efs&dmp&pmp-1	0.33	5/20 & 5/30									
Efs&dmp&pmp-2	0.25	5/8,	0	60	64	80	71	89	81	25	6035
Efs&dmp&pmp-2	0.33	5/20 & 5/30									
AE B049913 01 EC39 A1 +	0.08 +	5/8,	0	84	71	91	100	90	88	33	7995
triflusulfuron +	0.00384 +										
clopyralid-1 +	0.03 +										
MSO	1.5% v/v										
AE B049913 01 EC39 A1 +	0.16 +	5/20,									
triflusulfuron +	0.00384 +	5/30 & 6/6									
clopyralid-1 +	0.03 +										
MSO	1.5% v/v										
Efs&dmp&pmp-1 +	0.08 +	5/8,	0	84	83	100	100	92	96	32	7770
triflusulfuron +	0.00384 +										
clopyralid-1 +	0.03 +										
MSO	1.5% v/v										
Efs&dmp&pmp-1 +	0.16 +	5/20,									
triflusulfuron +	0.00384 +	5/30 & 6/6									
clopyralid-1 +	0.03 +										
MSO	1.5% v/v										
Efs&dmp&pmp-2 +	0.08 +	5/8,	0	89	79	93	100	91	93	34	8190
triflusulfuron +	0.00384 +										
clopyralid-2 +	0.03 +										
MSO	1.5% v/v										
Efs&dmp&pmp-2 +	0.16 +	5/20,									
triflusulfuron +	0.00384 +	5/30 & 6/6									
clopyralid-2 +	0.03 +										
MSO	1.5% v/v										
AE B038584 01 EC30 A3	0.25	5/8,	3	61	68	80	80	70	72	22	5405
AE B038584 01 EC30 A3	0.33	5/20,									
AE B038584 01 EC30 A3	0.33	5/30									
Dmp&pmp-1	0.25	5/8,	0	66	66	89	88	79	78	30	7240
Dmp&pmp-1	0.33	5/20,									
Dmp&pmp-1	0.33	5/30									
Dmp&pmp-2	0.25	5/8,	3	74	68	90	83	70	82	32	7685
Dmp&pmp-2	0.33	5/20,									
Dmp&pmp-2	0.33	5/30									

Table 2. continued

Treatment[2]	Rate	Application date	Crop injury	Weed control[1] KCHSC	CHEAL	AMARE	SONOL	ECHCG	SETVI	Root yield	Extractable sugar
	lb ai/A		----------	----------	----------	--%--	----------	----------	----------	ton/A	lb/A
AE B038584 01 EC30 A3 +	0.08 +	5/8,	3	85	88	94	100	97	97	33	8020
triflusulfuron +	0.00384 +										
clopyralid-1 +	0.03 +										
MSO	1.5% v/v										
AE B038584 01 EC30 A3 +	0.16 +	5/20,									
triflusulfuron +	0.00384 +	5/30 & 6/6									
clopyralid-1 +	0.03 +										
MSO	1.5% v/v										
Dmp&pmp-1 +	0.079 +	5/8,	0	85	73	84	98	83	97	32	7620
triflusulfuron +	0.00384 +										
clopyralid-1 +	0.03 +										
MSO	1.5% v/v										
Dmp&pmp-1 +	0.158 +	5/20 &									
triflusulfuron +	0.00384 +	5/30									
clopyralid-1 +	0.03 +										
MSO	1.5% v/v										
Dmp&pmp-2 +	0.08 +	5/8,	0	78	90	90	100	95	99	34	8150
triflusulfuron +	0.00384 +										
clopyralid-2 +	0.03 +										
MSO	1.5% v/v										
Dmp&pmp-2 +	0.16 +	5/20,									
triflusulfuron +	0.00384 +	5/30 & 6/6									
clopyralid-2 +	0.03 +										
MSO	1.5% v/v										
Hand weeded check			4	95	89	85	70	84	90	33	7995
LSD (0.05)			ns	15	11	ns	13	14	14	6	ns

[1] Weeds evaluated for control were kochia (KCHSC), common lambsquarters (CHEAL), redroot pigweed (AMARE), annual sowthistle (SONOL), barnyardgrass (ECHCG), and green foxtail (SETVI).

[2] AE B049913 01 EC18 A2 is an experimental formulation of ethofumesate, desmedipham, and phenmedipham; AE B038584 01 EC30 A3 is an experimental formulation of desmedipham and phenmedipham. Efs&dmp&pmp-1 is a commercial formulation of a 1:1:1 mixture of ethofumesate, desmedipham, and phenmedipham sold as Progress. Efs&dmp&pmp-2 is a commercial formulation of a 1:1:1 mixture of ethofumesate, desmedipham, and phenmedipham sold as Des-Phen-Etho. Dmp&pmp-1 is a commercial formulation of a 1:1 mixture of desmedipham and phenmedipham sold as Betamix. Dmp&pmp-2 is a commercial formulation of a 1:1 mixture of desmedipham and phenmedipham sold as D-P mix. Clopyralid-1 is a commercial formulation sold as Stinger. Clopyralid-2 is a commercial formulation sold as Clopyr-Ag. MSO is methylated seed oil.

Late season weed control in sugar beet. Don W. Morishita, Robyn C. Walton, and Michael P. Quinn. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to determine the effect of late season control methods on crop injury, weed control, and sugar beet yield. The experimental design was a randomized complete block with four replications. Individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (17.9% sand, 61.8% silt, and 20.3% clay) with a pH of 8.1, 1.6% organic matter, and CEC of 16-meq/100 g soil. 'HM 2984RZ' sugar beet was planted April 16, 2003, in 22-inch rows at a rate of 57,024 seed/A. Kochia (KCHSC), redroot pigweed (AMARE), common lambsquarters (CHEAL), annual sowthistle (SONOL), barnyardgrass (ECHCG), and green foxtail (SETVI) were the major weed species present. Herbicides were applied by spraying or using a wick applicator. Sprayed herbicides were applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 8001 flat fan nozzles. Wicked herbicides were applied with a hand held rope wick applicator. The applicator was constructed of 1 inch PVC pipe with a loop of rope made for wicking herbicides. Additional environmental and application information is given in Table 1. Crop injury and weed control were evaluated visually August 20, which was 14 days after the last herbicide application. The two center rows of each plot were harvested mechanically September 30.

Table 1. Environmental conditions at application and weed species densities.

Application date	May 2	May 20	May 30	July 15	August 6
Application timing[1]	Cotyledon	2-4 lf	4-6 lf	Wiper-1	Wiper-2
Air temperature (F)	48	69	69	79	89
Soil temperature (F)	40	69	63	76	76
Relative humidity (%)	64	14	63	26	28
Wind velocity (mph)	5	4	8	4	6
Cloud cover (%)	80	15	25	0	25
Weed species (plants/ft^2)					
kochia		1	1	1	1
pigweed, redroot		1	1	1	1
lambsquarters, common		3	1	1	1
sowthistle, annual		3	2	2	5
grasses		7	20	20	20

[1] Wick-1 and wick-2 refer to late postemergence herbicides applied with a hand-held rope wick applicator.

Crop injury was observed after the last herbicide application (Table 2). The late hand weeding treatment and two of the glyphosate treatments injured sugar beet 13 to 33%. Interestingly, crop injury was only observed in the lowest (25%) and highest glyphosate concentrations (50%). The 37.5% concentration did not injure the crop. Why this was observed is unknown. KCHSC control ranged from 73 to 100%. All of the glyphosate or glyphosate + fluroxypyr treatments controlled KCHSC equally and ranged from 80 to 90%. Fluroxypyr controlled KCHSC 74 and 93% with the 25 and 50% concentrations, respectively. No differences in CHEAL, AMARE, and SONOL control were observed and weed control generally average >80%. The hand weeded as needed treatment averaged 94% SETVI control and was better than 11 of the 14 herbicide treatments. ECHCG control in the hand weeded as needed treatment also averaged 94%, but was statistically equal to all but four of the 14 herbicide treatments. Root yield of all treatments ranged from 12 (untreated check) to 39 ton/A while sucrose yield ranged from 2,865 (untreated check) to 9,475 lb/A. The hand weeded as needed treatment had the highest root and sucrose yield. However, root yield was only significantly higher than four other herbicide treatments and sucrose yield was higher than six herbicide treatments. All of the treatments had yields greater than the untreated check.

Table 2. Crop injury, weed control, and sugar beet yield using a wiper applicator for weed control in sugar beet near Kimberly, Idaho.

			Crop	Weed control[1]						Root	Extractable
Treatment[2]	Rate	Timing	injury	KCHSC	CHEAL	AMARE	SONOL	SETVI	ECHCG	yield	sugar
	lb ai/A		%							ton/A	lb/A
Check	-		-	-	-	-	-	-	-	12	2864
Hand weed as needed			0	100	95	99	97	94	94	39	9477
Efs&dmp&pmp + triflusulfuron Efs&dmp&pmp + triflusulfuron + clopyralid	0.25 + 0.0156 0.33 + 0.0156 + 0.094	5/2 5/20 & 5/30	0	73	92	97	100	75	75	35	8602
Efs&dmp&pmp + triflusulfuron + clopyralid glyphosate	0.33 + 0.0156 + 0.094 25% conc.	5/20 & 5/30 7/15 & 8/6	33	83	91	97	100	76	86	32	7767
Efs&dmp&pmp + triflusulfuron + clopyralid glyphosate	0.33 + 0.0156 + 0.094 37.5% conc	5/20 & 5/30 7/15 & 8/6	3	88	93	97	100	73	86	31	7511
Efs&dmp&pmp + triflusulfuron + clopyralid glyphosate	0.33 + 0.0156 + 0.094 50% conc.	5/20 & 5/30 7/15 & 8/6	21	90	96	96	100	79	86	31	7511
Efs&dmp&pmp + triflusulfuron + clopyralid glyphosate + fluroxypyr	0.33 + 0.0156 + 0.094 12.5% + 12.5% conc	5/20 & 5/30 7/15 & 8/6	1	80	91	96	99	75	76	33	8119
Efs&dmp&pmp + triflusulfuron + clopyralid fluroxypyr	0.33 + 0.0156 + 0.094 25% conc.	5/20 & 5/30 7/15 & 8/6	1	74	91	99	99	63	66	32	7965
Efs&dmp&pmp + triflusulfuron + clopyralid fluroxypyr	0.33 + 0.0156 + 0.094 50% conc.	5/20 & 5/30 7/15 & 8/6	4	93	84	91	98	73	56	36	8812

Table 2. continued

			Crop	Weed control[1]						Root	Extractable
Treatment[2]	Rate	Timing	injury	KCHSC	CHEAL	AMARE	SONOL	SETVI	ECHCG	Yield	Sugar
	lb ai/A		----	----	----	--%--	----	----	----	ton/A	lb/A
Efs&dmp&pmp +	0.33 +	5/20 & 5/30	0	78	93	95	97	66	73	32	7818
triflusulfuron +	0.0156 +										
clopyralid	0.094										
mesotrione	12.5% conc	7/15 & 8/6									
Efs&dmp&pmp +	0.33 +	5/20 & 5/30	0	75	93	97	99	53	61	29	7119
triflusulfuron +	0.0156 +										
clopyralid	0.094										
mesotrione	25% conc.	7/15 & 8/6									
Efs&dmp&pmp +	0.33 +	5/20 & 5/30	0	85	85	98	93	69	71	30	7443
triflusulfuron +	0.0156 +										
clopyralid	0.094										
ethofumesate	25	7/15 & 8/6									
Efs&dmp&pmp +	0.33 +	5/20 & 5/30	0	94	75	95	96	68	87	35	8539
triflusulfuron +	0.0156 +										
clopyralid	0.094										
ethofumesate	50% conc.	7/15 & 8/6									
Efs&dmp&pmp +	0.33 +	5/20 & 5/30	3	78	83	87	97	64	79	32	7943
triflusulfuron +	0.0156 +										
clopyralid	0.094										
mow one time		8/5									
Efs&dmp&pmp +	0.33 +	5/20 & 5/30	3	84	93	99	99	80	80	35	8539
triflusulfuron +	0.0156 +										
clopyralid	0.094										
mow two times		8/5 & 9/5									
Efs&dmp&pmp +	0.33 +	5/20 & 5/30	13	97	98	99	99	88	88	37	8988
triflusulfuron +	0.0156 +										
clopyralid	0.094										
hand weed late		8/5									
LSD (0.05)			10	17	ns	ns	ns	16	21	7	1609

[1] Weeds evaluated for control were kochia (KCHSC), common lambsquarters (CHEAL), redroot pigweed (AMARE), annual sowthistle (SONOL), green foxtail (SETVI), and barnyard grass (ECHCG).

[2] Efs&dmp&pmp is a 1:1:1 commmercial formulation of ethofumesate, desmedipham, and phenmedipham.

Comparison of soil active herbicides used with postemergence herbicides in sugar beet. Don W. Morishita, Robyn C. Walton, and Michael P. Quinn. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A field experiment was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to compare combinations of soil-applied and postemergence herbicides for weed control in sugar beet. Experimental design was a randomized complete block with four replications. Individual plots were four rows by 30 ft. Soil type was a Portneuf silt loam (17.9% sand, 61.8% silt, and 20.3% clay) with a pH of 8.1, 1.6% organic matter, and CEC of 16-meq/100 g soil. 'HM 2984RZ' sugar beet was planted April 16, 2003, in 22-inch rows at a rate of 57,024 seed/A. Kochia (KCHSC), common lambsquarters (CHEAL), redroot pigweed (AMARE), common mallow (MALNE), annual sowthistle (SONOL), green foxtail (SETVI), and barnyardgrass (ECHCG) were the major weed species present. Herbicides were broadcast-applied with a CO_2-pressurized bicycle-wheel sprayer calibrated to deliver 10 gpa using 8001 flat fan nozzles. Additional environmental and application information is given in Table 1. Crop injury and weed control were evaluated visually 19 days after the last herbicide treatment on July 1. The two center rows of each plot were harvested mechanically September 30.

Table 1. Environmental conditions at application and weed species densities.

Application date	May 2	May 8	May 20	May 30	June 12
Application timing	Pre	Cotyledon	2-4 lf	6 lf	14-18 lf
Air temperature (F)	43	50	69	66	79
Soil temperature (F)	40	44	69	62	82
Relative humidity (%)	66	40	14	72	9
Wind velocity (mph)	5	2	4	5	3
Cloud cover (%)	75	100	15	90	25
Weed species (plants/ft^2)					
kochia			30	38	43
pigweed, redroot			15	22	28
lambsquarters, common			3	2	3
mallow, common			13	10	13
sowthistle, annual			2	10	6
grasses			29	33	29

Crop injury ranged from 0 to 6%, but there were no differences among herbicide treatments (Table 2). Kochia control ranged from 64 to 98% among herbicide treatments. Ethofumesate applied PRE at 1.0 and 1.5 lb ai/A followed by ethofumesate & desmedipham & phenmedipham (efs&dmp&pmp) + triflusulfuron + clopyralid (included in the second and third applications) postemergence was among the treatments with the best control. Pyrazon applied PRE followed by efs&dmp&pmp + triflusulfuron + clopyralid postemergence was among the treatments with the lowest kochia control. All of the herbicides controlled common lambsquarters better than 80% with the exception of dimethenamid tank mixed with efs&dmp&pmp + triflusulfuron + clopyralid applied on the last application date (May 30). No difference in redroot pigweed or annual sowthistle control was observed among herbicide treatments and control ranged from 94 to 100%. Additionally, no difference in common mallow, green foxtail, or barnyardgrass control was observed among herbicide treatments. However, populations of these three species throughout the experimental area were somewhat variable, which resulted in more variability in control ratings.

Sugar beet root and sucrose yield in the untreated check averaged 9 ton/A and 7,475 lb/A, respectively. Yields of the herbicide treatments ranged from 32 to 38 ton/A and 7,360 to 8,740 lb/A root and sucrose, respectively. No differences in root or sucrose yield were observed among herbicide treatments. All herbicide treatments had higher root, and sucrose yields than the check.

Table 2. Weed control and sugar beet yield with preemergence and postemergence herbicide applications near Kimberly, Idaho.

Treatment[2]	Rate	Application date	Crop injury	Weed control[1]							Root yield	Extractable sugar
				KCHSC	CHEAL	AMARE	SONOL	MALNE	SETVI	ECHCG		
	lb ai/A		%								ton/A	lb/A
Check	-		-	-	-	-	-	-	-	-	9	2090
Efs&dmp&pmp +	0.25 +	5/8	0	81	78	97	100	76	81	95	32	7380
triflusulfuron	0.0156											
Efs&dmp&pmp +	0.33 +	5/20 & 5/30										
triflusulfuron +	0.0156 +											
clopyralid +	0.094 +											
dimethenamid-P	0.328	5/30										
Efs&dmp&pmp +	0.25 +	5/8	4	74	87	94	100	91	95	100	32	7360
triflusulfuron	0.0156											
Efs&dmp&pmp +	0.33 +	5/20 & 5/30										
triflusulfuron +	0.0156 +											
clopyralid +	0.094 +											
dimethenamid-P	0.75	5/20										
Efs&dmp&pmp +	0.25 +	5/8	4	80	89	99	100	83	95	100	33	7740
triflusulfuron	0.0156											
Efs&dmp&pmp +	0.33 +	5/20 & 5/30										
triflusulfuron +	0.0156 +											
clopyralid +	0.094 +											
dimethenamid-P	0.75	5/30										
Efs&dmp&pmp +	0.25 +	5/8	0	81	80	100	100	76	100	100	33	7785
triflusulfuron	0.0156											
Efs&dmp&pmp +	0.33 +	5/20 & 5/30										
triflusulfuron +	0.0156 +											
clopyralid +	0.094 +											
dimethenamid-P	0.656	5/20										
Efs&dmp&pmp +	0.25 +	5/8	6	78	89	96	95	83	95	98	32	7460
triflusulfuron	0.0156 /											
Efs&dmp&pmp +	0.33 +	5/20 & 5/30										
triflusulfuron +	0.0156 +											
clopyralid +	0.094 +											
dimethenamid-P	0.75	5/30										
Efs&dmp&pmp +	0.25 +	5/8	0	80	89	100	100	71	95	98	35	8190
triflusulfuron	0.0156											
Efs&dmp&pmp +	0.33 +	5/20 & 5/30										
triflusulfuron +	0.0156 +											
clopyralid +	0.094 +											
dimethenamid-P +	0.75 +	6/12										
trifluralin	0.5											
Efs&dmp&pmp +	0.25 +	5/8	3	68	81	98	100	84	100	100	35	8000
triflusulfuron	0.0156											
Efs&dmp&pmp +	0.33 +	5/20 & 5/30										
triflusulfuron +	0.0156 +											
clopyralid +	0.094 +											
metolachlor	1.27	5/20										

Table 2. continued

Treatment[2]	Rate	Application date	Crop injury	Weed control[1]							Root yield	Extractable sugar
				KCHSC	CHEAL	AMARE	SONOL	MALNE	SETVI	ECHCG		
	lb ai/A		%								ton/A	lb/A
Efs&dmp&pmp +	0.25 +	5/8	1	79	81	99	100	69	77	97	32	7475
triflusulfuron	0.0156											
Efs&dmp&pmp +	0.33 +	5/20 & 5/30										
triflusulfuron +	0.0156 +											
clopyralid +	0.094 +											
metolachlor	1.27	5/30										
Ethofumesate	1.0 /	5/2	2	94	98	100	100	88	91	96	38	8740
efs&dmp&pmp +	0.25 +	5/8										
triflusulfuron	0.0156											
efs&dmp&pmp +	0.33 +	5/20 & 5/30										
triflusulfuron +	0.0156 +											
clopyralid	0.094											
Ethofumesate	1.5 /	5/2	0	94	100	100	100	91	93	94	32	7380
efs&dmp&pmp +	0.25 +	5/8										
triflusulfuron	0.0156											
efs&dmp&pmp +	0.33 +	5/20 & 5/30										
triflusulfuron +	0.0156 +											
clopyralid	0.094											
Ethofumesate-2	1.0	5/2	2	98	99	100	99	73	89	84	35	8040
efs&dmp&pmp-2 +	0.25 +	5/8										
triflusulfuron	0.0156											
efs&dmp&pmp-2 +	0.33 +	5/20 & 5/30										
triflusulfuron +	0.0156 +											
clopyralid-2	0.094											
Ethofumesate-2	1.5 /	5/2	0	85	99	97	98	86	100	97	33	7675
efs&dmp&pmp-2 +	0.25 +	5/8										
triflusulfuron	0.0156 /											
efs&dmp&pmp-2 +	0.33 +	5/20 & 5/30										
triflusulfuron +	0.0156 +											
clopyralid-2	0.094											
Pyrazon	1.95	5/2	0	69	87	98	100	81	94	100	33	7570
efs&dmp&pmp +	0.25 +	5/8										
triflusulfuron	0.0156 /											
efs&dmp&pmp +	0.33 +	5/20 & 5/30										
triflusulfuron +	0.0156 +											
clopyralid	0.094											
Pyrazon	4.6	5/2	0	64	98	100	100	86	96	98	33	7630
efs&dmp&pmp +	0.25 +	5/8										
triflusulfuron	0.0156											
efs&dmp&pmp +	0.33 +	5/20 & 5/30										
triflusulfuron +	0.0156 +											
clopyralid	0.094											
LSD (0.05)			ns	19	15	ns	ns	ns	ns	ns	8	1800

[1] Weeds evaluated for control were kochia (KCHSC), common lambsquarters (CHEAL), redroot pigweed (AMARE), annual sowthistle (SONOL), common mallow (MALNE), green foxtail (SETVI), and barnyardgrass (ECHCG).

[2] Ethofumesate is Nortron SC and ethofumesate-2 is Etho SC, efs&dmp&pmp is Progress and efs&dmp&pmp-2 is Des-Phen-Etho, clopyralid is Stinger and clopyralid-2 is Clopyr Ag.

Control of ventenata in Kentucky bluegrass. Janice M. Reed and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) A study was conducted near Nezperce, ID to evaluate the effect of flucarbazone alone and in combination with broadleaf herbicides on control of ventenata in Kentucky bluegrass. The experiment was conducted in a two year old stand of 'Nublue' Kentucky bluegrass. Plots were 8 by 30 ft arranged in a randomized complete block design with four replications and included an untreated check. Treatments were applied with a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). Weed control and Kentucky bluegrass injury were evaluated visually. Plots were swathed on July 14 and harvested on July 24, 2003.

Table 1. Application data.

Date	April 23, 2003
Air temperature (F)	66
Relative humidity (%)	54
Wind (mph, direction)	2, W
Cloud cover (%)	75
Soil temperature at 2 in (F)	54
Bluegrass growth stage	3 inches tall
Ventenata growth stage	0.5 to 1.5 inches tall

No treatment injured Kentucky bluegrass (data not shown). All treatments reduced ventenata height compared to the untreated, but did not prevent ventenata seed production (Table 2). Ventenata was stunted the most (48%) with flucarbazone + 2,4-D and least with flucarbazone + dicamba or bromoxynil. Kentucky bluegrass seed yield did not differ among treatments.

Table 2. Vetenata control and Kentucky bluegrass seed yield with flucarbazone treatments.

Treatment[1]	Rate[2]	Ventenata control[3]	Bluegrass seed yield
	lb ai/A	%	lb/A
Flucarbazone	0.027	36	440
Flucarbazone + 2,4-D amine	0.027 + 0.475	48	479
Flucarbazone + dicamba	0.027 + 0.25	22	474
Flucarbazone + bromoxynil	0.027 + 0.25	19	481
Untreated	----	--	473
LSD (0.05)		10	NS

[1] All treatments applied with a 90% non-ionic surfactant (R-11) at 0.25% v/v.

[2] 2,4-D and dicamba rates are in lb ae/A.

[3] Ventenata control (stunting) evaluated June 2, 2003.

Wild oat control in seedling Kentucky bluegrass seed production. Larry H. Bennett, Sandra M. Frost, and Daniel A. Ball. (Columbia Basin Agricultural Research Center, Oregon State University, Pendleton, OR 97801). A study was conducted at the Hermiston Agricultural Research and Experiment Station in Hermiston, OR to evaluate wild oat control in seedling Kentucky bluegrass for seed production. Kentucky bluegrass (KBG) variety "Baron" was planted August 25, 2002. Tame oats were broadcast seeded on September 4, 2002 to simulate a wild oat infestation. Two application timings were used in this study; early postemergence (EPOST) and mid postemergence (MPOST). All treatments were made with a hand-held CO_2 sprayer delivering 16 gpa at 30 psi (Table 1). Plots were 6 by 35 ft arranged in a randomized complete block design with 4 replications. Evaluations of crop injury were made on October 31, 2002, and March 25, 2003. Evaluation of oat control was made on October 31, 2002. Plots were swathed on June 19, 2003 and harvested on July 3, 2003 with a small plot combine. Seed samples were cleaned prior to yield determination.

Table 1. Application and soil data.

Location		Hermiston, Oregon	
Application date	September 26,2002		October 8, 2002
Application timing	EPOST		MPOST
Kentucky bluegrass stage	2-3 leaf		3-4 leaf
Oat growth stage	3 leaf		5-6 leaf
Air temp (F)	57		58
Relative humidity (%)	56		72
Wind velocity (mph)	calm		1-2
Soil temp 2 inch (F)	54		54
pH		6.9	
OM (%)		1.0	
Texture		sandy loam	

MSMA treatments gave marginal control of oats, but crop tolerance was good and yields were unaffected by MSMA treatments (Table 2). Flucarbazone treatments provided good crop safety as well as fair to excellent oat control. The early post treatment was slightly more effective than the later post treatment. Yields with flucarbazone were similar to MSMA. Fenoxaprop, clodinafop, and imazamethabenz + difenzoquat treatments gave good oat control, but crop injury was severe and yields were greatly reduced. Ethofumesate did not appear to be as injurious as previous three treatments when visual injury ratings were taken. However, very little seed was produced in plots that were treated with ethofumesate.

Table 2. Herbicide treatment effects on seedling Kentucky bluegrass and wild oats in Hermiston, OR in 2003.

Treatment	Rate	Application timing	KBG injury 10-31-02	KBG injury 3-25-03	Oats Control 10-31-02	KBG Yield
	lb ai/A		--------------------%--------------------			lb/A
MSMA	4.5	EPOST	0	0	13	270
MSMA	6.0	EPOST	1	1	19	320
Imazamethabenz + difenzoquat	0.234 + 0.5	EPOST	68	78	92	30
Fenoxaprop	0.083	EPOST	76	99	95	0
Flucarbazone	0.027	EPOST	29	6	97	360
Clodinafop	0.05	EPOST	85	99	98	4
Ethofumesate	1.0	EPOST	50	54	69	70
MSMA	4.5	MPOST	0	0	35	390
MSMA	6.0	MPOST	0	4	45	450
Imazamethabenz + difenzoquat	0.234 + 0.5	MPOST	28	64	61	80
Fenoxaprop	0.083	MPOST	45	97	84	9
Flucarbazone	0.027	MPOST	5	8	76	380
Clodinafop	0.05	MPOST	45	99	86	17
Ethofumesate	1.0	MPOST	3	21	14	0
Ethofumesate/ethofumesate	1.0/1.0	EPOST/ MPOST	56	93	96	0
Untreated check			0	0	0	180
LSD (0.05)			10	9	12	62

[1] Non-ionic surfactant (R-11) at 0.25% v/v was added to all treatments with the exception of fenoxaprop and clodinafop. Additive DSV at 10 fl oz/A was added to the clodinafop.

Broadleaf weed control in field corn with postemergence herbicides. Richard N. Arnold, Michael K. O'Neill and Dan Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 14, 2003 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of field corn (var. Pioneer 34N44) and annual broadleaf weeds to postemergence herbicides. Soil type was a Wall sandy loam with a pH of 7.8 and an organic matter content of less than 1%. The experimental design was a randomized complete block with three replications. Individual plots were 4, 34 in rows 30 ft long. Field corn was planted with flexi-planters equipped with disk openers on May 14. Postemergence treatments were applied on June 2 when corn was in the 4th leaf stage and weeds were small. All treatments had methylated seed oil and 32-0-0 applied at 0.5 and 1.0 percent v/v added to the spray mixture. DPX 79406 is a packaged mix of rimsulfuron and nicosulfuron and has a one to one ratio of each. Black nightshade, prostrate and redroot pigweed, and common lambsquarters infestations were heavy and Russian thistle infestations were light throughout the experimental area. Treatments were evaluated on August 13.

No crop injury was observed in any of the treatments. All treatments except the weedy check gave excellent control of redroot and prostrate pigweed and common lambsquarters. Nicosulfuron plus rimsulfuron, DPX 79406, and nicosulfuron plus rimsulfuron plus diflufenzopyr plus dicamba applied at 0.035, 0.023, and 0.035 plus 0.09 lb ai/A and the check gave poor control of black nightshade. Russian thistle control was poor with nicosulfuron plus rimsulfuron, DPX 79406 and foramsulfuron applied at 0.035, 0.023, and 0.033 lb ai/A.

Table. Broadleaf weed control in field corn with postemergence herbicides.

		Weed control				
Treatments[1]	Rate	AMARE	AMABL	CHEAL	SOLNI	SASKR
	lb ai/A			%		
Nicosulfuron + rimsulfuron (pm)	0.035	98	94	96	50	40
Nicosulfuron + rimsulfuron (pm) + dicamba	0.035+0.25	99	96	97	90	97
Nicosulfuron + rimsulfuron (pm) + dicamba + atrazine (pm)	0.035+0.4	97	98	99	95	96
Nicosulfuron + rimsulfuron (pm) + diflufenzopyr + dicamba (pm)	0.035+0.09	98	97	96	58	97
Nicosulfuron + rimsulfuron (pm) + mesotrione	0.035+0.06	98	98	98	98	63
DPX 79406	0.023	98	95	95	38	38
DPX 79406 + dicamba + atrazine (pm)	0.023+0.4	99	98	98	96	98
DPX 79406 + diflufenzopyr + dicamba (pm)	0.023+0.09	98	98	98	96	96
Foramsulfuron	0.033	98	97	96	84	38
Foramsulfuron + dicamba	0.033+0.25	97	98	96	96	98
Foramsulfuron + diflufenzopyr + dicamba (pm)	0.033+0.09	98	98	100	95	96
Foramsulfuron + dicamba + atrazine (pm)	0.033+0.4	98	98	97	98	97
Foramsulfuron + mesotrione	0.033+0.06	98	98	97	96	65
Weedy check		0	0	0	0	0

[1] pm equal packaged mix.

Broadleaf weed control in field corn with preemergence followed by sequential postemergence herbicides. Richard N. Arnold, Michael K. O'Neill and Dan Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 12, 2003 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of field corn (var. Pioneer 34N44) and annual broadleaf weeds to preemergence followed by sequential postemergence herbicides. Soil type was a Wall sandy loam with a pH of 7.8 and an organic matter content of less than 1%. The experimental design was a randomized complete block with three replications. Individual plots were 4, 34 in rows 30 ft long. Field corn was planted with flexi-planters equipped with disk openers on May 12. Preemergence treatments were applied on May 14 and immediately incorporated with 0.75 in of sprinkler-applied water. Postemergence treatments were applied on June 2 when corn was in the 4th leaf stage and weeds were small. Treatments with diflufenzopyr plus dicamba had a nonionic surfactant and 32-0-0 added at 0.25 and 0.5 percent v/v to the spray mixture. Black nightshade, prostrate and redroot pigweed, and common lambsquarters infestations were heavy and Russian thistle infestations were light throughout the experimental area. Treatments were evaluated on July 3.

Dimethenamid-p plus pendimethalin applied preemergence at 0.66 plus 1.0 lb ai/A followed by a sequential postemergence treatment of atrazine plus dicamba applied at 0.8 lb ai/A caused the highest injury rating of 6. All treatments except the weedy check gave good to excellent control of common lambsquarters, black nightshade, redroot and prostrate pigweed. Russian thistle control was poor with s-metolachlor applied preemergence at 0.95 lb ai/A followed by a sequential postemergence treatment of mesotrione plus atrazine applied at 0.094 plus 0.25 lb ai/A.

Table. Broadleaf weed control in field corn with preemergence followed by sequential postemergence herbicides.

		Crop	Weed control				
Treatments[1]	Rate	injury	CHEAL	SOLNI	AMARE	AMABL	SASKR
	lb ai/A	—%—			%		
S-metolachlor + atrazine (pm)/mesotrione	2.0/0.094	0	99	96	100	100	98
S-metolachlor/mesotrione + atrazine	0.95/0.094+0.25	0	98	100	98	98	63
Dimethenamid-p/dicamba + atrazine (pm)	0.66/0.8	4	100	100	100	100	96
Dimethenamid-p/diflufenzopyr + dicamba (pm) + atrazine	0.66/0.175+0.5	3	100	99	99	100	100
Dimethenamid-p + atrazine/ diflufenzopyr + dicamba (pm)	0.66+0.8/0.175	1	99	100	98	100	99
Dimethenamid-p + pendimethalin/atrazine + dicamba (pm)	0.66+1.0/0.8	6	100	100	100	100	100
Dimethenamid-p + pendimethalin/diflufenzopyr + dicamba (pm) + atrazine	0.66+1.0/0.175+ 0.5	4	100	100	100	100	99
Weedy check		0	0	0	0	0	0

[1] pm equal packaged mix with first treatment being applied preemergence then a slash, followed by a sequential postemergence treatment.

Broadleaf weed control in field corn with preemergence herbicides. Richard N. Arnold, Michael K. O'Neill and Dan Smeal. (New Mexico State University Agricultural Science Center, Farmington, NM 87499) Research plots were established on May 13, 2003 at the Agricultural Science Center, Farmington, New Mexico to evaluate the response of field corn (Pioneer 34N44) and annual broadleaf weeds to preemergence herbicides. Soil type was a Wall sandy loam with a pH of 7.8 and an organic matter content of less than 1%. The experimental design was a randomized complete block with three replications. Individual plots were 4, 34 in rows 30 ft long. Treatments were applied with a compressed air backpack sprayer calibrated to deliver 30 gal/A at 30 psi. Field corn was planted with flexi-planters equipped with disk openers on May 13. Treatments were applied on May 14 and immediately incorporated with 0.75 in of sprinkler-applied water. Black nightshade, common lambsquarters, redroot and prostrate pigweed infestations were heavy and Russian thistle infestations were light throughout the experimental area. Crop injury evaluations were made on June 12 and weed control evaluations were made on July 17.

Flufenacet plus atrazine plus isoxaflutole and s-metolachlor plus isoxaflutole applied at 0.2 plus 0.66 plus 0.024 and 0.95 plus 0.024 lb ai/A caused the highest injury ratings of 7. Broadleaf weed control was good to excellent with all treatments except the check.

Table. Broadleaf weed control in field corn with preemergence herbicides.

			Weed control				
Treatments[1]	Rate	Crop injury	AMABL	AMARE	SOLNI	SASKR	CHEAL
	lb ai/A	—%—			%		
Flufenacet + metribuzin (pm) + atrazine	0.17+0.66	0	98	98	95	97	98
Flufenacet + flufenacet + isoxaflutole (pm)	0.2+0.16	1	98	98	95	98	100
Flufenacet + atrazine	0.45+0.66	1	97	99	98	100	97
Flufenacet + isoxaflutole	0.45+0.024	5	100	100	99	99	100
Flufenacet + mesotrione	0.45+0.147	2	99	98	98	95	98
Flufenacet + flufenacet + isoxaflutole (pm)	0.158+0.127	1	98	100	99	99	96
Flufenacet + atrazine + isoxaflutole	0.2+0.66+0.024	7	100	98	98	100	99
Dimethenamid-p + isoxaflutole	0.56+0.0.147	4	98	100	100	100	100
Dimethenamid-p + mesotrione	0.56+0.024	4	98	98	100	99	98
Dimethenamid-p + atrazine	0.56+0.66	2	98	99	96	98	99
Dimethenamid-p + atrazine + isoxaflutole	0.56+0.66+0.024	4	99	100	98	100	100
Dimethenamid-p + atrazine + mesotrione	0.56+0.66+0.147	4	99	98	100	98	97
S-metolachlor + isoxaflutole	0.95+0.024	7	96	100	100	100	97
S-metolachlor + mesotrione	0.95+0.147	0	99	99	98	96	99
S-metolachlor + atrazine (pm)	2.25	0	98	98	99	98	97
Weedy check		0	0	0	0	0	0

[1] pm equal packaged mix.

Performance of postemergence wild proso millet herbicides in field corn. John O. Evans and R. William Mace (Department of Plants, Soils and Biometeorology, Utah State University, Logan, Utah 84322-4820). A study was conducted at the Jensen Farm in Logan, UT to determine the influence of several postemergence wild proso millet (PANMI) herbicides. Glyphosate-resistant corn hybird DK662 was planted at 35,000 seeds/A on May 10, 2003. Postemergence treatments were applied June 3, in a randomized block design, using three replications. Treatments were applied June 3, to 10 by 30 ft plots with a CO_2 backpack sprayer using flatfan Turbojet 015 nozzles calibrated to deliver 25 gpa at 39 psi. The soil was a Provo silt loam with 7.8 pH and O.M. content of 4%. Corn was 9 to 11 inches tall at application time and was in the 6 leaf stage. Wild proso millet was in the 3 leaf stage and at a density of 8 plants per ft^2.

No crop injury occurred with any herbicide treatment. All treatments gave excellent control of wild proso millet and common lambsquarters (CHEAL). Percent control increased somewhat between evaluation dates for wild proso millet control. There were no lambsquarters plants left in any treatment except the controls at the second evaluation date. Yields were not significantly different for any treatment.

Table. Broadleaf weed control in silage corn, Logan, UT.

Treatment	Rate	Crop			Weed control		
		Injury		Yield	PANMI		CHEAL
		7/02/03	7/29/03	7/29/03	7/02	7/29	7/02
	lb/A	--------- %---------		T/A	--------- %---------		
Untreated		0	0	39.8	0	0	0
Formasulfuron[a]	0.0657	0	0	36.7	94.3	97.7	98.3
Formasulfuron[a]	0.077	0	0	42.6	86.7	91.7	95
Formasulfuron[a] + diflufenzopyr	0.0065+0.175	0	0	39.3	88.3	99.3	100
Formasulfuron[a] + mesotrione	0.065+0.047	0	0	37.7	81.7	93.3	100
Formasulfuron[a] + atrazine	0.065+0.75	0	0	41.4	80	91	99.3
Formasulfuron[a] + dimethenamid	0.065+0.47	0	0	38.4	86.7	91.7	96.7
DPX-79406[b] + diflufenzopyr	0.017+0.047	0	0	37.7	97	96.3	98.3
Nicosulfuron[a] + diflufenzopyr	0.031+0.047	0	0	39.3	98.3	96.7	99.3
Acetochlor[a] + formasulfuron	1.8+0.076	0	0	40	99.3	100	100
LSD (0.05)		0	0	13.7	11.9	7.4	5.0

[a] MSO at .75 qt/A plus 28% N at 2 qt/A added.

[b] NIS at 0.5 % V/V plus N at 2 qt/A added.

Flumioxazin in fallow and spring wheat. Joan Campbell and Donn Thill. (Crop and Weed Science Division, University of Idaho, Moscow, Idaho 83844-2339) Two experiments were established near Moscow, Idaho to determine weed control in fallow with flumioxazin and spring wheat tolerance to flumioxazin. Experiments were adjacent to each other in the same field. Treatments were applied with a CO_2 pressurized backpack sprayer delivering 10 gpa at 3 mph and 32 psi (Table 1). Spring wheat (CL-0612 x SWP965001) was direct seeded May 17, 2003. The experimental design was a randomized complete block with four replications and 8 by 30 ft experimental units. Soil pH, organic matter, CEC, and type were 5.4, 2.7%, 22 cmol/kg, and silt loam, respectively. Weed control and crop injury were evaluated visually on May 15 (data not shown) and June 2, 2003 and wheat yield was harvested at maturity.

Table 1. Environmental conditions at the time of application.

Application date	November 3, 2002	April 28, 2003
Air temperature (F)	42	70
Relative humidity (%)	55	61
Soil temperature (F)	35	50
Volunteer wheat, TRZAW	None	2 to 4 leaf
Panicle willowweed, EPIBR	None	3 inch
Sheperherd's-purse, CAPBP	None	2 to 4 inch
Prickly lettuce, LACSE	None	1 to 2 leaf

Prickly lettuce, panicle willowweed, and shepherd's-purse control on June 2 ranged from 94 to 99% (Table 2). Volunteer wheat control was 98 and 99% with flumioxazin plus glyphosate and glyphosate alone, respectively. Flumioxazin alone only injured volunteered wheat 5% compared to the untreated control.

Table 2. Weed control in fallow with flumioxazin applied in the fall.

Treatment	Rate	Application date	TRZAW	LACSE	EPIBR	CAPBP
			%			
Untreated	-	-	-	-	-	-
Flumioxazin	0.063 lb ai/A	November 6, 2002	5	94	96	99
Flumioxazin +	0.063 lb ai/A	November 6, 2002	98	96	94	95
glyphosate +	0.5 lb ai/A	April 28, 2003				
AMS[1]	17 lb ai/100 gal	April 28, 2003				
Glyphosate	0.5 lb ai/A	April 28, 2003	99	94	94	97
LSD (0.05)			1	NS	NS	NS

[1] Ammonium nitrate sulfate (Bronc)

Spring wheat was not visibly injured during the growing season (data not shown) and wheat grain yield and test weight were not affected by fall applied flumioxazin (Table 3).

Table 3. Spring wheat tolerance to flumioxazin applied in the fall.

Treatment	Rate	Application date	Wheat grain yield	Wheat test weight
			lb/A	lb/bu
Untreated	-	-	1853	59
Flumioxazin	0.063 lb ai/A	November 6, 2002	2100	60
Flumioxazin +	0.063 lb ai/A	November 6, 2002	1992	59
glyphosate +	0.5 lb ai/A	April 28, 2003		
AMS[1]	17 lb ai/100 gal	April 28, 2003		
Glyphosate	0.5 lb ai/A	April 28, 2003	1925	59
LSD (0.05)			NS	NS

[1] Ammonium nitrate sulfate (Bronc)

Fallow weed control with glyphosate plus broadleaf herbicides and adjuvants. Joan Campbell and Donn Thill. (Crop and Weed Science Division, University of Idaho, Moscow, Idaho 83844-2339) One experiment was established near Lewiston, Idaho to determine weed control in fallow with glyphosate plus broadleaf herbicides. A second experiment was established near Moscow, Idaho to determine the effect of adjuvants plus glyphosate on weed control in fallow. Treatments were applied with a CO_2 pressurized backpack sprayer delivering 10 gpa at 3 mph and 32 psi (Table 1). The experimental design was a randomized complete block with four replications and 8 by 30 ft experimental units. Weed control was evaluated visually and data are shown as percent control compared to the untreated check treatment.

Table 1. Environmental information at the time of application.

Location	Lewiston, Idaho	Moscow, Idaho
Application date	April 22, 2003	May 27, 2003
Tumble mustard	6 to 18 inch tall	-
Downy brome	Boot to early head	-
Prickly lettuce	Rosette to bolt, 2 to 25 leaves	-
Panicle willowweed	-	4 to 8 inch tall
Volunteer wheat	18 inch tall, jointing	10 to 16 inch tall
Air temperature (F)	60	88
Soil temperature at 3 inch (F)	50	64
Relative humidity (%)	70	55

In the glyphosate plus broadleaf herbicides experiment, weed control ranged between 93 and 100% for species present on May 7 (Table 2). Tumble mustard, downy brome and prickly lettuce control did not vary among treatments. Volunteer wheat control was not different among treatments containing the 0.56 or 0.75 lb ae/A glyphosate equivalent. At the 0.375 glyphosate equivalent rate, control was 94% with glyphosate alone compared to 96 and 97% control with the other treatments. All weeds were controlled 100% by 4 weeks after application (data not shown).

In the adjuvant experiment on June 4, volunteer wheat control ranged from 75 to 79% control with all treatments containing glyphosate at 0.28 lb ae/A (Table 3). Volunteer wheat control was less than 73% for all treatments containing glyphosate at 0.14 lb ae/A and control was lowest (46%) with glyphosate applied without an adjuvant. Glyphosate plus AMS/citric acid (60%) improved volunteer wheat control compared to glyphosate at 0.14 lb ae/A without adjuvants, but all the other adjuvants increased control compared to AMS/citric acid. Volunteer wheat control was 100% with all treatments by July 2. Panicle willowweed was not controlled as effectively as volunteer wheat. Panicle willowweed control ranged from 26 to 40% on June 4. By July 2, panicle willowweed control was between 83 and 93% with treatments containing glyphosate at 0.14 lb ae/a and was between 90 and 94% with treatments containing glyphosate at 0.28 lb ae/A. Panicle willowweed control was improved with the addition of adjuvants, except AMS/citric acid, when glyphosate was applied at 0.14 lb ae/A.

Table 2. Weed control with glyphosate plus broadleaf herbicides in fallow near Lewiston, Idaho.

		Weed control 2 weeks after treatment			
Treatment[1]	Rate	Tumble mustard	Volunteer wheat	Downy brome	Prickly lettuce
	lb ae/a	% of untreated control			
Untreated	-	-	-	-	-
Glyphosate 0.375 lb ae/A equivalent					
Glyphosate/dicamba	0.38	97	96	96	96
Glyphosate/2,4-D	0.42	98	97	94	95
Glyphosate + 2,4-D[2]	0.375 + 0.04	99	97	98	97
Glyphosate K salt	0.375	97	94	97	96
Glyphosate 0.56 lb ae/A equivalent					
Glyphosate/dicamba	0.57	99	97	98	98
Glyphosate/2,4-D	0.622	99	97	98	97
Glyphosate + 2,4-D[2]	0.56 + 0.06	99	98	97	98
Glyphosate K salt	0.56	99	97	98	94
Glyphosate 0.75 lb ae/A equivalent					
Glyphosate/dicamba	0.76	98	97	95	93
Glyphosate/2,4-D	0.83	99	98	96	99
Glyphosate + 2,4-D[2]	0.75 + 0.08	99	98	97	96
Glyphosate K salt	0.75	99	98	94	100
LSD (0.05)		NS	2	NS	NS

[1] All treatments contained ammonium sulfate at 8.5 lb/100 gal.

[2] Nonionic surfactant (R-11) added at 0.25% v/v

Table 3. Volunteer wheat and panicle willowweed control in fallow with glyphosate plus adjuvants near Moscow Idaho.

		Weed control			
		Volunteer wheat		Panicle willowweed	
Treatment[1]	Rate	June 4	July 2	June 4	July 2
		%			
Glyphosate	0.14 lb ae/A	46	100	26	83
Glyphosate+AMS/citric acid	0.14 lb ae/A+1.84 lb ai/100 gal	60	100	30	84
Glyphosate+AMS/citric acid+NIS	0.14 lb ae/A+1.84 lb ai/100 gal+0.25% v/v	68	100	34	88
Glyphosate+AMS/NH_4NO_3/NIS	0.14 lb ae/A+0.75% v/v	68	100	30	87
Glyphosate+AMS/citric acid/EDT	0.14 lb ae/A+0.5% v/v	61	100	29	87
Glyphosate+AMS/citric acid/EDT+NIS	0.14 lb ae/A+0.5% v/v+0.25% v/v	68	100	34	88
Glyphosate+AMS/NIS/EDT (dry)	0.14 lb ae/A+10 lb ai/100 gal	73	100	33	91
Glyphosate+AMS/citric acid+deposition aid	0.14 lb ae/A+1.84 lb ai/100 gal+1.5 fl oz/A	66	100	31	88
Glyphosate+AMS/citric acid+deposition aid+NIS	0.14 lb ae/A+1.84 lb ai/100 gal+1.5 fl oz/A+0.25% v/v	66	100	35	91
Glyphosate+AMS	0.14 lb ae/A+8.5 lb ai/100 gal	69	100	30	88
Glyphosate+AMS+NIS	0.14 lb ae/A+8.5 lb ai/100 gal+0.25% v/v	71	100	33	93
Glyphosate	0.28 lb ae/A	79	100	38	92
Glyphosate+AMS/citric acid	0.28 lb ae/A+1.84 lb ai/100 gal	75	100	39	90
Glyphosate+AMS/citric acid+NIS	0.28 lb ae/A+1.84 lb ai/100 gal+0.25% v/v	78	100	40	92
Glyphosate+AMS/NH_4NO_3/NIS	0.28 lb ae/A+0.75% v/v	76	100	35	91
Glyphosate+AMS/citric acid/EDT	0.28 lb ae/A+0.5% v/v	75	100	36	91
Glyphosate+AMS/citric acid/EDT+NIS	0.28 lb ae/A+0.5% v/v+0.25% v/v	79	100	35	94
Glyphosate+AMS/NIS/EDT (dry)	0.28 lb ae/A+10 lb ai/100 gal	79	100	38	92
Glyphosate+AMS/citric acid+deposition aid	0.28 lb ae/A+1.84 lb ai/100 gal+3 fl oz/A	79	100	36	94
Glyphosate+AMS/citric acid+deposition aid+NIS	0.28 lb ae/A+1.84 lb ai/100 gal+3 fl oz/A+0.25% v/v	78	100	35	93
Glyphosate+AMS	0.28 lb ae/A+8.5 lb ai/100 gal	76	100	38	94
Glyphosate+AMS+NIS	0.28 lb ae/A+8.5 lb ai/100 gal+0.25% v/v	74	100	30	91
Untreated control	--	-	-	-	-
LSD (0.05)		8	NS	6	3

[1] Chemicals used are as follows: Glyphosate was Glystar, AMS/citric acid was Bronc Max, NIS was R-11 nonionic surfactant, AMS/NH_4NO_3/NIS was Cayuse Plus, AMS/citric acid/EDT was Bronc Max EDT, AMS/NIS/EDT was BroncPlusDry-EDT, deposition aid was In-Place, AMS was Bronc.

Russian thistle control in chemical fallow. Larry H. Bennett, Sandra M. Frost, and Daniel A. Ball. (Columbia Basin Agricultural Research Center, Pendleton, OR 97801). A study was initiated near Lexington, Oregon in a wheat stubble field to evaluate Russian thistle control during the fallow period with several soil residual herbicides in combination with glyphosate. Plots were 15 by 45 ft arranged in a randomized complete block design with three replications. Early preemergence (EPRE) and preemergence (PRE) herbicides treatments were applied with a tractor-mounted sprayer using compressed air, calibrated to deliver 10 gpa at 30 psi (Table 1). Russian thistle control was rated visually on May 7, June 12, and July 7, 2003.

Table 1. Application and soil data.

Location		Lexington, Oregon	
Application date	December 13, 2002		March 12, 2003
Russian thistle growth stage	EPRE		PRE
Air temperature (F)	49		47
Relative humidity (%)	95		86
Wind (mph)	2		3
Cloud cover (%)	100		50
Soil temperature at 2 in (F)	49		44
pH		7.8	
OM (%)		1.6	
Texture		silt loam	

Glyphosate used in the treatments controlled volunteer wheat in the plots. Sulfentrazone applied at the early timing (December) gave better control of Russian thistle than the late timing (March) (Table 2). Flumioxazin at both timings gave fair to good control at the early ratings, but by the last rating, control was poor. Metribuzin and atrazine applied at the late timing did not provide acceptable control of Russian thistle. The Lexington, OR area has relatively low rainfall (about 10 in/year) with most of it coming in the winter. Sulfentrazone needs moisture for activation. The later application timing may not have received sufficient moisture before germination of Russian thistle. Greater amounts of precipitation after application may have resulted in the early (EPRE) treatments giving better control than the late (PRE) treatments.

Table 2. Russian thistle control ratings with various residual herbicides near Lexington, Oregon in 2003.

		Application	Russian thistle control		
Treatments	Rate	timing	May 7, 2003	June 12, 2003	July 6, 2003
	lb ai/A		%	%	%
Untreated control			0	0	0
Sulfentrazone	0.125	EPRE	85	80	80
Sulfentrazone	0.25	EPRE	96	93	92
Flumioxazin	0.0637	EPRE	65	0	10
Flumioxazin	0.0956	EPRE	67	17	8
Sulfentrazone	0.125	PRE	86	53	37
Sulfentrazone	0.25	PRE	93	72	43
Flumioxazin	0.0637	PRE	75	17	3
Flumioxazin	0.0956	PRE	82	23	12
Atrazine	0.4	PRE	68	10	0
Metribuzin	0.5	PRE	72	17	5
LSD (0.05)			18	17	14

[1] All treatments were tank-mixed with glyphosate at 0.375 lb ae/A.

Rattail fescue control in chemical fallow. Sandra M. Frost, Larry H. Bennett, and Daniel A. Ball. (Columbia Basin Agricultural Research Center, Pendleton, OR 97801) A study was established in summer fallow near Walla Walla, WA to investigate the response of Rattail fescue (*Vulpia myuros* L.) to different formulations and timings of glyphosate. Plots were 9 by 20 ft arranged in a randomized complete block design with 4 replications. Herbicide treatments were applied using a hand-held CO_2 sprayer delivering 10 gpa at 30 psi. Early postemergence (EPOST) treatments were applied April 10, 2003 (Table 1). Mid postemergence (MPOST) treatments were applied May 6, 2003. Control of rattail fescue was visually evaluated on May 1, and June 30, 2003. Rattail fescue seed heads were clipped from 3, 1/16 m quadrats per plot July 1, 2003. Seed heads were bulked by plot, dry stored for 3 months, and cleaned by hand. Dry stored seed was planted into flats of potting soil (Professional Growing Mix from SunGro Horticulture) and put in a greenhouse maintained at 70F/65F with 12 hours of daylight. If a seed lot weighed more than 5 g, only 5 g were planted. Flats were irrigated with overhead misters. Fourteen days after planting the germinated rattail seedlings in each flat were counted. The germination count data was adjusted for total clean seed weight if a 5 g sub-sample was planted. Twenty-five percent of the planted flat area was counted. The numbers of plants were converted to number of plants per square meter.

Table 1. Application and soil data.

Location	Pendleton, OR	
Application date	April 10, 2003	May 6, 2003
Application timing	EPOST	MPOST
Vol. wheat growth stage	5-6 leaf	2-3 node
Rattail fescue growth stage	5-7 leaf	2 node
Air temperature (F)	67	50
Relative humidity (%)	58	68
Wind (mph)	0-1	2-4
Cloud cover (%)	30	90
Soil temperature at 2 in (F)	62	52
pH	5.7	
OM (%)	4.4	
Texture	Silt loam	

Initial visual ratings were taken prior to application of the MPOST treatments. The glyphosate acid formulation appeared to be slightly more effective than the isopropylamine salt at equivalent rates. Imazamox was the least effective of the treatments. The final visual rating showed that the EPOST treatments were generally ineffective in controlling rattail fescue. The MPOST treatments were more effective, with the acid formulation giving better control than the isopropylamine salt. Split applications of glyphosate were very effective in controlling rattail fescue with either formulation. The 14-day germination counts showed that the untreated control averaged over 130,000 plants/m^2. All of the treated plots had significantly fewer plants. The split applications of glyphosate and glyphosate acid, as well as the MPOST applications of glyphosate acid were the most effective treatments, averaging less that 1,500 plants/m^2. No seed was produced in the treatment receiving split applications of glyphosate acid. It appears that glyphosate acid is more effective in controlling rattail fescue than the isopropylamine salt of glyphosate. This is likely due to better uptake of the acid formulation. Split applications were more effective than single applications and the MPOST applications were more effective than the EPOST applications.

Table 2. Rattail fescue response to herbicide treatment.

Treatment[1]	Rate[2]	Timing	Rattail fes. control 5-1-03	Rattail fes. control 6-30-03	Rattail fescue 14-day germination 11-21-03
	lb ae/A		----------%----------		----Plants/m^2----
Glyphosate	0.75	EPOST	69	36	27,200
Glyphosate	0.937	EPOST	81	35	16,390
Glyphosate	1.125	EPOST	91	54	7,840
Glyphosate acid	0.75	EPOST	91	54	6,650
Glyphosate acid	0.937	EPOST	93	59	3,530
Glyphosate acid	1.125	EPOST	94	45	5,840
Glyphosate + sulfentrazone	0.75 + 0.188	EPOST	75	40	8,840
Glyphosate/ glyphosate	0.563 / 0.563	EPOST/ LPOST	61	96	1,240
Glyphosate/ glyphosate	0.75 / 0.75	EPOST/ LPOST	79	99	620
Glyphosate acid / glyphosate acid	0.563 / 0.563	EPOST/ LPOST	80	99	0
Imazamox	0.047	EPOST	45	34	25,900
Glyphosate	0.75	MPOST	--	74	17,790
Glyphosate	0.937	MPOST	--	71	19,410
Glyphosate	1.125	MPOST	--	86	10,330
Glyphosate acid	0.75	MPOST	--	95	760
Glyphosate acid	0.937	MPOST	--	94	1,000
Glyphosate acid	1.125	MPOST	--	97	100
Glyphosate + sulfentrazone	0.75 + 0.188	MPOST	--	73	24990
Imazamox	0.047	MPOST	--	44	4,460
Untreated check			--		130,630
LSD (0.05)			10	12	17,940

[1] 90% nonionic surfactant (R-11) at 0.25% v/v was added to the glyphosate acid and imazamox treatments. 32% urea ammonium nitrate at 2.5% v/v was also added to the imazamox treatments.

[2] Rates for sulfentrazone and imazamox are expressed as lb ai/A.

Rattail fescue control in established fine fescue seed production. Larry H. Bennett, Sandra M. Frost, and Daniel A. Ball. (Columbia Basin Agricultural Research Center, Oregon State University, Pendleton, OR 97801) A study was initiated in established fine fescue at the Hermiston Agricultural Research and Extension Center near Hermiston Oregon. Chewings fine fescue had been planted in the fall of 2001 and was going into the second year of production. The plot area was naturally infested with rattail fescue, which is a serious weed problem in many of the grass seed growing areas in the Pacific Northwest. This species can cause yield losses in the field, and contaminates the harvested seed crop. Plots were 6 by 30 ft arranged in a randomized complete block design with four replications. Preemergence (PRE), early postemergence (EPOST), and late postemergence (LPOST) herbicide treatments were applied using a CO_2-pressurized backpack sprayer calibrated to deliver 16 gpa at 30 psi (Table 1). Rattail fescue control was visually rated on October 7, 2002 and April 22, 2003. Initial rattail fescue control ratings were taken before the early post treatments were applied, so only those plots which had preemergence treatments gave any control. Visible crop injury ratings were taken on November 26, 2002. The fine fescue was swathed on June 19, 2003 and harvested with a small-plot combine on July 8, 2003. The harvested seed was then cleaned and yields were determined.

Table 1. Application and soil data.

Location		Hermiston, Oregon	
Application date	August 28, 2002	October 9, 2002	March 7, 2003
Application timing	PRE	EPOST	LPOST
Fine fescue growth stage	1-3 in	3-4 in	6-8 in
Rattail fescue growth stage	PRE	1-2 in	3-4 in
Air temperature (F)	72	65	48
Relative humidity (%)	60	44	64
Wind (mph)	2-3	5-6	1-2
Cloud cover (%)	0	0	20
Soil temperature at 2 in (F)	69	54	40
pH		7.1	
OM (%)		1.2	
Texture		sandy loam	

Six of the nine treated plots had pendimethalin + S-metholachlor applied preemergence. Rattail fescue control was fair to good with these treatments (Table 2). Flufenacet + metribuzin gave comparable control, while pendimethalin applied alone was slightly less effective. There was no crop injury from preemegence treatments (data not shown). Early postemergence treatments with metribuzin caused some visual crop injury either alone or in combination with oxyfluorfen. Visual ratings taken April 25, 2003 showed pendimethalin + S-metolachlor followed by any of the postemergence treatments gave better rattail fescue control than without postemergence treatments. Flufenacet + metribuzin or pendimethalin applied preemergence gave less than 50% control. The untreated control had the lowest yield and was significantly different from six of the nine other treatments.

Table 2. Rattail fescue control, crop injury ratings, and yield of fine fescue.

Treatment	Rate	Application timing	Rattail fescue control[1] 10/7/02	Rattail fescue control[1] 4/22/03	Fine fescue injury 11/26/03	Fine fescue yield
	--lb ai/A--		-----%-----		-----%-----	---lb/A---
Pendimethalin	2.0	PRE	70	48	0	976
Flufenacet + metribuzin	0.31 + 0.08	PRE	78	45	0	795
Pendimethalin + S-metholachlor	2.0 + 0.64	PRE	83	65	0	773
Pendimethalin + S-metholachlor/ oxyfluorfen + metribuzin	2.0 + 0.64/ 0.063 + 0.19	PRE/ EPOST	75	95	16	853
Pendimethalin + S-metholachlor/ metribuzin	2.0 + 0.64/ 0.19	PRE/ EPOST	79	88	11	981
Pendimethalin + S-metholachlor/ oxyfluorfen	2.0 + 0.64/ 0.125	PRE/ EPOST	81	78	0	984
Pendimethalin + S-metholachlor/ oxyfluorfen / pendimethalin	2.0 + 0.64/ 0.125 / 2.0	PRE/ EPOST /LPOST	74	85	0	746
Pendimethalin + S-metholachlor/ oxyfluorfen / ethofumesate	2.0 + 0.64/ 0.125 / 1.0	PRE/ EPOST /LPOST	79	90	0	898
Oxyfluorfen + metribuzin/ pendimethalin	0.063 + 0.19 / 2.0	EPOST/ LPOST	0	82	14	864
Untreated control			0	0	0	607
LSD (0.05)			7	18	5	233

[1] None of the postemergence treatments had been applied when the October 7, 2002 ratings were taken.

Flax response to application timing of POST herbicides. Gregory J. Endres and Blaine G. Schatz. (Carrington Research Extension Center, North Dakota State Univ., Carrington, ND 58421) The trial was conducted to evaluate flax response to three application timings of selected POST herbicides. The experimental design was a randomized complete block with a split-plot arrangement (main plots=herbicide application timing and subplots=herbicide treatments) and three replicates. The trial was conducted on a conventional-tilled, loam soil with 6.8 pH and 3.2% organic matter at Carrington, ND in 2003. 'Cathay' flax was seeded on May 15 at the rate of 42 lb/A. Herbicide treatments were applied to the center 6.7 ft of 10- by 25-ft plots with a CO_2 pressurized hand-held plot sprayer delivering 10 gal/A at 30 psi through 8002 flat fan nozzles for the PRE treatment and 17 gal/A at 35 psi through 80015 flat fan nozzles for POST treatments. PRE sulfentrazone was applied on May 16 with 63 F, 60% RH, 100% cloudy sky and dry soil surface. Total rainfall was 0.96 inches during the 2 days following sulfentrazone application. Early POST (POST A) treatments were applied on June 9 with 67 F, 75% RH, and 10 mph wind to 1- to 2-inch tall flax. Mid POST (POST B) treatments were applied on June 18 with 71 F, 42% RH, and 6 mph wind to 6- to 7-inch tall flax, 4- to 6-inch tall green and yellow foxtail, 3- to 7-inch tall wild buckwheat, 2- to 6-inch tall common lambsquarters, 1- to 2-inch tall prostrate pigweed, and 3- to 8-inch tall redroot pigweed. Late POST (POST C) treatments were applied on June 27 with 63 F, 81% RH, and 9 mph wind to 10- to 15-inch tall flax, 8- to 10-inch tall green and yellow foxtail, 6- to 8-inch tall wild buckwheat, 4- to 10-inch tall common lambsquarters, and 6- to 12-inch tall redroot pigweed. Average plant density in untreated plots on July 3: flax = $93/ft^2$, redroot and prostrate pigweed = $4/ft^2$, and yellow and green foxtail, wild buckwheat, and common lambsquarters = $1/ft^2$. The trial was harvested on September 4 with a plot combine.

Due to generally low weed density, weed competition with flax was expected to be minimal. Averaged across herbicide treatments, broadleaf weed control was 85% with early herbicide application compared to 71 to 75% with the 2 later applications (data not shown). Flax injury (growth reduction) evaluated 7 days after herbicide application was less with flax at 1- to 2-inch height compared to later flax stages (Table 1). Days to bloom was shorter, bloom duration extended, and seed yield and oil content generally were higher with the first two herbicide application timings compared to the late timing. Plant injury occurred with all herbicide treatments and ranged from 17 to 42% with treatments that included clopyralid&MCPA or thifensulfuron (Table 2). Also, plant height was reduced 2 to 6 inches, days to bloom extended 1 to 5 days, and physiological maturity extended 1 to 4 days. However, flax yield generally was similar to the untreated check. Flax injury was 13% or less with bromoxynil&MCPA or bromoxynil&MCPA+clethodim+COC applied to 1- to 2-inch or 6- to 7-inch tall flax (Table 3). However, at each herbicide application timing, yield was similar among treatments.

Table 1. Flax response to three application timings across herbicide treatments. Carrington, ND, 2003.

	Flax						
Herbicide application timings[1]	Injury[2]	Days to bloom	Bloom duration	PM[3]	Seed yield	Test weight	Oil content
	%	days	days	days	bu/A	lb/bu	%
POSTA	14	52	21	92	42.9	54.1	41.4
POSTB	23	52	21	90	46.0	54.1	40.8
POSTC	26	56	17	91	39.9	54.1	40.4
LSD (0.05)	8	1	1	NS	3.8	NS	0.5

[1] POSTA=1- to 2-inch tall flax; POSTB=6- to 7-inch tall flax; POSTC=10- to 15-inch tall flax.

[2] Injury=% growth reduction by visual evaluation 7 d after treatment.

[3] PM=Physiological maturity from seeding date.

Table 2. Agronomic traits of flax as influenced by herbicide treatment, Carrington, ND, 2003.

Herbicide			Plant	Days to		Seed
Treatment[1]	Rate	Injury[2]	height	bloom	PM[3]	yield
	lb ai/A	%	inch	days	days	bu/A
Bromoxynil&MCPA	0.23&0.23	8	14	53	90	43.9
Clopyralid&MCPA	0.07&0.39	20	12	53	91	40.3
Bromoxynil&MCPA+clopyralid& MCPA	0.23&0.23+0.07&0.39	26	12	54	91	40.5
Bromoxynil&MCPA+clethodim+COC	0.23&0.23+0.08+2pt	13	13	52	90	45.6
Sulfentrazone(PRE)/Bromoxynil& MCPA+clethodim+COC	0.19/0.23&0.23+ 0.08+2pt	11	14	52	90	47.5
Clopyralid&MCPA+clethodim+COC	0.07&0.39+0.08+2pt	17	13	53	92	45.1
Bromoxynil&MCPA+clopyralid& MCPA+clethodim+COC	0.23&0.23+0.07&0.39+ 0.08+2pt	42	11	54	91	40.7
Bromoxynil&MCPA+thifensulfuron	0.23&0.23+0.008	38	10	56	93	40.8
Bromoxynil&MCPA+thifensulfuron	0.23&0.23+0.004	34	10	56	93	42.2
Untreated Check	x	0	16	51	89	42.8
LSD (0.05)		7	2	1	1	4.5

[1] COC=Scoil, a methylated seed oil from AGSCO, Grand Forks, ND.

[2] Injury=% growth reduction by visual evaluation 7 d after treatment.

[3] PM=Physiological maturity from seeding date.

Table 3. Flax injury and yield as impacted by three application timings of POST herbicides, Carrington, ND, 2003.

		Herbicide application timing[1]					
		POSTA		POSTB		POSTC	
Herbicide		Flax					
Treatment[2]	Rate	Injury[3]	Yield	Injury	Yield	Injury	Yield
	lb ai/A	%	bu/A	%	bu/A	%	bu/A
Bromoxynil&MCPA	0.23&0.23	2	42.6	7	49.6	17	39.5
Clopyralid&MCPA	0.07&0.39	20	34.3	25	45.4	15	41.1
Bromoxynil&MCPA+clopyralid& MCPA	0.23&0.23+0.07&0.39	17	43.7	22	41.6	38	36.4
Bromoxynil&MCPA+clethodim+COC	0.23&0.23+0.08+2pt	8	44.7	13	48.2	18	44.0
Sulfentrazone(PRE)/Bromoxynil& MCPA+clethodim+COC	0.19/0.23&0.23+ 0.08+2pt	7	50.4	8	47.8	18	44.2
Clopyralid&MCPA+clethodim+COC	0.07&0.39+0.08+2pt	12	42.6	15	51.2	25	41.4
Bromoxynil&MCPA+clopyralid& MCPA+clethodim+COC	0.23&0.23+0.07&0.39+ 0.08+2pt	27	40.8	38	45.5	62	35.7
Bromoxynil&MCPA+thifensulfuron	0.23&0.23+0.008	25	42.7	50	43.4	40	36.3
Bromoxynil&MCPA+thifensulfuron	0.23&0.23+0.004	25	45.0	50	43.9	28	37.5
Untreated Check	x	0	42.2	0	43.0	0	43.3
Interaction of Timing x Herbicide: LSD (0.05)		13	NS	13	NS	13	NS

[1] POSTA=1- to 2-inch tall flax; POSTB=6- to 7-inch tall flax; POSTC=10- to 15-inch tall flax.

[2] COC=Scoil, a methylated seed oil from AGSCO, Grand Forks, ND.

[3] Injury=% growth reduction by visual evaluation 7 d after treatment.

Weed control with soil- and POST-applied herbicides in field pea. Gregory J. Endres, Robert A. Henson, and Blaine G. Schatz. (Carrington Research Extension Center, North Dakota State Univ., Carrington, ND 58421) Weed control and field pea response to selected soil- and POST-applied herbicides were evaluated in a randomized complete block design with three replicates. The experiment was conducted on a Heimdahl loam soil with 7.9 pH and 2.9% organic matter at Carrington, ND in 2003. The trial area was cultivated on May 15 with a Melroe culti-harrow. Herbicide treatments were applied at 18 gal/A and 30 psi through 8001 flat fan nozzles to 5 by 25 ft plots with a CO_2 pressurized hand-held plot sprayer. PPI treatments were applied on May 16 with 54 F, 86% RH, and 95% clear sky and immediately incorporated twice using a field cultivator plus harrow set at a 2- to 3-inch depth. On May 16, inoculated 'Integra' field pea was planted in 7-inch rows at pure live seed rates of 300,000 seeds/A. PRE treatments were applied on a dry soil surface on May 16 with 55 F, 92% RH, 10 mph wind, and100% cloudy sky. A total of 1.12 inches of rainfall occurred during the 2-day period following application of PRE treatments. POST treatments were applied on June 10 with 62 F, 75% RH, 9 mph wind, and 100% cloudy sky to 3- to 5-inch tall field pea, 2- to 4-leaf yellow and green foxtail, 0.5- to 2-inch tall common lambsquarters, 0.5- to 1-inch tall redroot and prostrate pigweed, and 1- to 3-inch tall volunteer flax. Average plant density in untreated plots on June 13: field pea = $9/ft^2$, yellow and green foxtail = $45/ft^2$, common lambsquarters = $3/ft^2$, redroot and prostrate pigweed = $12/ft^2$, and volunteer flax = $2/ft^2$. The trial was harvested with a plot combine on August 26.

Good to excellent foxtail, common lambsquarters, and pigweed control (88 to 99%) and good volunteer flax control (81 to 84%) was achieved with PPI ethalfluralin+metribuzin, ethalfluralin+imazethapyr, and pendimethalin+ imazethapyr (Table 1). However, ethalfluralin+metribuzin caused 20 to 25% pea injury and reduced seed yield (Table 2). Sequential soil-applied/POST treatments provided 86 to 99% control of foxtail, common lambsquarters, and pigweed, and pea yield of 52.3 to 58.2 bu/A but injury ranged from 9 to 21%. PRE pendimethalin+imazethapyr improved foxtail control compared to imazethapyr. POST imazethapyr and imazamox generally provided similar weed control and pea yield. Imazamox at 0.03 lb/A + bentazon or bentazon+sethoxydim provided 83 to 86% control of foxtail and 98 to 99% control of common lambsquarters and pigweed. Treatments that included bentazon+sethoxydim injured pea 9 to 21% but yield ranged from 48.0 to 58.2 bu/A. POST metribuzin at 0.19 lb/A provided 93% volunteer flax control but pea injury ranged from 28 to 33%.

Table 1. Weed control in field pea, Carrington, 2003.

		7/8				7/30		
Treatment[1]	Rate	Foxtail spp.[2]	Common lambs- quarters	Pigweed spp.[2]	Vol. flax	Foxtail spp.	Common lambs- quarters	Pigweed spp.
	lb ai/A	% control						
Untreated	x	0	0	0	0	0	0	0
PPI/POST								
Ethalfluralin+ metribuzin	0.75+0.38	88	99	98	81	92	98	97
Etha+imazethapyr	0.75+0.03	94	98	98	84	95	98	98
Pendimethalin+imep	0.52+0.03	90	98	98	82	91	98	99
Imep+sulfentrazone	0.03+0.19	73	99	99	73	70	99	99
Pend/bentazon+ sethoxydim+ imazamox+COC+ 28%N	1.46/0.8+ 0.2+0.015+1%+ 2pt	96	99	99	76	98	98	99
PRE/POST								
Imep	0.03	72	98	99	67	70	98	99
Imep+pend	0.03+0.52	81	97	99	62	83	98	99
Imep&glyphosate	0.05&0.56	75	98	98	78	75	99	99
Imep&glyt/bent+seth+ COC	0.05&0.56/0.8+0 .2+2pt	86	92	96	57	87	91	99
Imep&glyt+glyt/ bent+seth+COC	0.03&0.37+ 0.28/ 0.8+0.2+2pt	90	92	93	69	89	93	95
POST								
Bent+seth+COC	0.8+0.2+2pt	85	99	58	33	84	97	67
Imep+NIS	0.03+0.25%	80	52	99	33	80	67	99
Immx+NIS	0.03+0.25%	78	63	99	33	79	70	99
Immx+bent+NIS+ 28%N	0.03+0.19+ 0.25%+2pt	85	98	99	33	83	98	99
Immx+bent+seth+ NIS+28%N	0.03+0.3+0.075 + 0.25%+2pt	86	98	99	43	86	99	99
Immx+bent+seth+ NIS+28%N	0.015+0.8+0.2+ 0.25%+2pt	80	96	99	50	75	99	99
Immx+bent+seth+ COC+28%N	0.015+0.8+0.2+ 1%+2pt	80	96	96	37	73	99	99
Metr+seth+COC	0.13+0.2+2pt	82	99	76	60	78	99	82
Metr+seth+COC	0.19+0.2+2pt	88	99	81	93	79	99	84
LSD (0.05)		8	9	9	21	11	4	8

[1] etha=ethalfluralin; imep=imazethapyr; pend= pendamenthalin; bent=bentazon; seth=sethoxydim; glyt=glyphosate; immx=imazamox; metr=metribuzin; COC=Hasten, a methylated seed oil from Wilbur-Ellis, Fresno, CA; NIS=Preference, a nonionic surfactant from Agriliance, St. Paul, MN.

[2] Foxtail spp.=Yellow and green; Pigweed spp.=Redroot and prostrate.

Table 2. Field pea response to herbicide treatments, Carrington, 2003.

		Crop injury		
Treatment[1]	Rate	6/26	7/8	Seed yield
	lb ai/A	------------- %	-------------	bu/A
Untreated	x	0	0	31.6
PPI/POST				
Ethalfluralin+metribuzin	0.75+0.38	25	20	45.3
Etha+imazethapyr	0.75+0.03	4	5	53.8
Pendimethalin+imep	0.52+0.03	0	0	60.4
Imep+sulfentrazone	0.03+0.19	17	13	55.7
Pend/bentazon+sethoxydim+ imazamox+COC+28%N	1.46/0.8+0.2+0.015+1%+2pt	21	18	52.3
PRE/POST				
Imep	0.03	0	0	52.7
Imep+pend	0.03+0.52	0	0	57.0
Imep&glyphosate	0.05&0.56	0	0	56.4
Imep&glyt/bent+seth+COC	0.05&0.56/0.8+0.2+2pt	11	12	54.0
Imep&glyt+glyt/bent+seth+COC	0.03&0.37+0.28/0.8+0.2+2pt	12	9	58.2
POST				
Bent+seth+COC	0.8+0.2+2pt	13	10	48.0
Imep+NIS	0.03+0.25%	0	0	51.2
Immx+NIS	0.03+0.25%	0	0	50.6
Immx+bent+NIS+28%N	0.03+0.19+0.25%+2pt	0	3	44.5
Immx+bent+seth+NIS+28%N	0.03+0.3+0.075+0.25%+2pt	19	15	54.9
Immx+bent+seth+NIS+28%N	0.015+0.8+0.2+0.25%+2pt	16	12	50.5
Immx+bent+seth+COC+28%N	0.015+0.8+0.2+1%+2pt	16	14	53.4
Metr+seth+COC	0.13+0.2+2pt	17	14	48.6
Metr+seth+COC	0.19+0.2+2pt	33	28	58.9
LSD (0.05)		8	7	12.6

[1] etha=ethalfluralin; imep=imazethapyr; pend= pendamenthalin; bent=bentazon; seth=sethoxydim; glyt=glyphosate; immx=imazamox; metr=metribuzin; COC=Hasten, a methylated seed oil from Wilbur-Ellis, Fresno, CA; NIS=Preference, a nonionic surfactant from Agriliance, St. Paul, MN.

Herbicide combinations for season-long weed control in peppermint. Richard Affeldt, Chuck Cole, Carol Mallory-Smith, Jed Colquhoun, and Darrin Walenta. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR, 97331-3002) A trial was replicated in western, central, and eastern Oregon to evaluate season-long weed control in peppermint. Treatments compared flumioxazin or oxyfluorfen as part of a winter burn-down, followed by sulfentrazone, pendimethalin, clomazone, and/or norflurazon for residual summer-annual weed control.

Herbicides were applied at 20 gpa and 20 psi. Trials were conducted in growers' fields in randomized complete blocks with four replications of 8 ft by 20 ft plots. Soil data and herbicide application information are presented in Table 1. Visual evaluations of peppermint injury and weed control were conducted through the spring. Final evaluations from May and June are presented in Table 2. Peppermint fresh weight was obtained by hand-harvesting three 1-sq yd quadrats of peppermint in each plot. Samples were air dried and oil yield was obtained through steam distillation.

There was minimal crop injury in all three trials and common groundsel control was very good. Excellent kochia control was also observed in central Oregon. No treatment reduced fresh weight or oil yield compared to the untreated check (Table 3). Yield differences among herbicide treatments were most likely caused by variability in the peppermint stand, not treatment effects.

Table 1. Soil and herbicide application information.

	Soil			Application date	
Location	Type	pH	O.M.	Fall	Spring
Western, Linn Co.	Chehalis silty clay loam	5.3	6.1	Dec 6, 2002	Jan 27, 2003
Central, Crook Co.	Ochoco sandy loam	5.8	4.9	Dec 19, 2002	Feb 18, 2003
Eastern, Union Co.	Alicel sandy loam	5.3	3.0	Nov 19, 2002	Mar 10, 2003

Table 2. Peppermint injury and weed control at three locations in Oregon.

			------- Western -------		-------------- Central --------------			Eastern
Treatment	Rate	Timing	Mint 6/12/03	Common groundsel	Mint 6/17/03	Common groundsel	Kochia	Mint 5/8/03
	lb a.i./A		% injury	% control	% injury	---- % control ----		% injury
Flumioxazin+paraquat / sulfentrazone+clomazone	0.125+0.375 / 0.125+0.5	December / February	0	100	5	100	100	9
Oxyfluorfen+paraquat / sulfentrazone+clomazone	0.5+0.375 / 0.125+0.5	December / February	0	100	5	100	100	5
Flumioxazin+paraquat / sulfentrazone+norflurazon	0.125+0.375 / 0.125+0.79	December / February	0	100	3	95	100	9
Oxyfluorfen+paraquat / sulfentrazone+norflurazon	0.5+0.375 / 0.125+0.79	December / February	0	100	0	100	100	10
Flumioxazin+paraquat / sulfentrazone+pendimethalin	0.125+0.375 / 0.125+2.0	December / February	0	100	10	93	100	16
Oxyfluorfen+paraquat / sulfentrazone+pendimethalin	0.5+0.375 / 0.125+2.0	December / February	0	100	0	93	100	10
Untreated check	0.0	---	0	0	0	0	0	0
LSD $_{(0.05)}$	---	---	NS	0	NS	11	0	6

Table 3. Peppermint fresh weight and oil yield at three locations in Oregon

			------- Western -------		------- Central -------		-------- Eastern --------	
Treatment	Rate	Timing	Fresh wt.	Oil yield	Fresh wt.	Oil yield	Fresh wt.	Oil yield
	lb a.i./A		lb/3 yd^2	lb/A	lb/3 yd^2	lb/A	lb/3 yd^2	lb/A
Flumioxazin+paraquat / sulfentrazone+clomazone	0.125+0.375 / 0.125+0.5	December / February	11.9	51.8	20.6	68.9	17.0	89.7
Oxyfluorfen+paraquat / sulfentrazone+clomazone	0.5+0.375 / 0.125+0.5	December / February	15.2	59.7	19.4	60.5	22.5	101.0
Flumioxazin+paraquat / sulfentrazone+norflurazon	0.125+0.375 / 0.125+0.79	December / February	11.9	52.9	20.5	67.4	20.8	105.6
Oxyfluorfen+paraquat / sulfentrazone+norflurazon	0.5+0.375 / 0.125+0.79	December / February	13.3	57.9	21.3	73.7	18.9	86.8
Flumioxazin+paraquat / sulfentrazone+pendimethalin	0.125+0.375 / 0.125+2.0	December / February	13.8	62.5	19.9	68.4	17.5	80.9
Oxyfluorfen+paraquat / sulfentrazone+pendimethalin	0.5+0.375 / 0.125+2.0	December / February	14.1	62.9	20.1	66.5	19.3	93.9
Untreated check	0.0	---	14.7	54.9	20.4	69.6	18.0	90.3
LSD $_{(0.05)}$	---	---	NS	NS	NS	11.6	3.9	17.0

Tolerance of peppermint to flumioxazin and oxyfluorfen combinations with paraquat. Richard Affeldt, Chuck Cole, Carol Mallory-Smith, Jed Colquhoun, and Darrin Walenta. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR, 97331-3002) A trial was replicated in western, central, and eastern Oregon to evaluate peppermint crop safety from dormant-season herbicide applications. Oxyfluorfen is commonly used in dormant peppermint because of good crop safety and the wide spectrum of weeds controlled. Flumioxazin has not been as safe or as effective as oxyfluorfen. Split-applications of 0.125 lb a.i./A of flumioxazin were evaluated in an attempt to reduce crop injury that was observed in previous research using a 0.25 lb a.i./A rate.

Herbicides were applied at 20 gpa and 20 psi. Trials were conducted in growers' fields in randomized complete blocks with four replications of 8 ft by 20 ft plots. Soil data and herbicide application information are presented in Table 1. Visual evaluations of peppermint injury and weed control were conducted through the spring. Final evaluations from May and June are presented in Table 2. Peppermint fresh weight was obtained by hand-harvesting three 1-sq yd quadrats of peppermint in each plot. Samples were air dried and oil yield was obtained through steam distillation.

The peppermint in central Oregon was quite vigorous, and injury was minimal from these treatments (Table 2). However, injury from split-applications was severe and fresh weight was reduced about 30% in western Oregon, where the mint was verticillium wilt infected and propane-flamed. Injury was also observed to a lesser extent in eastern Oregon in a weak stand of mint. Flumioxazin at 0.125 lb a.i./A per season, alone or with paraquat, was as safe as oxyfluorfen with paraquat at either timing in all three trials.

Table 1. Soil and herbicide application information.

	Soil			Application date	
Location	Type	pH	O.M.	Fall	Spring
Western, Lane Co.	Camas gravelly sandy loam	5.4	6.7	Dec 31, 2002	Jan 27, 2003
Central, Deschutes Co.	Lafollette sandy loam	6.1	3.4	Dec 19, 2002	Feb 18, 2003
Eastern, Union Co.	Alicel fine sandy loam	5.1	4.1	Nov 14, 2002	Mar 10, 2003

Table 2. Peppermint injury and yield at three locations in Oregon.

			---- Western ----			---- Central ----			Eastern
Treatment	Rate	Applic. timing	7/2/03	Fresh wt.	Oil yield	7/17/03	Fresh wt.	Oil yield	5/23/03
	Lb a.i./A		% injury	lb/3 yd^2	lb/A	% injury	lb/3 yd^2	lb/A	% injury
Flumioxazin	0.125	Fall	5	22.9	71.4	0	17.8	68.2	5
Flumioxazin+paraquat	0.125+0.375	Fall	5	22.0	70.4	0	17.5	73.6	3
Oxyfluorfen+paraquat	0.5+0.375	Fall	0	26.0	72.6	0	17.1	75.3	1
Flumioxazin / flumioxazin	0.125 / 0.125	Fall / Spring	28	20.0	65.5	0	16.9	71.5	4
Flumioxazin+paraquat / flumioxazin+paraquat	0.125+0.375 / 0.125+0.375	Fall / Spring	33	16.9	64.9	0	17.5	74.3	18
Flumioxazin	0.125	Spring	0	22.9	72.4	0	17.9	68.6	1
Flumioxazin+paraquat	0.125+0.375	Spring	0	21.0	68.7	0	18.5	77.3	9
Oxyfluorfen+paraquat	0.5+0.375	Spring	0	24.1	71.6	0	17.6	75.1	6
Untreated check	0.0	---	0	27.2	67.0	0	18.4	74.7	0
LSD$_{(0.05)}$	---	---	16	6	NS	NS	NS	NS	8

Annual bluegrass control in carbon-seeded perennial ryegrass. Chuck Cole, Richard Affeldt, Carol Mallory-Smith, and Jed Colquhoun. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002) Three trials were conducted to evaluate soil-applied herbicides as diuron supplements for the control of annual bluegrass in carbon-seeded perennial ryegrass. Two sites were in growers' fields located in Tangent and Shedd and were infested with annual bluegrass that was purportedly diuron-resistant. A third site was located at the OSU Hyslop Research Farm near Corvallis and was infested with non-resistant annual bluegrass. Activated carbon was applied over the seed row in a 1-inch-wide band at 300 lb/A during the planting process for each trial. Treatments were applied to 8 ft by 25 ft plots with a single-wheel compressed air sprayer calibrated to deliver 20 gpa. The experimental design was a randomized complete block with four replications. Herbicide application and site conditions are presented in Table 1.

Table 1. Agronomic, application, and soil data for three trial sites in western Oregon.

	Corvallis	Tangent	Shedd
Planting date	September 23, 2002	October 7, 2002	October 2, 2002
Swathing date	July 8, 2003	July 11, 2003	July 10, 2003
Threshing date	July 17, 2003	July 21, 2003	July 23, 2003
Treatment application			
Application date	September 23, 2002	October 8, 2002	October 4, 2002
Air temperature (F)	84	72	56
Soil temperature (F)	70	68	52
Relative humidity (%)	20	55	83
Cloud cover (%)	50	20	100
Wind speed (mph)	5	2	1
Soil			
pH	5.8	5.0	6.7
Organic matter (%)	2.4	6.2	6.2
Texture	Woodburn silt loam	Dayton silt loam	Amity silt loam

Annual bluegrass control and perennial ryegrass injury were evaluated visually. The perennial ryegrass was swathed and then machine-threshed with a small-plot combine. Perennial ryegrass seed was cleaned with an air screen machine prior to weighing and yield calculations.

Visible perennial ryegrass injury--moderate chlorosis-- was evident in treatments containing norflurazon at all three locations, but had mostly subsided by February and did not result in seed yield reductions (data not shown).

Residual annual bluegrass control was improved at all three locations with the addition of either norflurazon or pronamide to diuron applied at 1.6 lb ai/A compared to diuron applied alone at 2.4 lb ai/A (Table 2). The supplemental use of the higher rates of norflurazon and pronamide with diuron provided the most consistent annual bluegrass control. Residual annual bluegrass control was poor were flumioxazin was applied with diuron.

Table 2. Annual bluegrass control in perennial ryegrass at three sites in western Oregon.

		Annual bluegrass control					
		Corvallis		Tangent		Shedd	
Treatment	Rate	Oct.7	Feb.5	Nov.4	Feb.7	Nov.4	Feb.7
	lb a.i./A	%					
Untreated check	0	--	--	--	--	--	--
Diuron + norflurazon	1.6 + 0.98	96	78	94	79	95	85
Diuron + norflurazon	1.6 + 1.96	98	75	97	90	98	90
Diuron + pronamide	1.6 + 0.375	99	80	98	81	96	79
Diuron + pronamide	1.6 + 0.5	99	85	99	89	98	90
Diuron + flumioxazin	1.6 + 0.1	94	69	94	50	93	44
Diuron + flumioxazin	1.6 + 0.2	94	50	96	51	97	48
Diuron	2.4	89	50	91	50	90	38
Pronamide + norflurazon	0.375 + 0.98	98	88	95	85	93	83
Pronamide + flumioxazin	0.375 + 0.1	99	76	96	88	96	83
LSD (0.05)		3.9	7.0	2.9	9.5	3.3	11.8

Grass weed control in imidazolinone-resistant winter wheat with imazamox. Traci A. Rauch and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established in Clearfield (imidazolinone-resistant) winter wheat near Lewiston, Idaho, Pullman, Washington, and Bonners Ferry, Idaho to evaluate downy brome, Italian ryegrass, and wild oat control, respectively. Wheat was seeded on October 3 and 4, and November 7, 2002 near Bonners Ferry, Pullman, and Lewiston, respectively. In Bonners Ferry, wheat was reseeded and the study relocated on May 12, 2003 due to flooding. In all experiments, plots were 8 by 30 ft arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). The Lewiston site was oversprayed with 2,4-D ester at 0.5 lb ae/A and fluroxypyr 0.125 lb ae/A on May 1, 2003, and the Bonners Ferry site was oversprayed with MCPA ester at 0.5 lb ae/A on June 20, 2002. Wheat injury and weed control were evaluated visually during the growing season. Wheat seed was harvested with a small plot combine on July 30 and August 7, 2003 at the Lewiston and Pullman locations, respectively. The Bonners Ferry site was not harvested due to a poor wheat stand after reseeding.

Table 1. Application and soil data.

Location	Pullman, Washington	Lewiston, Idaho	Bonners Ferry, Idaho
Application date	May 7, 2003	April 28, 2003	June 16, 2003
Wheat variety	ID-587	F2020	Fidel
Growth stage			
Wheat	3 to 4 tiller	3 to 4 tiller	3 to 5 tiller
Italian ryegrass	3 to 4 tiller	--	--
Wild oat (AVEFA)	--	--	2 to 4 leaf
Downy brome (BROTE)	--	3 to 5 leaf	--
Air temperature (F)	45	50	80
Relative humidity (%)	75	71	50
Wind (mph, direction)	2, E	1, W	1, NW
Cloud cover (%)	10	40	10
Soil moisture	wet	damp	dry
Soil temperature at 2 in (F)	43	45	70
pH	5.1	6.1	7.6
OM (%)	3.5	5.5	4.0
CEC (meq/100g)	23	38	10.5
Texture	silt loam	silt loam	silt loam

At the Pullman study on May 22, all treatments injured wheat 4 to 6% (Table 2). By June 17, no treatment visibly injured wheat (data not shown). All treatments controlled Italian ryegrass 88 to 94%. Wheat yield was greatest with imazamox at 0.0312 lb ai/A + nitrogen at 30% v/v (98 bu/A), but did not differ from imazamox at 0.0312 lb ai/A + nitrogen at 10 or 50% v/v (90 to 96 bu/A). Wheat test weight ranged from 60.0 to 60.8 lb/bu and did not differ among treatments.

At the Lewiston study on June 2, 2003, wheat was injured 11% by imazamox at 0.0312 lb ai/A + nitrogen at 10% v/v and was not different from the low rate of imazamox combined with nitrogen at 2.5 and 50% v/v (6%) (Table 3). By June 24, no treatment visibly injured wheat (data not shown). All treatments controlled downy brome 84 to 92%. Wheat yield with proproxycarbazone (67 bu/A) was greater than all other treatments except the untreated check (64 bu/A). All imazamox treatments, except at 0.039 lb ai/A + nitrogen at 10% v/v, yielded less than the untreated check. Wheat yield was poorly correlated with downy brome control due to a heavy non-imidazolinone volunteer winter wheat population. In imazamox treated plots, all volunteer non-imidazolinone resistant wheat was killed and overall wheat stand reduced. Wheat test weight ranged from 60.6 to 61.5 lb/bu and did not differ among treatments.

At the Bonners Ferry study on July 17, imazamox at 0.039 lb ai/A + nitrogen at 2.5% v/v injured wheat 11% but was not different from imazamox at 0.039 lb ai/A + nitrogen at 10% v/v or imazamox at 0.0312 lb ai/A with nitrogen at 30 or 50% v/v (9 to 10%) (Table 4). On August 8, wheat was visibly injured by imazamox at 0.0312 lb ai/A with nitrogen at 30 and 50% v/v (6 to 9%). Wild oat control was 98 to 99% with all treatments.

Table 2. Italian ryegrass control and wheat injury, yield, and test weight with imazamox near Pullman, Washington in 2003.

Treatment[1]	Rate	Wheat injury[2,3]	Italian ryegrass control[2,4]	Wheat[2]	
				Yield	Test weight
	lb ai/A	------------%-----------		bu/A	lb/bu
Imazamox +	0.031				
nitrogen	2.5% v/v	4	89	83	60.8
Imazamox +	0.031				
nitrogen	10% v/v	5	91	90	60.7
Imazamox +	0.031				
nitrogen	30% v/v	6*	90*	98*	60.8*
Imazamox +	0.031				
nitrogen	50% v/v	7	92	96	60.5
Imazamox +	0.031				
AMS	15 lb/100 gal	6	93	84	60.6
Imazamox +	0.039				
nitrogen	2.5% v/v	6*	88*	87*	60.7*
Imazamox +	0.039				
nitrogen	10% v/v	6*	94*	81*	60.3*
Untreated check	--	--	--	75	60.0
LSD (0.05)		NS	NS	10	NS
Density (plants/ft^2)			85		

[1] Nitrogen is 32% urea ammonium nitrate, AMS is ammonium sulfate (Bronc), and 90% nonionic surfactant (R-11) was applied with all treatments at 0.25% v/v.

[2] Due to water stress in low-lying areas, only 3 replications were analyzed, or 2 replications if marked with (*).

[3] May 22, 2003 evaluation.

[4] July 9, 2003 evaluation.

Table 3. Downy brome control and wheat injury, yield, and test weight with imazamox near Lewiston, Idaho in 2003.

Treatment[1]	Rate	Wheat injury[2]	Downy brome control[3]	Wheat	
				Yield	Test weight
	lb ai/A	-------------%------------		bu/A	lb/bu
Proproxycarbazone	0.04	0	84	67	61.0
Imazamox +	0.031				
nitrogen	2.5% v/v	6	87	52	61.0
Imazamox +	0.031				
nitrogen	10% v/v	11	91	52	60.6
Imazamox +	0.031				
nitrogen	30% v/v	2	92	52	61.2
Imazamox +	0.031				
nitrogen	50% v/v	6	98	55	61.4
Imazamox +	0.031				
AMS	15 lb/100 gal	4	88	51	61.4
Imazamox +	0.039				
nitrogen	2.5% v/v	2	92	54	61.5
Imazamox +	0.039				
nitrogen	10% v/v	2	89	58	61.2
Untreated check	--	--	--	64	60.8
LSD (0.05)		6	NS	7	NS
Density (plants/ft^2)			10		

[1] Nitrogen is 32% urea ammonium nitrate, AMS is ammonium sulfate (Bronc), and 90% nonionic surfactant (R-11) was applied with all treatments at 0.25% v/v.

[2] June 2, 2003 evaluation.

[3] June 24, 2003 evaluation.

Table 4. Wheat injury and wild oat control with imazamox near Bonners Ferry, Idaho in 2003.

Treatment[1]	Rate	Wheat injury		Wild oat control[2]
		July 17	August 6	
	lb ai/A	--------%	--------	--------
Imazamox +	0.031			
NIS +	0.25% v/v			
nitrogen	2.5% v/v	7	2	99
Imazamox +	0.031			
NIS +	0.25% v/v			
nitrogen	10% v/v	7	3	99
Imazamox +	0.031			
NIS +	0.25% v/v			
nitrogen	30% v/v	10	9	98
Imazamox +	0.031			
NIS +	0.25% v/v			
nitrogen	50% v/v	9	6	99
Imazamox +	0.031			
NIS +	0.25% v/v			
AMS	15 lb/100 gal	7	4	99
Imazamox +	0.039			
NIS +	0.25% v/v			
nitrogen	2.5% v/v	11	5	99
Imazamox +	0.039			
NIS +	0.25% v/v			
nitrogen	10% v/v	10	5	99
Flucarbazone +	0.027			
NIS	0.25% v/v	5	0	99
Mesosulfuron/safener +	0.0089			
safener +	0.0356			
NIS +	0.5% v/v			
nitrogen	2.5% v/v	0	1	99
Mesosulfuron/safener +	0.0089			
safener +	0.0356			
MSO +	1.5 pt/A			
nitrogen	2.5% v/v	0	1	99
Mesosulfuron +	0.0089			
safener +	0.0534			
MSO +	1.5 pt/A			
nitrogen	2.5% v/v	0	2	99
LSD (0.05)		3	3	NS
Density (plants/ft^2)				2

[1] NIS = 90% nonionic surfactant (R-11), nitrogen= 32% urea ammonium nitrate, MSO = methylated seed oil. Mesosulfuron/safener premix treatments had a 1:2 ratio of mesosulfuron to safener (mefenpyr-diethyl) which is needed for crop safety in winter wheat. A higher ratio (1:6) of safener to mesosulfuron may have been needed due to spring reseeding.

[2] August 6, 2003 evaluation.

Downy brome control in winter wheat. Traci A. Rauch and Donald C. Thill (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established near Lewiston, Idaho in 'F2020' (imidazolinone-resistant soft white) and 'Boundary' (hard red) winter wheat. Three studies evaluated downy brome (BROTE) control and wheat response with 1) flufenacet combinations in 'F2020'wheat, and 2) proproxycarbazone with broadleaf herbicides and 3) proproxycarbazone with various nitrogen rates, both in 'Boundary' wheat. All plots were 8 by 30 ft arranged in a randomized complete block design with four replications. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). All studies were oversprayed with thifensulfuron/tribenuron at 0.014 lb ai/A and 2,4-D ester at 0.5 lb ae/A to control broadleaf weeds on May 1, 2003. In all experiments, wheat injury and downy brome control were evaluated visually, and wheat seed was harvested on July 30, 2003.

Table 1. Application and soil data.

Study	Proproxycarbazone + broadleaf combinations	Proproxycarbazone + nitrogen rates	Flufenacet combinations		
Application date	4/21/03	4/15/03	11/11/02	4/15/03	4/28/03
Wheat growth stage	3 to 4 tiller	2 to 3 tiller	preemergence	1 tiller	3 to 4 tiller
Downy brome growth stage	3 to 4 leaf	2 to 4 leaf	preemergence	1 to 3 leaf	3 to 5 leaf
Air temperature (F)	62	50	47	56	50
Relative humidity (%)	57	71	73	55	71
Wind (mph, direction)	2, NW	2, SW	1, SW	5, W	2, W
Cloud cover (%)	30	30	99	75	40
Soil moisture	dry	damp	damp	damp	damp
Soil temperature at 2 in (F)	50	47	40	50	45
pH	5.5		6.1		
OM (%)	3.0		5.5		
CEC (meq/100g)	19		38		
Texture	silt loam		silt loam		

In the proproxycarbazone + broadleaf herbicides study, no treatment visibly injured winter wheat (data not shown). Downy brome control was better with proproxycarbazone + metribuzin and proproxycarbazone at 0.027 lb ai/A + bromoxynil/MCPA than proproxycarbazone alone at 0.027 lb ai/A or combined with fluroxypyr or 2,4-D ester (Table 2). Overall, downy brome control was not reduced by the addition of any broadleaf herbicide when compared to the same rate of proproxycarbazone alone. Wheat grain yield was lowest for the untreated check (40 bu/A) but did not differ among all treatments. Wheat seed test weight ranged from 62.1 to 63.1 lb/bu for all treatments and did not differ among treatments (data not shown).

In the proproxycarbazone + nitrogen study, all treatments applied with nitrogen at 100% v/v injured wheat 4% on April 28, 2003 (Table 3). By May 21, no treatment visually injured wheat (data not shown). Proproxycarbazone at 0.04 lb ai/A + nitrogen at 100% v/v controlled downy brome 91%, but was not different from sulfosulfuron + nitrogen at 100% v/v (78%). Wheat grain yield was lowest for the untreated check (46 bu/A) but did not differ among all treatments. Nitrogen at 100% v/v plus proproxycarbazone at 0.04 lb ai/A or sulfosulfuron reduced wheat seed test weight compared to all other treatments, except proproxycarbazone at 0.027 lb ai/A + nitrogen at 100% v/v.

In the flufenacet combination study, wheat was injured 1 to 8% but was not different among treatments (Table 4). Downy brome control was better with imazamox at 0.048 lb ai/A, mesosulfuron + MSO, and all flufenacet combinations, except with metribuzin (85 to 97%) than sulfosulfuron, proproxycarbazone, flufenacet, and metribuzin alone or metribuzin + flufenacet (25 to 60%). Wheat grain yield ranged from 44 to 52 bu/A and tended to be lower in imazamox treated plots (44 to 45 bu/A), but did not differ among treatments. In imazamox treated plots, all volunteer non-imidazolinone resistant wheat was killed and overall wheat stand reduced. Wheat seed test weight ranged from 60.4 to 61.7 lb/bu and did not differ among treatments (data not shown).

Table 2. Downy brome control and wheat yield with proproxycarbazone combined with broadleaf herbicides near Lewiston, Idaho in 2003.

Treatment[1]	Rate	Downy brome control[2]	Wheat yield
	lb ai/A	%	bu/A
Proproxycarbazone	0.027	54	45
Proproxycarbazone	0.04	62	46
Proproxycarbazone + metribuzin	0.027 + 0.141	69	48
Proproxycarbazone + metribuzin	0.04 + 0.141	69	46
Proproxycarbazone + bromoxynil/MCPA	0.027 + 0.75	68	46
Proproxycarbazone + bromoxynil/MCPA	0.04 + 0.75	64	46
Proproxycarbazone + MCPA ester	0.027 + 0.75	64	46
Proproxycarbazone + MCPA ester	0.04 + 0.75	66	52
Proproxycarbazone + fluroxypyr	0.027 + 0.187	55	47
Proproxycarbazone + fluroxypyr	0.04 + 0.187	59	48
Proproxycarbazone + carfentrazone	0.027 + 0.008	59	53
Proproxycarbazone + carfentrazone	0.04 + 0.008	60	46
Proproxycarbazone + thifensulfuron/tribenuron	0.027 + 0.014	58	50
Proproxycarbazone + thifensulfuron/tribenuron	0.04 + 0.014	58	46
Proproxycarbazone + 2,4-D ester	0.027 + 0.5	44	48
Proproxycarbazone + 2,4-D ester	0.04 + 0.5	69	48
Untreated check	--	--	40
LSD (0.05)		12	NS
Density (plants/ft^2)		30	

[1] All treatments were applied with 90% nonionic surfactant (R-11) at 0.25% v/v. MCPA, 2,4-D and fluroxypyr treatments were in lb ae/A.

[2] June 24, 2003 evaluation.

Table 3. Downy brome control and wheat injury, yield, and test weight with proproxycarbazone with various nitrogen rates near Lewiston, Idaho in 2003.

Treatment[1]	Rate[2]	Wheat injury[3]	BROTE control[4]	Wheat	
				Yield	Test weight
	lb ai/A	----------%---------		bu/A	lb/bu
Sulfosulfuron	0.031	0	64	53	63.0
Proproxycarbazone	0.027	0	62	51	63.3
Proproxycarbazone	0.04	0	65	54	63.3
Sulfosulfuron + nitrogen	0.031 + 50	0	69	55	63.1
Proproxycarbazone + nitrogen	0.027 + 50	0	74	52	63.0
Proproxycarbazone + nitrogen	0.04 + 50	0	70	54	63.2
Sulfosulfuron + nitrogen	0.031 + 100	4	78	53	62.3
Proproxycarbazone + nitrogen	0.027 + 100	4	75	53	62.7
Proproxycarbazone + nitrogen	0.04 + 100	4	91	54	62.4
Untreated check	--	--	--	46	63.2
LSD (0.05)		1	16	NS	0.6
Density (plants/ft^2)			30		

[1] 90% nonionic surfactant (R-11) applied at 0.5% v/v with sulfosulfuron and 0.25% v/v with proproxycarbazone.

[2] Nitrogen (32% urea ammonium nitrate) rates are in % v/v.

[3] April 28, 2003 evaluation.

[4] June 24, 2003 evaluation.

Table 4. Downy brome control and wheat injury, yield, and test weight with flufenacet combinations near Lewiston, Idaho in 2003.

Treatment[1]	Rate[2]	Application timing[3]	Wheat injury[4]	Downy brome control[5]	Wheat yield
	lb ai/A		----------------	%----------------	bu/A
Flufenacet	0.36	preemergence	0	44	50
Sulfosulfuron	0.031	1-3 lf	0	52	48
Sulfosulfuron + flufenacet	0.031 + 0.36	1-3 lf +preemergence	0	85	47
Proproxycarbazone	0.04	1-3 lf	2	45	47
Proproxycarbazone + flufenacet	0.04 + 0.36	1-3 lf + preemergence	0	89	49
Mesosulfuron/safener + NIS	0.0134 + 0.5	1-3 lf	1	82	52
Mesosulfuron/safener + flufenacet + NIS	0.0134 + 0.36 + 0.5	1-3 lf + preemergence	2	88	49
Mesosulfuron/safener + MSO	0.0134 +1.5	1-3 lf	4	93	51
Mesosulfuron/safener + flufenacet + MSO	0.0134 + 0.36 + 1.5	1-3 lf + preemergence	0	97	52
Metribuzin	0.25	3-5 lf	0	25	49
Metribuzin + flufenacet	0.25 + 0.36	3-5 lf + preemergence	0	60	46
Metribuzin + sulfosulfuron	0.25 + 0.031	3-5 lf + 1-3 lf	0	76	50
Metribuzin + proproxycarbazone	0.25 + 0.04	3-5 lf + 1-3 lf	0	84	48
Imazamox	0.04	1-3 lf	8	81	45
Imazamox	0.048	1-3 lf	1	92	44
Untreated check	--		--	--	47
LSD (0.05)			NS	25	NS
Density (plants/ft^2)				5	

[1] Mesosulfuron/safener treatments included a 1:2 ratio of mesosulfuron to safener (mefenpyr-diethyl). NIS = 90% nonionic surfactant (R-11) and MSO = methylated seed oil. NIS was applied with proproxycarbazone and imazamox treatments at 0.25% v/v and sulfosulfuron treatments at 0.5% v/v. Urea ammonium nitrate 32% was applied with mesosulfuron at 2 qt/A and imazamox at 1 qt/A.

[2] NIS rates in % v/v and MSO in pt/A.

[3] Application timing based on downy brome growth stage.

[4] June 2, 2003 evaluation.

[5] June 24, 2003 evaluation.

Weed control in imidazolinone-resistant winter wheat with imazamox and other grass herbicides. Traci A. Rauch and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established in Clearfield (imidazolinone-resistant) winter wheat to examine weed control in 2003 and herbicide soil persistence in 2004 with flucarbazone, imazamox, proproxycarbazone, and sulfosulfuron. Wheat was seeded on October 3 and 8, and November 7, 2002 near Bonners Ferry, Moscow, and Lewiston, Idaho, respectively. In Bonners Ferry, wheat was reseeded and the study relocated on May 12, 2003 due to flooding. In all experiments, plots were 16 by 30 ft arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 30 psi and 3 mph (Table 1). The Moscow location was oversprayed with thifensulfuron/tribenuron at 0.016 lb ai/A and bromoxynil /MCPA at 0.75 lb ae/A on April 29, 2003; the Lewiston site was oversprayed with 2,4-D ester at 0.5 lb ae/A and fluroxypyr 0.125 lb ae/A on May 1, 2003; and the Bonners Ferry site was oversprayed with MCPA ester at 0.5 lb ae/A on June 20, 2003. Wheat injury and weed control were evaluated visually during the growing season. Wheat seed was harvested with a small plot combine on July 30 and August 8, 2003 at the Lewiston and Moscow locations, respectively. The Bonners Ferry site was not harvested due to a poor wheat stand after reseeding. In spring 2004, each plot in all experiments will be planted to spring barley and yellow mustard to evaluate soil persistence of all herbicide treatments.

Table 1. Application and soil data.

Location	Moscow, Idaho	Lewiston, Idaho	Bonners Ferry, Idaho
Application date	April 30, 2003	April 28, 2003	June 16, 2003
Wheat variety	F2020	F2020	Fidel
Growth stage			
Wheat	3 to 4 tiller	3 to 4 tiller	3 to 5 tiller
Wild oat (AVEFA)	--	--	2 to 4 leaf
Downy brome (BROTE)	--	3 to 5 leaf	--
Air temperature (F)	47	59	74
Relative humidity (%)	78	64	50
Wind (mph, direction)	4, W	2, W	2, NW
Cloud cover (%)	100	55	10
Soil moisture	wet	damp	dry
Soil temperature at 2 in (F)	47	47	65
pH	5.2	6.1	7.6
OM (%)	2.6	5.5	4.0
CEC (meq/100g)	18	38	10.5
Texture	silt loam	silt loam	silt loam

Imazamox injured wheat 4 to 15% at all locations at any evaluation date, except Lewiston on May 21 (Table 2). At Lewiston, imazamox at 0.08 lb ai/A controlled downy brome 98% but did not differ from imazamox at 0.04 lb ai/A (90%) or proproxycarbazone at 0.04 lb ai/A (80%). At Bonners Ferry, wild oat control was 95 to 99% with all treatments.

At Moscow, wheat yield (111 to 121 bu/A) and test weight (59.8 to 60.7 lb/bu) did not differ among treatments or from the untreated check (Table 3). At Lewiston, wheat yield with flucarbazone at 0.027 lb ai/A (60 bu/A) was greater than sulfosulfuron at 0.062 lb ai/A, proproxycarbazone at 0.04 lb ai/A, the imazamox treatments, and the untreated check. Imazamox treatments yielded less than all other treatments including the untreated check. Wheat yield was poorly correlated with downy brome control due to a heavy non-imidazolinone volunteer winter wheat population. In imazamox treated plots, all volunteer non-imidazolinone resistant wheat was killed and overall wheat stand reduced. Wheat test weight with imazamox at 0.04 lb ai/A (62.2 bu/A) was greater than all other treatments including the untreated check, except imazamox at 0.08 lb ai/A (62.1 bu/A)and proproxycarbazone at 0.08 lb ai/A (61.2 bu/A).

Table 2. Wheat injury and weed control near Moscow, Lewiston, and Bonners Ferry, Idaho in 2003.

		Wheat injury					Weed control	
		Moscow	Lewiston		Bonners Ferry		BROTE	AVEFA
Treatment[1]	Rate	May 29	May 21	June 3	June 17	August 8	June 24	August 8
	lb ai/A	%						
Imazamox	0.04	4	0	15	4	7	90	99
Imazamox	0.08	9	5	11	12	8	98	99
Sulfosulfuron	0.031	0	0	0	0	1	64	95
Sulfosulfuron	0.062	0	0	0	2	2	68	99
Flucarbazone	0.027	0	0	0	0	1	62	98
Flucarbazone	0.054	0	0	0	4	2	40	99
Proproxycarbazone	0.04	0	0	0	0	0	80	99
Proproxycarbazone	0.08	1	0	0	3	0	71	99
LSD (0.05)		3	3	4	6	4	22	NS
Density (plants/ft^2)							5	2

[1] 90% nonionic surfactant (R-11) was applied at 0.5% v/v with sulfosulfuron and 0.25% v/v with all other treatments. 32% nitrogen (UAN) was applied at 1 qt/A with all imazamox treatments.

Table 3. Wheat yield and test weight near Moscow and Lewiston, Idaho in 2003.

		Wheat yield		Wheat test weight	
Treatment[1]	Rate	Moscow	Lewiston	Moscow	Lewiston
	lb ai/A	bu/A		lb/bu	
Imazamox	0.04	111	33	59.9	62.2
Imazamox	0.08	114	37	59.8	62.1
Sulfosulfuron	0.031	121	57	60.4	60.6
Sulfosulfuron	0.062	118	53	60.6	60.5
Flucarbazone	0.027	115	60	60.3	60.9
Flucarbazone	0.054	115	56	60.7	61.0
Proproxycarbazone	0.04	117	53	60.5	60.8
Proproxycarbazone	0.08	116	58	60.5	61.2
Untreated check	--	116	51	60.0	60.5
LSD (0.05)		NS	7	NS	1.1

[1] 90% nonionic surfactant (R-11) was applied at 0.5% v/v with sulfosulfuron and 0.25% v/v with all other treatments. 32% nitrogen (UAN) was applied at 1 qt/A with all imazamox treatments.

Mayweed chamomile control with thifensulfuron plus tribenuron combinations. Joan Campbell and Donn Thill. (Crop and Weed Science Division, University of Idaho, Moscow, Idaho 83844-2339) An experiment was established south of Moscow, Idaho to determine mayweed chamomile control in winter wheat with a four to one ratio of thifensulfuron to tribenuron. Treatments were applied on May 1, 2003 with a CO_2 pressurized backpack sprayer delivering 10 gpa at 3 mph and 32 psi. Wheat was 8 to 10 in. tall with 6 tillers and mayweed chamomile was 1 to 2 in. diameter at a density of 20 plants/ft^2. Relative humidity, air and soil temperatures were 66%, 61 and 42 F, respectively. Soil pH, organic matter, CEC and texture were 5.4, 3%, 22 cmol/kg, and silt loam, respectively. The experimental design was a randomized complete block with three replications and 8 by 30 ft experimental units. The entire experiment was treated with fenoxaprop/safener on May 12 for wild oat control. Weed control was evaluated visually on June 18 and wheat grain was harvested at maturity.

Mayweed chamomile control ranged from 80 to 90% with thifensulfruon plus tribenuron combinations with other broadleaf herbicides (Table). Mayweed chamomile control with thifensulfruon plus tribenuron alone ranged from 44 to 73%. Sulfonylurea herbicides in general and thifensulfruon/tribenuron specifically, usually provide excellent (>90%) mayweed chamomile control. The poor control in this experiment is likely due to a resistant population. Seed was collected to verify this hypothesis. Grain yield and test weight did not vary among treatments.

Table. Mayweed chamomile control in winter wheat.

Treatment[1]	Rate[2]	Mayweed chamomile control	Wheat	
			Grain yield	Test weight
	lb ai/A	%	lb/A	lb/bu
Untreated control	-	-	4799	59
Thifensulfuron +	0.0125	90	5080	58
tribenuron +	0.0031			
fluroxypyr +	0.094			
2,4-D ester	0.375			
Thifensulfuron +	0.0187	83	4403	57
tribenuron +	0.0047			
fluroxypyr +	0.094			
2,4-D ester	0.375			
Thifensulfuron +	0.025	85	5371	58
tribenuron +	0.0062			
fluroxypyr +	0.094			
2,4-D ester	0.375			
Thifensulfuron +	0.0281	83	5942	59
tribenuron +	0.007			
fluroxypyr +	0.094			
2,4-D ester	0.375			
Thifensulfuron +	0.0125	83	5807	59
tribenuron +	0.0031			
bromoxynil/MCPA	0.5			
Thifensulfuron +	0.0187	80	4836	58
tribenuron +	0.0047			
bromoxynil/MCPA	0.5			
Thifensulfuron +	0.025	88	6450	60
tribenuron +	0.0062			
bromoxynil/MCPA	0.5			
Thifensulfuron +	0.0281	90	6471	60
tribenuron +	0.007			
bromoxynil/MCPA	0.5			
Fluroxypyr +	0.094	78	4683	58
2,4-D ester +	0.375			
bromoxynil/MCPA	0.5			
Thifensulfuron +	0.0125	54	4884	58
tribenuron	0.0031			
Thifensulfuron +	0.0187	64	5615	59
tribenuron	0.0047			
Thifensulfuron +	0.025	44	5177	58
tribenuron	0.0062			
Thifensulfuron +	0.0281	73	5982	60
tribenuron	0.007			
LSD (0.05)		18	NS	NS

[1] NIS at 0.25% v/v was applied with all treatments except fluroxypyr plus 2,4-D plus bromoxynil/MCPA.

[2] 2,4-D ester rate is given as lb ae/A.

Evaluation of kochia control in winter wheat. John O. Evans and R. William Mace. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820) Utah 100 winter wheat was planted October 5, 2002 on the Utah State University Research Farm at Cache Junction, Utah. Herbicide treatments including bromoxynil/MCPA, fluroxypyr, tribenuron, and clopyralid/2,4-D were applied to evaluate kochia (KOCSC) control. Individual treatments were applied to 10 by 30 foot plots with a CO_2 sprayer using Turbojet 015 nozzles calibrated to deliver 25 gpa at 40 psi. The soil was a Trenton silty clay loam with 7.6 pH and O.M. content of 2 percent. Treatments were applied postemergence April 28, 2003 in a randomized block design, with three replications. Wheat ranged in size from 8 to10 inches tall. Weeds averaged 1 to 2 inches tall with a density of 5 plants / ft^2. Visual evaluations of crop injury and weed control were completed May20, and June 9. Plots were harvested August 18, 2003.

There was some injury to wheat evident at the second evaluation date. This was noted as a stunting of the plants that matched plot boundaries but was inconsistent with plot replication. No good explanation was found. Kochia control was excellent for all treatments except for clopyralid/2,4-D and a slight reduction in control for the bromoxynil/MCPA + thifensulfuron treatment. Yields were not significantly different but were reduced due to drought conditions and lack of irrigaition.

Table. Evaluation of Kochia control in wheat.

		Wheat			Weed control	
		Injury		Yield	KOCSC	
Treatment	Rate	5/20	6/09	8/18	5/20	6/09
	lb/A	-------%-------		Bu/A	--------%--------	
Untreated		0	0	14.6	0	0
Bromoxynil/MCPA[a]	0.75	0	0	10.4	93.3	100
Bromoxynil/MCPA[a] + fluroxypyr	0.5+0.062	0	0	8.3	98.3	98.3
Bromoxynil/MCPA[a] + fluroxypyr + thifensulfuron[b]	0.5+0.062+0.005	0	3.3	8.6	100	100
Bromoxynil/MCPA[a] + fluroxypyr + thifensulfuron	0.5+0.062+0.005	0	0	10.7	100	100
Bromoxynil/MCPA[a] + thifensulfuron[b]	0.5+0.014	0	3.3	8.7	91.7	96.3
Bromoxynil/MCPA[a] + tribenuron[b]	0.5+0.0078	0	3.3	6.7	100	100
Bromoxynil/MCPA[a] + fluroxypyr + thifensulfuron[b]	0.375+0.062+0.01	0	5	5.4	100	100
Bromoxynil/MCPA[a] + fluroxypyr + tribenuron[b]	0.375+0.062+0.0082	0	6.7	5.7	100	100
Clopyralid/2,4-D	0.45	0	3.3	10.8	0	0
$LSD_{(0.05)}$				8.8	2.1	3.2

[a] Bromoxynil&MCPA was a commercial premix Bronate Advanced containing both octanoic and heptanoic formulation of bromoxynil.

[b] NIS added at 0.25% v/v added.

Wild oat and interrupted windgrass control in winter wheat with clodinafop and mesosulfuron. Joan Campbell and Donn Thill. (Crop and Weed Science Division, University of Idaho, Moscow, Idaho 83844-2339) An experiment was established south of Moscow, Idaho to determine wild oat and interrupted windgrass control in winter wheat. Treatments were applied on May 10, 2003 with a CO_2 pressurized backpack sprayer delivering 10 gpa at 3 mph and 32 psi. Wheat was 16 in. tall with 3 to 6 tillers, wild oat had 2 to 4 tillers and interrupted windgrass had 2 leaves. Relative humidity, air and soil temperatures were 79%, 50 and 40 F, respectively. Soil pH, organic matter, CEC and texture were 5.4, 3%, 22 cmol/kg, and silt loam, respectively. The experimental design was a randomized complete block with three replications and 8 by 30 ft experimental units. Weed control and crop injury were evaluated visually on June 18 and July 20 and wheat grain was harvested at maturity.

Wild oat and interrupted windgrass were effectively controlled by all treatments by July 20 (Table). Wheat was stunted 2% with mesosulfuron + MSO + nitrogen fertilizer compared to the untreated control, but grain yield and test weight were not affected.

Table. Wild oat and interrupted windgrass control in winter wheat.

Treatment	Rate	Wild oat		Windgrass		Wheat injury	Grain yield	Test weight
		June 18	July 20	June 18	July 20			
		%					lb/A	lb/bu
Untreated control	-	-		-		-	6030	60
Clodinafop	0.05 lb ai/A	95	99	83	99	0	5600	60
Clodinafop	0.0625 lb ai/A	95	99	87	99	0	6633	60
Clodinafop +	0.05 lb ai/A	95	99	72	99	0	5848	59
thifensulfuron/tribenuron +	0.0188 lb ai/A							
bromoxynil /MCPA +	0.25 lb ae/A							
nonionic surfactant[1]	0.25% v/v							
Clodinafop +	0.0625 lb ai/A	96	99	87	99	0	6029	60
thifensulfuron/tribenuron +	0.0188 lb ai/A							
bromoxynil/MCPA +	0.25 lb ae/A							
nonionic surfactant[1]	0.25% v/v							
fenoxaprop/safener	0.083 lb ai/A	96	99	95	99	0	6122	60
fenoxaprop/safener +	0.083 lb ai/A	94	99	88	99	0	6010	60
thifensulfuron/tribenuron +	0.0188 lb ai/A							
bromoxynil /MCPA +	0.25 lb ae/A							
nonionic surfactant[1]	0.25% v/v							
Flucarbazone +	0.027 lb ai/A	95	99	95	99	0	6440	60
nonionic surfactant	0.25% v/v							
Flucarbazone +	0.027 lb ai/A	95	99	96	99	0	6626	59
thifensulfuron/tribenuron +	0.0188 lb ai/A							
bromoxynil/MCPA +	0.25 lb ae/A							
nonionic surfactant[1]	0.25% v/v							
Mesosulfuron +	0.0089 lb ai/A	95	99	95	99	2	6217	59
MSO +	1.5 pint/A							
nitrogen fertilizer[1]	4 pint/A							
Mesosulfuron +	0.0089	95	99	96	99	0	6697	59
nonionic surfactant +	0.5% v/v							
nitrogen fertilizer[1]	4 pint/A							
LSD (P=0.05)		NS	NS	NS	NS	1	NS	NS

[1] Nitrogen fertilizer was 32% urea ammonium nitrate and nonionic surfactant was R-11.

Reduced oat control in winter wheat with mesosulfuron-methyl and broadleaf herbicides. Chuck Cole, Carol Mallory-Smith, Richard Affeldt, and Jed Colquhoun (Department of Crop and Soil Science, Oregon State University, Corvallis, OR 97331-3002). Field trials were conducted at the Hyslop Research Laboratory near Corvallis, Oregon in 2001 and 2002 to evaluate whether certain broadleaf herbicides affect oat control with mesosulfuron. Treatments were applied to 8 ft by 35 ft plots in 2001 and 8 ft by 28 ft plots in 2002 with a single-wheel compressed-air sprayer calibrated to deliver 20 gpa. Experimental design was a randomized complete block with 4 and 5 replications for 2001 and 2002, respectively. Herbicide application and site conditions are presented in Table 1.

Table 1. Agronomic, application, and soil data for two trials near Corvallis, OR.

Experiment	2001	2002
Planting date	October 15, 2001	October 29, 2002
Treatment application		
Application date	December 7, 2001	January 23, 2003
Air temperature (F)	65	60
Soil temperature (F)	49	45
Relative humidity (%)	60	51
Cloud cover (%)	90	50
Wind speed (mph)	0	2
Wheat stage of growth	3-4 leaf	4-6 tiller
Oat stage of growth	3-4 leaf	3-4 tiller
Soil		
pH	5.8	5.1
Organic matter (%)	2.4	2.6
Texture	Woodburn silt loam	Woodburn silt loam

'Madsen' and 'Foote' winter wheat were seeded in October 2001 and 2002, respectively. 'Cayuse' oat was seeded over the trial area after drilling the winter wheat. Two formulations of mesosulfuron-methyl were included in the trials: a 75% DF formulation that contained only mesosulfuron-methyl and a 60.8% DF formulation that also contained iodosulfuron. All mesosulfuron-methyl treatments were applied at 0.0134 lb ai/A with UAN at 0.5 gal/A, NIS at 0.25% v/v, and a crop safener, mefenpyr-diethyl at 0.268 lb ai/A. Diclofop-ethyl at 1 lb ai/A plus a premix containing bromoxynil and MCPA at 0.75 lb/A was included as a standard treatment. Both trials were oversprayed for broadleaf weed control.

In 2001, oat control developed slowly following application of either mesosulfuron-methyl formulation and increased through May 2002. Oat control was comparable with the two formulations of mesosulfuron-methyl in 2001. Mesosulfuron-methyl in combinations with bromoxynil plus MCPA at 0.75 lb ai/A, 2,4-D amine at 0.375 lb ae/A, or dicamba at 0.125 lb ai/A antagonized oat control in both years and reduced grain yield compared to each mesosulfuron-methyl formulation applied alone in 2001. The combination treatment of mesosulfuron-methyl, 2,4-D amine, and dicamba was the most antagonistic. In 2002, the 60.8% DF formulation of mesosulfuron-methyl with iodosulfuron provided greater oat control than the 75% DF formulation of mesosulfuron-methyl alone. Grain yield was reduced when dicamba was used in combination with mesosulfuron-methyl (Table 2).

Table 2. The effect of broadleaf herbicides on oat control and wheat yield with mesosulfuron-methyl.

		Oat control[2]		Wheat yield	
Treatment[1]	Rate	2001	2002	2001	2002
	lb ai/A	- - - - - - - - - %- - - - - - - - -		- - - - - - - - bu/A- - - - - - -	
Untreated check	0	0	0	6.0	83.8
Mesosulfuron	0.0134	100	91	67.0	115.1
Mesosulfuron + iodosulfuron	0.0134	97	95	61.7	119.4
Mesosulfuron + bromoxynil + MCPA	0.0134 + 0.75	38	70	46.2	115.9
Mesosulfuron + 2,4-D amine	0.0134 + 0.375	65	60	52.0	118.7
Mesosulfuron + dicamba	0.0134 + 0.125	45	50	44.6	106.4
Mesosulfuron + 2,4-D amine + dicamba	0.0134 + 0.375 + 0.125	28	52	33.7	114.5
Diclofop + bromoxynil + MCPA	1 + 0.75	71	92	52.4	119.6
LSD (0.05)		34.1	3.9	21.72	10.51

[1] 32% nitrogen (urea ammonium nitrate) at 0.5 gal/A, 90% non-ionic surfactant (R-11) at 0.25 % v/v, and mefenpyr-diethyl at 0.268 lb ai/A were applied with all mesosulfuron treatments. Mefenpyr + iodosulfuron was applied as a co-formulation. Bromoxynil + MCPA was applied as a commercial premix. 2,4-D rate is expressed as lb ae/A.

[2] Oat control 165 DAT and 124 DAT for 2001 and 2002 experiments, respectively.

Field horsetail and smooth scouringrush control in winter wheat. Traci A. Rauch and Donald C. Thill. (Crop and Weed Division, University of Idaho, Moscow, ID 83844-2339) Studies were established in winter wheat near Moscow and Genesee, Idaho to evaluate field horsetail and smooth scouringrush control, respectively. Plots were 8 by 25 ft at Moscow and 8 by 30 ft at Genesee, Idaho. All plots were arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). In both experiments, wheat injury and weed control was evaluated visually. The Moscow and Genesee studies were not harvested due to non-uniform wheat and smooth scouringrush populations, respectively.

Table 1. Application and soil data.

Location	Moscow, Idaho			Genesee, Idaho		
Application timing	preemergence	early post	late post	preemergence	early post	late post
Application date	11/14/02	4/ 23/03	5/7/03	11/07/02	5/5/03	5/20/03
Growth stage						
Wheat	preemergence	2 to 3 tiller	3 to 5 tiller	preemergence	3 to 4 tiller	jointing
Field horsetail						
Reproductive	preemergence	5 inch	necrosis	--	--	--
Vegetative	preemergence	1 inch	6 inch	--	--	--
Smooth scouringrush	--	--	--	preemergence	1 to 2 inch	4 to 6 inch
Air temperature (F)	42	52	50	41	45	68
Relative humidity (%)	87	57	59	60	75	41
Wind (mph, direction)	4, W	0	0	0	0	0
Cloud cover (%)	100	80	100	100	10	90
Soil temperature at 2 in (F)	40	50	50	33	43	60
Soil moisture	wet	dry	wet	dry	wet	damp
pH		5.6			5.5	
OM (%)		2.6			5.0	
CEC (meq/100g)		18			35	
Texture		silt loam			silt loam	

In both studies, no treatment visibly injured wheat (data not shown). Chlorsulfuron at 0.0625 lb ai/A controlled field horsetail 94 to 98%, but did not differ from chlorsulfuron at 0.0313 lb ai/A (87 and 75%) or chlorsulfuron early postemergence at 0.0156 lb ai/A (78%) (Table 2). Smooth scouringrush control was best with chlorsulfuron at 0.0313 and 0.0625 lb ai/A (88 to 97%), but similar to chlorsulfuron/metsulfuron (70 and 80%). All other treatments only suppressed field horsetail or smooth scouringrush.

Table 2. Field horsetail and smooth scouringrush control in winter wheat near Moscow and Genesee, Idaho in 2003.

Treatment[1]	Rate	Application timing	Weed control	
			Field horsetail[2]	Smooth scouringrush[3]
	lb ai/A		%	
Chlorsulfuron	0.0156	preemergence	44	44
Chlorsulfuron	0.0313	preemergence	75	88
Chlorsulfuron	0.0625	preemergence	94	97
Chlorsulfuron/metsulfuron	0.0234	preemergence	45	80
Chlorsulfuron	0.0156	early post	78	56
Chlorsulfuron	0.0313	early post	87	88
Chlorsulfuron	0.0625	early post	98	90
Chlorsulfuron/metsulfuron	0.0234	early post	48	70
MCPA ester	0.5	late post	51	32
MCPA ester	1	late post	48	46
fluroxypyr/MCPA ester	0.67	late post	52	31
fluroxypyr/MCPA ester	1.22	late post	41	45
LSD (0.05)			37	30

[1] All early postemergence treatments included a 90% non-ionic surfactant (R-11) at 0.25% v/v. MCPA ester and fluroxypyr/MCPA ester rates are in lb ae/A.

[2] July 8, 2003 evaluation.

[3] July 23, 2003 evaluation.

Italian ryegrass control in winter wheat. Richard Affeldt, Chuck Cole, Carol Mallory-Smith, and Jed Colquhoun. (Department of Crop and Soil Science, Oregon State University, Corvallis, OR, 97331-3002) Three trials were conducted to evaluate herbicide combinations for Italian ryegrass control in fall-seeded wheat. One trial site was at the OSU Hyslop research farm near Corvallis where wheat was over-seeded with commercial Italian ryegrass. The trial at Hyslop was a randomized complete block with five replications of 8 ft by 28 ft plots. The other two trials were in growers' fields infested with diclofop-resistant Italian ryegrass near Wigrich and Perrydale. These two on-farm trials were randomized complete blocks with four replications of 8 ft by 25 ft plots. Herbicides were applied at 20 gpa and 20 psi. Herbicide application information is presented in Table 1. The wheat was harvested with a small-plot combine on July 24 at Hyslop, on August 11 at Wigrich, and on July 31 at Perrydale.

Italian ryegrass control was 98% or greater where flufenacet was followed by mesosulfuron at Hyslop and Wigrich (Table 2). Italian ryegrass control from these treatments was much lower at Perrydale. In all three trials mesosulfuron alone was somewhat less effective on Italian ryegrass than flufenacet followed by mesosulfuron, and resulted in lower grain yields at Perrydale (Table 3). Italian ryegrass control with mesosulfuron alone at Hyslop was possibly reduced because of rain within three hours after treatment. Diclofop-methyl was ineffective on Italian ryegrass at Wigrich and Perrydale and grain yield did not differ from the untreated check.

Wheat injury from flufenacet at Hyslop was caused by herbicide and disease interaction. Initially, the wheat stand was injured from flufenacet because of shallow planting. In March, much of the wheat in flufenacet-injured treatments was infected with a pathogen(s) that further reduced the stand. Even though wheat injury in flufenacet treatments was as high as 54% at the last evaluation, grain yield from injured treatments was similar to diclofop-methyl treatments at Hyslop where susceptible Italian ryegrass was seeded. No injury from flufenacet was observed at Wigrich or Perrydale and grain yields were greatest in treatments with flufenacet followed by mesosulfuron.

Table 1. Herbicide application information for three winter wheat trials in western Oregon.

	Hyslop	Wigrich	Perrydale
Application date[1]			
PES	October 18, 2002	November 6, 2002	November 6, 2002
POE	January 20, 2003	February 25, 2003	February 25, 2003
Air temperature (F)			
PES	70	56	50
POE	43	50	65
Soil temperature (F)			
PES	62	48	40
POE	42	52	50
Relative humidity (%)			
PES	50	73	78
POE	72	87	72
Wind velocity (mph)			
PES	5	3	0
POE	0	0	0
Growth stage			
Wheat			
PES	preemergence	preemergence	preemergence
POE	4 to 6 leaf, 1 tiller	4 to 8 leaf, 1 to 2 tillers	4 to 8 leaf, 1 to 2 tillers
Italian ryegrass			
PES	preemergence	preemergence	preemergence
POE	4 to 6 leaf, 1 tiller	3 to 8 leaf, 0 to 3 tillers	4-6 leaf, 1 to 2 tillers

[1] PES (preemergence surface), POE (post emergence)

Table 2. Italian ryegrass control following herbicide applications in western Oregon.

			Italian ryegrass control		
Treatment[1]	Rate	Applic. timing[2]	Hyslop[3]	Wigrich[4]	Perrydale[4]
	lb/A		--------------------%--------------------		
Flufenacet	0.267	PES	96	73	53
Flufenacet	0.333	PES	99	81	45
Flufenacet / mesosulfuron	0.267 / 0.013	PES / POE	99	98	75
Flufenacet / mesosulfuron	0.333 / 0.013	PES / POE	99	99	80
Mesosulfuron	0.011	POE	81	81	23
Mesosulfuron	0.013	POE	75	91	40
Diclofop-methyl	1.0	POE	100	5	18
Untreated check	0		0	0	0
LSD $_{(0.05)}$	---		6	14	25

[1] All mesosulfuron treatments included a safener (mefenpyr-diethyl) applied at a 1:2 ratio of mesosulfuron to safener, MSO (methylated seed oil) applied at 1.5 pt/A, and 32% urea ammonium nitrate applied at 3.8 pt/A.

[2] PES (preemergence surface), POE (post emergence)

[3] Evaluated May 5, 2003

[4] Evaluated May 21, 2003

Table 3. Wheat injury and wheat grain yield following herbicide applications in western Oregon.

			Wheat injury			Wheat yield		
Treatment[1]	Rate	Applic. timing[2]	Hyslop[3]	Wigrich[4]	Perrydale[4]	Hyslop	Wigrich	Perrydale
	lb/A		--------------%--------------			------------bu/A------------		
Flufenacet	0.267	PES	33	0	0	83	74	36
Flufenacet	0.333	PES	54	0	0	76	72	34
Flufenacet / mesosulfuron	0.267 / 0.013	PES / POE	44	0	0	81	89	49
Flufenacet / mesosulfuron	0.333 / 0.013	PES / POE	52	15	0	81	89	51
Mesosulfuron	0.011	POE	0	0	0	75	77	25
Mesosulfuron	0.013	POE	0	0	0	81	77	26
Diclofop-methyl	1.0	POE	0	0	0	81	41	11
Untreated check	0		0	0	0	61	34	9
LSD $_{(0.05)}$	---		8	4	0	11	16	8

[1] All mesosulfuron treatments included a safener (mefenpyr-diethyl) applied at a 1:2 ratio of mesosulfuron to safener, MSO (methylated seed oil) applied at 1.5 pt/A, and 32% urea ammonium nitrate applied at 3.8 pt/A.

[2] PES (preemergence surface), POE (post emergence)

[3] Evaluated May 5, 2003

[4] Evaluated May 21, 2003

Italian ryegrass control in winter wheat. Traci A. Rauch and Donald C. Thill (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Three studies were established near Pullman, Washington in 'IDO-587' imidazolinone-resistant soft white wheat to evaluate Italian ryegrass control and wheat injury and yield with 1)flucarbazone plus various adjuvants, 2)mesosulfuron with broadleaf herbicides, and 3)flufenacet combinations and mesosulfuron plus various adjuvants. All plots were 8 by 25 ft arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer (Table 1). In all experiments, wheat injury and Italian ryegrass control were evaluated visually on June 18 and July 9, 2003. Wheat seed yield was harvested from the flucarbazone and mesosulfuron plus broadleaf herbicides studies on August 7, 2003. The mesosulfuron plus adjuvants study was not harvested due to a non-uniform wheat stand (water logging).

Table 1. Application and soil data.

Study	Flucarbazone + adjuvant	Mesosulfuron + broadleaf combinations	Flufenacet combinations and mesosulfuron + adjuvants	
Application date	May 6, 2003	May 7, 2003	October 15, 2002	May 7, 2003
Wheat growth stage	1 to 2 tiller	1 to 2 tiller	preemergence	3 to 4 tiller
Italian ryegrass growth stage	3 to 4 tiller	3 to 4 tiller	preemergence	3 to 4 tiller
Air temperature (F)	49	42	65	52
Relative humidity (%)	65	81	40	60
Wind (mph, direction)	2, SW	2, E	1, NW	2, E
Cloud cover (%)	90	0	15	40
Soil moisture	wet	wet	very dry	moist
Soil temperature at 2 in (F)	40	45	50	50
Gpa	5	10	10	
Psi	34	34	34	
Mph	4.2	3	3	
Soil				
pH	5.1			
OM (%)	3.5			
CEC (meq/100g)	23			
Texture	silt loam			

In the flucarbazone + adjuvants study, no treatment visibly injured winter wheat (data not shown). Italian ryegrass control, wheat yield and test weight did not differ among treatments (Table 2).

In the mesosulfuron + broadleaf herbicides study, no treatment visibly injured winter wheat (data not shown). Mesosulfuron + NIS + fluroxypyr reduced Italian ryegrass control 2% compared to mesosulfuron + NIS, but all treatments controlled Italian ryegrass 96% or better (Table 3). Wheat grain yield was lowest for the untreated check (54 bu/A) but did not differ among treatments. Wheat seed test weight was higher with imazamox and mesosulfuron + NIS + thifensulfuron/tribenuron treatments (60.6 and 60.4 lb/bu) than the untreated check (58.9 lb/bu).

In the flufenacet combination and mesosulfuron + adjuvants study, wheat was injured 3 to 12% but did not differ among treatments (Table 4). Flufenacet/metribuzin + mesosulfuron controlled Italian ryegrass 99% which was not different from flufenacet/metribuzin + imazamox or any mesosulfuron treatment (87 to 98%). Italian ryegrass suppression was lowest with imazamox and diclofop (13 and 18%).

Table 2. Italian ryegrass control and wheat injury, yield, and test weight with flucarbazone combined with various adjuvants near Pullman, WA in 2003.

Treatment[1]	Rate[2]	Italian ryegrass control[3]	Wheat Yield	Wheat Test weight
	lb ai/A	%	bu/A	lb/bu
Flucarbazone + NIS	0.027 + 0.25	72	77	59.0
Flucarbazone + NIS/MSO	0.027 + 2.5	78	82	60.0
Flucarbazone + NIS/MSO/NH_4/buffer	0.027 + 1	77	86	59.3
Flucarbazone + NIS/AMS/NH_4NO_3	0.027 + 0.75	75	87	59.7
Flucarbazone + silicone based	0.027 + 0.25	73	86	59.6
Flucarbazone + NIS +	0.027 + 0.25			
deposition aid	2	76	87	60.2
Flucarbazone + NIS/MSO +	0.027 + 2.5			
deposition aid	2	79	82	59.1
Flucarbazone + NIS/MSO/NH_4/buffer +	0.027 + 1			
deposition aid	2	73	78	58.3
Flucarbazone + NIS/AMS/NH_4NO_3 +	0.027 + 0.75			
deposition aid	2	73	81	60.4
Flucarbazone + silicone based +	0.027 + 0.25			
deposition aid	2	71	85	59.7
Untreated check	--	--	71	58.8
LSD (0.05)		NS	NS	NS
Density (plants/ft^2)		134		

[1] NIS =nonionic surfactant, AMS = ammonium sulfate, MSO = modified seed oil. NIS is R-11, NIS/MSO is Hasten, NIS/MSO/ NH_4/buffer is Renegade, NIS/AMS/NH_4NO_3 is Cayuse Plus, silicone based is Syl-Tac and deposition aid is In-Place.

[2] All adjuvant rates are in % v/v, except the deposition aid, which is in fl oz/A.

[3] July 9, 2003 evaluation.

Table 3. Italian ryegrass control and wheat yield and test weight with mesosulfuron combined with broadleaf herbicides near Pullman, WA in 2003.

		Italian ryegrass	Wheat	
Treatment[1]	Rate	control[2]	Yield	Test weight
	lb ai/A	%	bu/A	lb/bu
Mesosulfuron/safener + NIS	0.0134	98	73	59.9
Mesosulfuron/safener + MSO	0.0134	99	78	59.6
Mesosulfuron/safener + thifensulfuron +NIS	0.0134 + 0.0211	98	73	59.9
Mesosulfuron/safener + thifensulfuron + MSO	0.0134 + 0.0211	99	71	59.7
Mesosulfuron/safener + thifensulfuron/tribenuron + NIS	0.0134 + 0.0187	98	62	60.4
Mesosulfuron/safener + thifensulfuron/tribenuron + MSO	0.0134 + 0.0187	99	65	59.7
Mesosulfuron/safener + thifensulfuron/tribenuron + bromoxynil + NIS	0.0134 + 0.0187 + 0.25	99	87	58.6
Mesosulfuron/safener + thifensulfuron/tribenuron + bromoxynil + MSO	0.0134 + 0.0187 + 0.25	99	84	58.7
Mesosulfuron/safener + fluroxypyr + NIS	0.0134 + 0.187	96	73	59.6
Mesosulfuron/safener + fluroxypyr + MSO	0.0134 + 0.187	98	82	59.4
Imazamox + NIS	0.048	97	74	60.6
Untreated check	--	--	54	58.9
LSD (0.05)		2	NS	1.2
Density (plants/ft^2)		120		

[1] Mesosulfuron/safener treatments included a 1:2 ratio of mesosulfuron to safener (mefenpyr-diethyl) and were applied with NIS (90% nonionic surfactant) at 0.5% v/v or MSO (methylated seed oil) at 1.5 pt/A and 32% urea ammonium nitrate at 4 pt/A. Imazamox treatments were applied with 90% nonionic surfactant (R-11) at 0.25% v/v and 32% urea ammonium nitrate at 2 pt/A. Bromoxynil and fluroxypyr rates are in lb ae/A.

[2] July 9, 2003 evaluation.

Table 4. Italian ryegrass control and wheat injury with flufenacet combinations and mesosulfuron combined with various adjuvants near Pullman, WA in 2003.

Treatment[1]	Rate[2]	Application timing[3]	Wheat injury[4]	Italian ryegrass control[5]
	lb ai/A		---------------%------------	
Flufenacet	0.27	pre	0	40
Flufenacet/metribuzin	0.34	pre	0	52
Triasulfuron	0.026	pre	0	59
Imazamox	0.048	3 - 4 tiller	10	13
Flufenacet/metribuzin + triasulfuron	0.34 + 0.026	pre	0	78
Flufenacet/metribuzin + imazamox	0.34 + 0.048	pre + 3 - 4 tiller	3	87
Flufenacet/metribuzin + mesosulfuron/safener +MSO + UAN	0.34 + 0.0134 + 1.5 + 4	pre + 3 - 4 tiller	10	99
Flufenacet + mesosulfuron/safener + MSO + UAN	0.27 + 0.0134 + 1.5 + 4	pre + 3 - 4 tiller	0	98
Mesosulfuron/safener + NIS	0.0134 + 0.5	3 - 4 tiller	5	89
Mesosulfuron/safener + NIS + UAN	0.0134 + 0.5 + 4	3 - 4 tiller	0	95
Mesosulfuron/safener + MSO	0.0134 + 1.5	3 - 4 tiller	5	94
Mesosulfuron/safener + MSO + UAN	0.0134 + 1.5 + 4	3 - 4 tiller	6	98
Mesosulfuron/safener + NIS/MSO	0.0134 + 1.5	3 - 4 tiller	12	98
Mesosulfuron/safener + NIS/MSO + UAN	0.0134 + 1.5 + 4	3 - 4 tiller	8	97
Diclofop	1	3 - 4 tiller	0	18
LSD (0.05)			NS	21
Density (plants/ft^2)				80

[1] NIS = 90% nonionic surfactant (R-11). UAN = 32% urea ammonium nitrate. MSO = modified seed oil. NIS/MSO is Hasten. Imazamox treatments were applied with NIS at 0.25% v/v and 32% urea ammonium nitrate at 2 pt/A. Mesosulfuron/safener treatments included a 1:2 ratio of mesosulfuron to safener (mefenpyr-diethyl).

[2] NIS rates are in % v/v and MSO, NIS/MSO and UAN rates are in pt/A.

[3] Application timing based on Italian ryegrass growth stage. Pre = preemergence.

[4] June 18, 2003 evaluation.

[5] July 9, 2003 evaluation.

Italian ryegrass control with non-ACCase inhibitor herbicides in spring wheat and pea. Traci A. Rauch and Donald C. Thill (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Populations of ACCase-resistant Italian ryegrass have been identified and are spreading in the Pacific Northwest. Studies were established near Genesee, Idaho in 'N269' spring wheat and near Moscow, Idaho in 'Cruiser' spring pea to evaluate control of suspected ACCase-resistant Italian ryegrass (LOLMU) with alternative herbicides. All plots were 8 by 30 ft arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). In the pea study, the postplant preemergence treatment was incorporated with two perpendicular passes of a spring-tooth harrow. Crop injury and Italian ryegrass control were evaluated visually on June 26 and July 23, 2003 at Genesee and on June 11 and June 26, 2003 at Moscow. Spring wheat seed was harvested on August 28, 2003. The spring pea site was not harvested due to poor Italian ryegrass control across all treatments.

Table 1. Application and soil data.

	Genesee, Idaho		Moscow, Idaho		
Application timing	preemergence	postemergence	postplant preemergence	preemergence	postemergence
Application date	May 7	May 29	May 7	May 7	May 29
Spring wheat growth stage	preemergence	3 to 4 leaf	--	--	--
Spring pea growth stage	--	--	preemergence	preemergence	4 node
LOLMU growth stage	preemergence	2 to 4 leaf	preemergence	preemergence	1 to 3 leaf
Air temperature (F)	50	73	50	58	73
Relative humidity (%)	53	55	61	50	55
Wind (mph, direction)	0	2, N	5, W	0	2, W
Cloud cover (%)	100	10	100	90	20
Soil temperature at 2 in (F)	50	60	50	50	65
Soil moisture	dry	dry	damp	damp	damp
pH	5.0		5.3		
OM (%)	3.7		3.0		
CEC (meq/100g)	22		16		
Texture	silt loam		silt loam		

At Genesee on June 10, wheat was injured 2 to 8% by flucarbazone and mesosulfuron treatments (Table 2). By June 26, only mesosulfuron still injured wheat (6%) (data not shown). Italian ryegrass control was best with mesosulfuron (98%). All other treatments did not adequately control Italian ryegrass (29 to 59%). Wheat grain yield was greatest with flufenacet/metribuzin + chlorsulfuron/metsulfuron (76 bu/A) but did not differ from flufenacet/metribuzin and mesosulfuron (68 to 72 bu/A). Wheat seed test weight ranged from 60 to 62 lb/bu and did not differ among treatments.

At Moscow on June 11, ethalfluralin plus flufenacet/metribuzin or dimethenamid injured pea 6 and 10% (Table 3). By June 26, pea injury ranged from 0 to 2% and was not different among treatments (data not shown). Dimethenamid suppressed Italian ryegrass 65%, but did not differ from metolachlor, imazethapyr + quizalofop or all ethalfluralin treatments (44 to 56%). No treatment provided acceptable control of Italian ryegrass.

Italian ryegrass seed was collected from both sites and will be tested for ACCase resistance in the greenhouse during winter 2003.

Table 2. Italian ryegrass control and spring wheat injury and yield near Genesee, Idaho in 2003.

Treatment[1]	Rate	Application timing[2]	Wheat			LOLMU control[4]
			injury[3]	yield	test weight	
	lb ai/A		%	bu/A	lb/bu	%
Pendimethalin	0.5	preemergence	0	61	61	23
Pendimethalin	0.62	preemergence	0	60	62	35
Flufenacet	0.36	preemergence	0	61	60	31
Flufenacet/metribuzin	0.34	preemergence	0	68	60	29
Chlorsulfuron/metsulfuron	0.0156	preemergence	0	67	60	41
Flufenacet/metribuzin +	0.34	preemergence				
chlorsulfuron/metsulfuron	0.0156	preemergence	0	76	60	36
Flufenacet/metribuzin +	0.34	preemergence				
flucarbazone	0.027	1 to 3 leaf	8	65	61	54
Flucarbazone	0.027	1 to 3 leaf	2	66	62	59
Mesosulfuron	0.0134	1 to 3 leaf	6	72	61	98
Clodinafop	0.063	1 to 3 leaf	0	56	60	29
Untreated check	--	--	--	59	61	--
LSD (0.05)			4	8	NS	30
Density (plants/ft^2)						60

[1] 90% nonionic surfactant (R-11) was applied at 0.25% v/v with flucarbazone. Methylated seed oil at 1.5 pt/A, 32% nitrogen (UAN) at 4 pt/A, and a 1:6 ratio of mesosulfuron to safener (mefenpyr-diethyl) were applied with mesosulfuron. Crop oil concentrate (Score) was applied at 0.8 pt/A with clodinafop.

[2] Application timing based on Italian ryegrass growth stage

[3] June 10, 2003 evaluation.

[4] July 23, 2003 evaluation.

Table 3. Italian ryegrass control and spring pea injury near Moscow, Idaho in 2003.

Treatment[1]	Rate	Application timing	Pea injury[2]	LOLMU control[3]
	lb ai/A		----------------%----------------	
Trifluralin	0.5	postplant preemergence	1	19
Ethalfluralin	0.56	postplant preemergence	1	52
Pendimethalin	0.62	postplant preemergence	0	19
Imazethapyr	0.047	postplant preemergence	0	0
Dimethenamid	0.84	postplant preemergence	1	65
Metolachlor	1.6	postplant preemergence	4	56
Ethalfluralin +	0.56	postplant preemergence		
dimethenamid	0.84		10	55
Flufenacet/metribuzin	0.34	preemergence	0	2
Metribuzin	0.38	preemergence	0	0
Flufenacet/metribuzin +	0.34	preemergence		
metribuzin	0.25		0	10
Ethalfluralin +	0.56	postplant preemergence		
flufenacet/metribuzin	0.34	preemergence	6	45
Imazethapyr +	0.047	postplant preemergence		
quizalofop	0.055	postemergence	0	44
Flufenacet/metribuzin +	0.34	preemergence		
quizalofop	0.055	postemergence	0	36
Quizalofop	0.055	postemergence		
bentazon	0.75		0	31
LSD (0.05)			5	21
Density (plants/ft^2)				45

[1] All quizalofop treatments were applied with crop oil concentrate (Moract) at 1% v/v.

[2] June 11, 2003 evaluation.

[3] June 26, 2003 evaluation.

Italian ryegrass control in winter wheat with flufenacet combinations. Traci A. Rauch and Donald C. Thill (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) A study was established near Moscow, Idaho in winter wheat to evaluate Italian ryegrass control and wheat injury with flufenacet alone and combined with other grass herbicides. All plots were 8 by 30 ft arranged in a randomized complete block design with four replications and included an untreated check. All herbicide treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). Wheat injury and Italian ryegrass control was evaluated visually on June 10 and 26, 2003. The experiment was not harvested due to a non-uniform winter wheat stand.

Table 1. Application and soil data.

Application timing	preemergence	postemergence
Application date	October 14, 2002	April 23, 2003
Wheat growth stage	preemergence	1 to 3 tiller
Italian ryegrass growth stage	preemergence	1 to 4 leaf
Air temperature (F)	57	50
Relative humidity (%)	44	59
Wind (mph, direction)	0	3, W
Cloud cover (%)	0	100
Soil moisture	very dry	dry
Soil temperature at 2 in (F)	50	50
pH	5.2	
OM (%)	3.4	
CEC (meq/100g)	20	
Texture	silt loam	

Mesosulfuron treatments and flufenacet + flucarbazone injured wheat 10 to 13% (Table 2). Italian ryegrass control was best with mesosulfuron alone (85%), but did not differ from triasulfuron plus flufenacet or flufenacet/metribuzin and flufenacet + mesosulfuron (68 to 83%). All other treatments suppressed Italian ryegrass 35 to 58%.

Table 2. Wheat injury and Italian ryegrass control near Moscow, Idaho in 2003.

Treatment[1]	Rate	Application timing	Wheat injury[2]	Italian ryegrass control[2]
	lb ai/A		%	%
Flufenacet/metribuzin	0.425	preemergence	1	38
Flufenacet	0.34	preemergence	0	38
Triasulfuron	0.026	preemergence	0	50
Chlorsulfuron/metsulfuron	0.0234	preemergence	0	44
Flucarbazone	0.027	1 to 4 leaf	0	35
Mesosulfuron/safener	0.0134	1 to 4 leaf	12	85
Flufenacet/metribuzin + triasulfuron	0.425 0.026	preemergence	5	82
Flufenacet/metribuzin + chlorsulfuron/metsulfuron	0.425 0.0234	preemergence	0	38
Flufenacet + triasulfuron	0.34 0.026	preemergence	0	68
Flufenacet + chlorsulfuron/metsulfuron	0.34 0.0234	preemergence	0	58
Flufenacet + flucarbazone	0.34 0.027	preemergence 1 to 4 leaf	10	49
Flufenacet + mesosulfuron/safener	0.34 0.0134	preemergence 1 to 4 leaf	13	83
LSD (0.05)			8	26
Density (plants/ft^2)				37

[1] Mesosulfuron/safener treatments included a 1:2 ratio of mesosulfuron to safener (mefenpyr-diethyl) and were applied with 32% urea ammonium nitrate at 4 pt/A and methylated seed oil at 1.5 pt/A. Flucarbazone treatments included nonionic surfactant (R-11) at 0.25% v/v.

[2] June 26, 2003 evaluation.

CLEARFIELD™ wheat varietal tolerance to imazamox application rates and timings. Daniel A. Ball, Jim Peterson, and Larry Bennett. (Columbia Basin Agricultural Research Center, Pendleton, OR 97801) A study was established at the Rugg Farm east of Pendleton, OR and at CBARC at Moro, OR. to evaluate tolerance of CLEARFIELD™ soft white winter wheat breeding lines to applications of imazamox. At both sites seven imazamox-tolerant wheat lines and one susceptible variety ('Stephens') were planted in fall of 2002. Due to dry conditions, wheat was seeded into dry soil and did not emerge until mid-December after the area received sufficient rains. The original treatment plan included a late fall timing when the wheat was in the four leaf stage, and another in the spring when the wheat was 5-7 leaf with 1-2 tillers. Due to late wheat germination, the first treatments (EPOST) were applied on February 18 and March 4, 2003, when the wheat was at the 4 leaf stage at Pendleton and Moro, respectively. The second applications (LPOST) were applied on March 18 and April 9, when the wheat was in the 5-7 leaf and 6-8 leaf stage at Pendleton and Moro, respectively. Treatments at the Pendleton site were applied with a hand-held CO_2 sprayer delivering 16 gpa at 30 psi. Treatments at the Moro site were applied using a tractor-mounted plot sprayer delivering 16 gpa at 30 psi. Individual plots were 5 by 18 ft in a factorial design with 4 replications. Conditions at time of applications are shown in Table 1. Precipitation near the sites is summarized in Table 2. Visible crop injury was evaluated on May 20 and May 21 at Pendleton and Moro, respectively.

Table 1. Application details.

	Pendleton		Moro	
Timing	EPOST	LPOST	EPOST	LPOST
Date	18 Feb, 2003	18 Mar, 2003	4 Mar, 2003	9 April, 2003
Air temperature (^{0}F)	44	57	40	50
Relative humidity (%)	88	50	84	62
Wind speed (mph)	6-8	2-4	4-8	1-2
Sky (% cloud cover)	95	5	80	5
Soil temperature at 2 in (^{0}F)	40	58	32	62

Crop injury at Pendleton was light to moderate from the 0.031 and 0.047 lb ai/A application rates depending on cultivar and application timing when evaluated on May 20 (Table 3). An exception was with the cultivar 'AP-04' that exhibited substantial injury at all application rates and timings. In general, crop injury was worse from the later application timing; a change from previous studies where crop injury was generally more evident from early applications of imazamox. Crop injury from the 0.094 lb ai/A rate was severe regardless of application timing or cultivar (Table 3). The reasons for this severe injury remain unclear. Visual evaluations from the Moro site, made on May 21, revealed that crop injury from imazamox treatments was light with all rates and timings of imazamox (Table 4). The cultivar 'AP-04' was the least tolerant of the Clearfield varieties, but injury was 11% or less. Even the susceptible variety 'Stephens' was not completely killed by most of the treatments. Yield data are given in Table 5.

Table 2. Precipitation Summary – Columbia Basin Ag. Research Center, Pendleton and Moro, OR.

Crop Yr	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
							in						
Pendleton													
2002-03	0.24	0.61	1.09	3.06	3.25	2.18	2.20	1.78	1.01	T	T	0.23	15.65
20 Yr Av	0.74	1.32	2.56	1.77	1.95	1.63	1.99	1.61	1.83	1.13	0.36	0.53	17.42
Moro													
2002-03	0.02	0.27	0.59	2.65	1.92	1.26	0.90	1.00	0.21	T	0.0	0.47	9.27
20 Yr Av	0.51	0.93	1.69	1.28	1.41	1.20	1.14	0.90	0.94	0.58	0.30	0.23	11.12

Table 3. CLEARFIELD™ wheat varietal tolerance to imazamox application rate and timing. Pendleton, OR. May 20, 2003.

Cultivar	EPOST (4-5 leaf)			LPOST (5-7 leaf)		
	0.031 lb ai/A	0.047 lb ai/A	0.094 lb ai/A	0.031 lb ai/A	0.047 lb ai/A	0.094 lb ai/A
	% visible crop injury					
FS-4	2	0	15	1	3	23
AP-04	19	27	33	33	25	47
ID587	1	4	17	1	3	21
OR007	1	2	18	1	3	25
OR008	2	6	17	1	2	22
ORCF-101	0	6	18	2	3	23
Clearfirst™	2	2	15	1	3	23
Stephens	100	100	100	99	99	100

Application rates are the amount of imazamox applied per acre. All treatments included a non-ionic surfactant at 0.25 % v/v and 32% liquid nitrogen at 2.5% v/v. EPOST applications made on February 18, 2003, and LPOST applications made on March 18, 2003. LSD (0.05) for all treatment by variety means = 4.

Table 4. CLEARFIELD™ wheat varietal tolerance to imazamox application rate and timing. Moro, OR. May 21, 2003.

Cultivar	EPOST (4-5 leaf)			LPOST (5-7 leaf)		
	0.031 lb ai/A	0.047 lb ai/A	0.094 lb ai/A	0.031 lb ai/A	0.047 lb ai/A	0.094 lb ai/A
	---------------------- % visible crop injury -----------------------					
FS-4	0	0	2	0	0	1
AP-04	3	8	10	4	7	11
ID587	0	2	4	0	0	2
OR007	0	2	3	1	1	2
OR008	0	0	2	0	0	1
ORCF-101	0	1	4	1	1	2
Clearfirst™	2	4	6	1	1	7
Stephens	73	95	100	80	84	88

Application rates are the amount of imazamox applied per acre. All treatments included a non-ionic surfactant at 0.25 % v/v and 32% liquid nitrogen at 2.5% v/v. EPOST applications made on February 18, 2003, and LPOST applications made on March 18, 2003. LSD (0.05) for treatment by variety means = 10.

Table 5. Effect of Imazamox applied early and late on yield of eight varieties of winter wheat at Pendleton and Moro, OR.

	EPOST (4-5 leaf)								LPOST (5-7 leaf)							
	0.031 lb ai/A		0.047 lb ai/A		0.094 lb ai/A		Control		0.031 lb ai/A		0.047 lb ai/A		0.094 lb ai/A		Control	
Cultivar	P[1]	M	P	M	P	M	P	M	P	M	P	M	P	M	P	M
	---bu/A---															
FS-4	105	75	120	65	110	70	110	60	130	70	120	65	105	70	120	60
AP-04	60	50	50	45	50	50	75	50	50	50	45	45	40	90	70	50
ID587	100	65	100	65	100	60	110	60	115	60	120	65	95	65	110	65
OR007	100	75	110	65	95	60	110	60	110	60	110	65	110	65	110	60
OR008	110	70	110	60	100	60	110	60	130	65	120	65	100	70	130	50
ORCF-101	105	70	100	60	90	60	100	60	110	60	110	65	100	60	110	55
Clearfirst™	90	55	95	55	90	50	100	50	105	50	105	60	90	50	110	50

1. P = Pendleton, M = Moro. Application rates are the amount of imazamox applied per acre. All treatments included a non-ionic surfactant at 0.25 % v/v and 32% liquid nitrogen at 2.5% v/v.

Tolerance of imidazolinone-resistant winter wheat varieties to imazamox. Traci A. Rauch and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Three studies were established near Lewiston, Moscow, and Nezperce, Idaho to evaluate injury and yield of three imidazolinone-resistant winter wheat varieties treated with two rates of imazamox applied at two growth stages. The experimental design was a randomized complete block, complete factorial with four replications. Main plots were three wheat varieties (Fidel, IDO-587, and OR CF-101), subplots were two application times (early and pre-joint) and sub-subplots were two imazamox rates (0.047 and 0.094 lb ai/A) and an untreated check. Imazamox treatments were applied using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). To control broadleaf weeds, the Lewiston location was oversprayed with metribuzin at 0.18 lb ai/A, bromoxynil at 0.25 lb ai/A, and tribenuron at 0.016 lb ai/A on April 3; the Nezperce location was oversprayed with thifensulfuron/tribenuron at 0.016 lb ai/A and bromoxynil/MCPA at 0.50 lb ae/A on April 18; and the Moscow location was oversprayed with thifensulfuron/tribenuron at 0.016 lb ai/A and bromoxynil/MCPA at 0.75 lb ae/A on April 29, 2003. In all experiments, wheat injury was evaluated visually, and wheat seed was harvested on July 22, August 8 and 12, 2003 at Lewiston, Moscow, and Nezperce, respectively.

Table 1. Application and soil data.

	Lewiston		Moscow		Nezperce	
Planting date	October 1, 2002		October 7, 2002		October 2, 2002	
Application date	2/27/03	3/27/03	3/24/03	4/23/03	3/28/03	4/28/03
Wheat growth stage	3 to 4 tiller	6 to 7 tiller	2 to 3 tiller	4 to 5 tiller	1 to 2 tiller	3 to 4 tiller
Air temperature (F)	45	45	45	45	42	65
Relative humidity (%)	65	68	55	55	69	42
Wind (mph, direction)	1, W	3, SW	0	3, W	3, SE	2, E
Cloud cover (%)	20	50	10	100	25	95
Soil moisture	wet	wet	wet	wet	wet	damp
Soil temperature at 2 in (F)	37	43	46	47	41	60
pH	5.4		5.2		5.0	
OM (%)	3.5		3.0		5.1	
CEC (meq/100g)	20		21		29	
Texture	silt loam		silt loam		silt loam	

At Lewiston, Fidel, OR CF-101, and IDO-587 wheat was injured 3, 2, and 1%, respectively [LSD (0.05) = 1]. Wheat injury was greater with imazamox at 0.094 lb ai/A (6%) than imazamox at 0.047 lb ai/A (0%) [LSD (0.05) = 2] and greater at the 3 to 4 tiller (3%) than the 6 to 7 tiller application time (1%) [LSD (0.05) = 1]. Fidel wheat injury was greater at the high rate of imazamox and the 3 to 4 tiller application time than IDO-587 and OR CF-101 wheat (Table 2 and 3). At the 3 to 4 tiller application time, wheat injury increased and yield decreased with increasing imazamox rate (Table 4). Test weight was greater for Fidel (61.0 lb/bu) than IDO-587 and OR CF-101 (57.2 and 56.4 lb/bu) [LSD (0.05) = 1.4].

At Moscow, wheat injury was higher with imazamox at 0.094 lb ai/A (7%) than the 0.047 lb ai/A rate (1%) [LSD (0.05 = 2]. Wheat injury with Fidel and OR CF-101 increased with imazamox rate (Table 2). The untreated check (143 bu/A) yielded more grain than both imazamox rates (135 and 137 bu/A) [LSD (0.05) = 2]. Test weight was greater for Fidel (61.1 lb/bu) than IDO-587 and OR CF-101 (59.1 and 58.9 lb/bu) [LSD (0.05) = 1.0]

At Nezperce, imazamox at 0.047 and 0.094 lb ai/A injured wheat 1 and 6%, respectively [LSD (0.05) = 2]. Wheat yield was reduced by imazamox at 0.094 lb ai/A (93 bu/A) compared to imazamox at 0.047 lb ai/A (100 bu/A) and the untreated check (100 bu/A) [LSD (0.05) =4]. Test weight ranged from 58.5 to 61.2 lb/bu and did not differ among wheat variety, application time or imazamox rate (data not shown).

Table 2. Wheat injury at Lewiston and Moscow averaged over imazamox application time in 2003.

Wheat variety	Imazamox rate[1]	Wheat injury Lewiston[2]	 Moscow[3]
	lb ai/A	--------------------%--------------------	
Fidel	0.047	0	0
	0.094	8	11
IDO-587	0.047	0	3
	0.094	4	5
OR CF-101	0.047	0	1
	0.094	5	5
LSD (0.05)		2	4

[1] Imazamox treatments were applied with 90% nonionic surfactant (R-11) at 0.25% v/v and 32% urea ammonium nitrate at 1 qt/A.

[2] June 23, 2003 evaluation.

[3] June 18, 2003 evaluation.

Table 3. Wheat injury at Lewiston averaged over imazamox rate in 2003.

Wheat variety	Application timing	Wheat injury[1]
		%
Fidel	3 to 4 tiller	5
	6 to 7 tiller	1
IDO-587	3 to 4 tiller	2
	6 to 7 tiller	1
OR CF-101	3 to 4 tiller	3
	6 to 7 tiller	1
LSD (0.05)		1

[1] June 23, 2003 evaluation.

Table 4. Wheat injury and yield at Lewiston averaged over variety in 2003.

Application time	Imazamox rate[1]	Lewiston Wheat injury[2]	 Yield
	lb ai/A	%	bu/A
3 to 4 tiller	0	--	111
	0.047	0	115
	0.094	10	107
6 to 7 tiller	0	--	115
	0.047	1	113
	0.094	1	116
LSD (0.05)		3	5

[1] Imazamox treatments were applied with 90% nonionic surfactant (R-11) at 0.25% v/v and 32% urea ammonium nitrate at 1 qt/A.

[2] June 23, 2003 evaluation.

Evaluation of herbicides for wild buckwheat control in spring wheat. John O. Evans and R. William Mace. (Department of Plants, Soils, and Biometeorology, Utah State University, Logan, Utah 84322-4820) Clearfield spring wheat was planted May 5, 2003 on the Wallace Beutler farm in North Logan. Herbicide treatments including fenoxaprop, fluroxypyr, tralkoxydim, bromoxynil/MCPA and quinclorac were applied to evaluate wild buckwheat (POLCO), lambsquarter (CHEAL), and prickly lettuce (LACSE) control. Individual treatments were applied to 7 by 30 foot plots with a CO_2 sprayer using Turbojet 015 nozzles calibrated to deliver 18 gpa at 40 psi. The soil was a Millville loam with 7.9 pH and O.M. content of less than 3%. Treatments were applied postemergence May 29, in a randomized block design, with three replications. Wheat ranged in size from 5 to 8 inches tall. Weeds averaged 2 to 3 inches tall with 2 to 3 leaves. Visual evaluations for crop injury and weed control were completed June 16, and July 10. Plots were harvested August 21, 2003.

There was no injury to wheat with any treatment. Wild buckwheat control was excellent for all treatments except fenoxaprop alone and quinclorac. Excellent prickly lettuce control was maintained through July by all treatments. Common lambsquarters was held in check with all treatments except quinclorac. Yields were highest for fenoxaprop + MCPA + thifensulfuron/tribenuron and were significantly different from quinclorac treatments.

Table. Evaluation of wild buckwheat control in wheat.

		Wheat			Weed control			
		Injury		Yield	POLCO		CHEAL	LACSE
Treatment	Rate	6/16	7/10	8/21	6/16	7/10	7/10	7/10
	lb/A	-------%-------		Bu/A		--------%--------		
Untreated		0	0	49.6	0	0	0	0
Fenoxaprop	0.104	0	0	42.1	13.3	10.1	94.7	97.2
Fenoxaprop + bromoxynil/MCPA[a]	0.104+0.5	0	0	54.7	68.3	100	91.7	95
Fenoxaprop + bromoxynil/MCPA[a] + fluroxypyr	0.104+0.375+0.062	0	0	37.2	76.3	96.7	93.3	96.7
Fenoxaprop + bromoxynil/MCPA[a] + thifensulfuron	0.104+0.375+0.005	0	0	40.3	73.3	100	100	100
Fenoxaprop + thifensulfuron + fluroxypyr	0.104+0.014+0.062	0	0	40.9	60.9	93.3	95	95
Fenoxaprop + bromoxynil/MCPA[a] + fluroxypyr + thifensulfuron	0.104+0.375+0.062 +0.005	0	0	43.8	96	100	100	98.3
Fenoxaprop + fluroxypyr + MCPA	0.104+0.062+0.023	0	0	53.6	33.3	95	91.7	100
Fenoxaprop + MCPA + thifensulfuron	0.104+0.023+0.014	0	0	55.9	48.3	95	98.3	90
Fenoxaprop + MCPA + thifensulfuron/tribenuron	0.104+0.023+0.014	0	0	63.4	85	96.7	100	100
Fenoxaprop + bromoxynil + thifensulfuron/tribenuron	0.104+0.25+0.014	0	0	47.8	77.7	99.3	100	100
Fenoxaprop + bromoxynil + thifensulfuron	0.104+0.25+0.014	0	0	52.4	98.7	96.7	100	99.3
Tralkoxydim[b] + bromoxynil/MCPA[a]	0.208+0.375	0	0	44.9	56.7	95	98.3	98.3
Fenoxaprop + bromoxynil/MCPA + fluroxypyr	0.105+0.5+0.062	0	0	32.3	89.9	97.6	90	100
Quinclorac[c]	0.33	0	0	16.7	0	0	76.7	99.7
Quinclorac[c]	0.33	0	0	26.5	0	0	73.3	100
$LSD_{(0.05)}$				21.1	41.8	7.2	6.6	5.1

[a] Bromoxynil&MCPA was a commercial premix Bronate Advanced containing both octanoic and heptanoic formulations of bromoxynil.

[b] Supercharge 0.5% v/v added.

[c] MSO at 0.75 pt/A + N at 2 qt/A added.

Canada thistle control with in-crop and post-harvest herbicide treatments in wheat. Rodney G. Lym. (Department of Plant Sciences, North Dakota State University, Fargo, ND 58105). Canada thistle has become the most costly invasive weed species for farmers in North Dakota and is estimated to infest over 8.5 million acres in the state. In a recent cropland survey, Canada thistle occurred in 39% of the quadrates used to estimate weed presence and density (20 quadrats per field in over 1500 fields across North Dakota). The purpose of this research was to evaluate Canada thistle control with tribenuron and tribenuron plus thifensulfuron applied in wheat followed by glyphosate applied post-harvest.

The experiment was established on cropland that had been fallow for several years and was heavily infested with Canada thistle. The soil was fertilized, cultivated, and then seeded to wheat on May 10, 2002. The initial herbicide treatments were applied on June 17 when the wheat was in the 4-leaf growth stage and Canad thistle was beginning to bolt and averaged 10 to 12 inches tall. The wheat was harvested on August 14 and glyphosate was applied on Sept. 26, 2002 when Canada thistle was in the rosette or post-flowering growth stage and 6 to 18 inches tall. The herbicides were applied using a hand-held boom sprayer delivering 8.5 gpa at 35 psi. The plots were 10 by 30 feet, and treatments were replicated four times in a randomized complete block design. Canada thistle top growth control was visually evaluated based on percent stand reduction compared to the untreated check.

All treatments evaluated controlled Canada thistle in-crop, which averaged 82 and 91% injury 21 and 35 DAT (days after treatment), respectively (data not shown). Thifensulfuron slightly injured wheat initially, especially when applied with tribenuron, but the crop recovered rapidly and no injury was visible by 21 DAT (Table). All in-crop treatments provided better than 90% Canada thistle control 2 MAT (months after treatment), but the weed began to regrow once the crop was harvested.

Canada thistle control 12 MAT averaged 98% with a post-harvest glyphosate treatment compared to 61% without glyphosate, regardless of the in-crop treatment (Table). Control was similar regardless of the glyphosate rate. Glyphosate provided an average of 98 and 88% Canada thistle control 12 and 15 MAT, respectively, following the first in-crop treatment compared to 99 and 90%, respectively, when no herbicide was applied in-crop. In summary, several herbicide treatments can be used to control Canada thistle in wheat during the growing season, but it is important to apply glyphosate post-harvest for long-term control in crop land.

Table. Canada thistle control in wheat with various herbicides spring-applied followed by glyphosate applied post-harvest.

Spring-applied treatments		Post-harvest		Wheat injury			Control		
				DAT[1]			MAT[2]		
Herbicides	Rate	Herbicides	Rate	7	14	21	2	12	15
	oz/A		oz/A	%					
Tribenuron + X-77[3]	0.125 + 0.25%	Glyphosate[6]	16	1	0.5	0	94	99	97
Tribenuron + X-77[3]	0.125 + 0.25%	Glyphosate[6]	32	0	0.5	0	98	99	94
Tribenuron + X-77[3]	0.19 + 0.25%	Glyphosate[6]	32	1	0.5	0	95	97	92
Tribenuron + X-77[3]	0.25 + 0.25%	Glyphosate[6]	32	1	1	0	98	99	85
Tribenuron + X-77[3]	0.25 + 0.25%	• • •	• •	1	1	0	94	63	53
Thifensulfuron / tribenuron[4] + 2,4-D + X-77[3]	0.15 + 0.074 + 6 + 0.25%	Glyphosate[6]	32	3	1.5	0	94	98	89
Thifensulfuron / tribenuron[4] + 2,4-D + X-77[3]	0.2 + 0.1 + 6 + 0.25%	Glyphosate[6]	32	4	2	0	92	98	65
Thifensulfuron / tribenuron[4] + 2,4-D + X-77[3]	0.25 + 0.125 + 6 + 0.25%	Glyphosate[6]	32	3	2.5	0	95	97	84
Thifensulfuron / tribenuron[4] + 2,4-D + X-77[3]	0.3 + 0.15 + 6 + 0.25%	Glyphosate[6]	32	3	1.5	0	95	99	90
Thifensulfuron / tribenuron[4] + 2,4-D + X-77[3]	0.3 + 0.15 + 6 + 0.25%	• • •	• •	4	2	0	98	74	51
Thifensulfuron / tribenuron[4] + X-77[3]	0.3 + 0.15 + 0.25%	• • •	• •	3	2	0	97	70	60
Clopyralid / MCPA[5]	1.7 + 9.4	• • •	• •	1	1	0	96	51	23
Clopyralid / MCPA[5]	1.7 + 9.4	Glyphosate[6]	32	2	2	0	98	97	86
None		Glyphosate[6]	32	0	0	0	0	99	90
Untreated		• • •	• •	0	0	0	0	0	0
LSD (0.05)				1	1	NS	7	9[7]	31

[1] Days after treatment (June 17, 2002). Wheat was seeded on May 10 and harvested on August 14, 2002.

[2] Months after the in-crop treatment. Glyphosate was applied on Sept. 26, 2002.

[3] X-77 surfactant from Loveland Industries, Greeley, CO.

[4] Commercial formulation - Harmony Extra by DuPont, Wilmington, DE.

[5] Commercial formulation - Curtail M by Dow AgroSciences Indianapolis, IN.

[6] Glyphosate isopropyl amine formulation was Roundup Ultra Max by Monsanto, St. Louis, MO.

[7] LSD (0.10).

Evaluation of broadleaf weed control in irrigated spring wheat. Michael P. Quinn, Don W. Morishita, and Robyn C. Walton. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to evaluate the efficacy of selected tank mix partners for broadleaf weed control in irrigated spring wheat. 'Alpowa' was planted April 11, 2003, at 100 lb/A. Experimental design was a randomized complete block with four replications and individual plots were 8 by 25 ft. Soil type was a Rad silt loam (20% sand, 71% silt, and 9% clay) with a pH of 8.1, 1.5% organic matter, and CEC of 17-meq/100 g soil. Herbicides were applied May 22, 2003, using a CO_2-pressurized bicycle-wheel sprayer with 11001 flat fan nozzles calibrated to deliver 10 gpa at 24 psi. Environmental conditions at application were as follows: air temperature 87 F, soil temperature 80 F, relative humidity 16%, wind speed 2 mph, and 25% cloud cover. AGH-2001, 2,4-D LV6, and E99 were accidentally applied with the early postemergence treatments instead of at tillering as planned. Crop injury and weed control was evaluated visually 45 days after treatment on July 7. Grain was harvested August 20 with a small-plot combine.

None of the treatments injured the crop (Table). Kochia control ranged from 28 to 100%. The lowest kochia control was with thifensulfuron & tribenuron at 0.028 lb ai/A indicating that the kochia in this study was ALS resistant. Other treatments that did not satisfactorily (>70%) control kochia were 2,4-D LV6, E99 (solventless 2,4-D), and bromoxynil & MCPA-2 at 0.75 lb ai/A. Kochia control with bromoxynil & MCPA-1 at the same rate was 80%. All of the tank mixtures containing fluroxypyr controlled kochia >95%. Common lambsquarters control ranged from 96 to 100% with no differences among herbicide treatments. Redroot pigweed control ranged from 84 to 100% and 11 of the 16 treatments controlled this weed 91% or better. Grain yield ranged from 7 to 45 bu/A and all herbicide treatments had higher yields than the untreated check except bromoxynil & MCPA-2 at 0.75 lb ai/A. Bromoxynil & MCPA-1 + fluroxypyr + thifensulfuron at 0.5 + 0.062 + 0.0047 lb ai/A and bromoxynil & MCPA-2 + dicamba at 0.5 + 0.125 lb ai/A were among the highest yielding treatments at 44 and 45 bu/A, respectively.

Table. Crop injury, weed control, and grain yield of selected broadleaf herbicide tank mixes in spring wheat near Kimberly, Idaho.

Treatment[2]	Rate	Crop injury	Weed control[1]			Grain yield
			KCHSC	CHEAL	AMARE	
	lb ai/A					bu/A
Check	-					7
Bromoxynil & MCPA-1	0.75	1	80	100	92	33
Bromoxynil & MCPA-1 +	0.5 +	0	100	98	84	39
fluroxypyr	0.062					
Bromoxynil & MCPA-1 +	0.5 +	1	97	98	99	33
fluroxypyr +	0.062 +					
thifensulfuron +	0.0047 +					
nonionic surfactant	0.25					
Bromoxynil & MCPA-1 +	0.5 +	0	98	100	99	44
fluroxypyr +	0.062 +					
thifensulfuron +	0.0047 +					
nonionic surfactant	0.25					
Bromoxynil & MCPA-1 +	0.5 +	0	82	100	100	37
thifensulfuron & tribenuron +	0.014 +					
nonionic surfactant	0.25					
Bromoxynil & MCPA-1 +	0.5 +	0	75	99	91	34
flucarbazone +	0.0078 +					
nonionic surfactant	0.25					
Bromoxynil & MCPA-1 +	0.375 +	0	99	98	99	41
fluroxypyr +	0.062 +					
thifensulfuron +	0.0047 +					
nonionic surfactant	0.25					
Bromoxynil & MCPA-1 +	0.375 +	0	96	99	94	28
fluroxypyr +	0.062 +					
flucarbazone +	0.0078 +					
nonionic surfactant	0.25					
Thifensulfuron & tribenuron +	0.028 +	0	28	100	100	26
nonionic surfactant	0.25					
AGH --2001 +	0.245 +	0	89	96	97	35
nonionic surfactant	0.25					
2,4-D LV6	0.46	0	31	100	89	25
E99	0.5	0	48	99	98	37
Bromoxynil & MCPA-2	0.75	1	50	99	86	20
Bromoxynil & MCPA-2 +	0.5 +	0	95	98	94	45
dicamba	0.125					
LSD (0.05)		ns	15	ns	9	17

[1] Weeds evaluated for control were kochia (KCHSC), common lambsquarters (CHEAL), and redroot pigweed (AMARE).

[2] Bromoxynil & MCPA-1 is Bronate Advanced and bromoxynil & MCPA-2 is Bison. AGH-2001 is a combination of carfentrazone & 2,4-D. E99 is a solvent less 2,4-D.

Comparison of wild oat herbicides tank mixed with broadleaf herbicides in spring wheat. Michael P. Quinn, Don W. Morishita, and Robyn C. Walton. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to compare the effectiveness of clodinafop, fluroxypyr, and flucarbazone in tank mixes with broadleaf herbicides. 'Alpowa' was planted April 12, 2003, at 100 lb/A. Experimental design was a randomized complete block with four replications and individual plots were 8 by 25 ft. Soil type was a Rad silt loam (20% sand, 71% silt, and 9% clay) with a pH of 8.1, 1.5% organic matter, and CEC of 17-meq/100 g soil. Herbicides were applied May 22, 2003, using a CO_2-pressurized bicycle-wheel sprayer with 11001 flat fan nozzles calibrated to deliver 10 gpa at 24 psi. Environmental conditions at application were as follows: air temperature 84 F, soil temperature 69 F, relative humidity 19%, wind speed 1 mph, and 5% cloud cover. Among those wild oat herbicide treatments that did not have a tank mix partner, a combination of bromoxynil & MCPA + fluroxypyr at 0.5 + 0.094 lb ai/A was applied 5 days after the wild oat herbicide applications. Crop injury and weed control was evaluated visually 17 days after treatment on July 8. Grain was harvested August 20 with a small-plot combine.

None of the treatments injured the crop (Table). All herbicide treatments controlled kochia (KCHSC), common lambsquarters (CHEAL), and redroot pigweed (AMARE) at least 99% with no differences among treatments. Wild oat (AVEFA) control was best with clodinafop + Score® alone, ranging from 73 to 78% and were different from all other treatments. All other treatments suppressed wild oat from 5 to 40%. A combination of reduced herbicide rate and apparent antagonism of clodinafop + bromoxynil & MCPA + fluroxypyr reduced wild oat control about 67%. Grain yields also were best with clodinafop + Score alone and ranged between 46 and 50 bu/A. All other treatments yielded between 19 to 31 bu/A and were not different from the check.

Table. Crop injury, weed control, and grain yield with wild oat and broadleaf herbicides near Kimberly, Idaho.

		Crop	Weed control[1]				Grain
Treatment[2]	Rate	injury	AVEFA	KCHSC	CHEAL	AMARE	yield
	lb ai/A	%	%	%	%	%	bu/A
Check	-	-	-	-	-	-	11
Clodinafop + Score	0.05 + 10.2 fl oz/A	0	78	100	100	100	46
Clodinafop + Score	0.0625 + 12.8 fl oz/A	0	73	98	100	100	50
Clodinafop + bromoxynil & MCPA + fluroxypyr + Score	0.05 + 0.5 + 0.094 + 10.2 fl oz/A	0	5	100	100	100	19
Clodinafop + bromoxynil & MCPA + fluroxypyr + Score	0.0625 + 0.5 + 0.094 + 12.8 fl oz/A	0	13	100	100	100	24
Fenoxaprop	0.083	0	25	100	100	100	19
Fenoxaprop + bromoxynil & MCPA + fluroxypyr	0.083 + 0.5 + 0.094	0	39	100	100	100	31
Flucarbazone + nonionic surfactant	0.027 + 0.25% v/v	0	41	100	100	100	28
Flucarbazone + bromoxynil & MCPA + fluroxypyr + nonionic surfactant	0.027 + 0.5 + 0.094 + 0.25% v/v	0	44	100	99	100	25
LSD (0.05)		ns	23	ns	ns	ns	17

[1] Weeds evaluated for control were wild oat (AVEFA), kochia (KCHSC), common lambsquarters (CHEAL), and redroot pigweed (AMARE).
[2] Score is a proprietary adjuvant.

Wild oat and broadleaf weed control with fenoxaprop and broadleaf tank mix partners. Don W. Morishita, Robyn C. Walton, and Michael P. Quinn. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to evaluate fenoxaprop tank mixed with broadleaf herbicides for wild oat control. 'Alpowa' was planted April 11, 2003, at 100 lb/A. Experimental design was a randomized complete block with four replications and individual plots were 8 by 25 ft. Soil type was a Rad silt loam (20% sand, 71% silt, and 9% clay) with a pH of 8.1, 1.5% organic matter, and CEC of 17-meq/100 g soil. Herbicides were applied May 22, 2003, using a CO_2-pressurized bicycle-wheel sprayer with 11001 flat fan nozzles calibrated to deliver 10 gpa at 24 psi. Environmental conditions at application were as follows: air temperature 90 F, soil temperature 72 F, relative humidity 16%, wind speed 1 mph, and 5% cloud cover. Wild oat (AVEFA) growth stage was 4 to 5 leaf and kochia (KCHSC), common lambsquarters (CHEAL), and redroot pigweed (AMARE) growth stages averaged 1 to 2 inches tall at application. Crop injury and weed control was evaluated visually 48 days after treatment on July 9. Grain was harvested August 26 with a small-plot combine.

No crop injury was observed with any of the herbicide treatments (Table). AVEFA control ranged from 46 to 78% among the herbicide treatments. The poor overall AVEFA control can be possibly attributed to the larger AVEFA size at herbicide application. All of the fenoxaprop + broadleaf herbicide tank mixtures had reduced AVEFA control compared to fenoxaprop alone, with the exception of fenoxaprop + fluroxypyr + thifensulfuron. Kochia control was unacceptable with fenoxaprop alone and in combination with thifensulfuron + MCPA. All other fenoxaprop + broadleaf herbicide combinations controlled KCHSC 82% or better. CHEAL control averaged 48 and 73% with fenoxaprop alone and fenoxaprop + fluroxypyr + thifensulfuron, respectively. All other fenoxaprop + broadleaf herbicide combinations controlled CHEAL 99 to 100%. AMARE control ranged from 96 to 100%. Although there is a statistical difference, it is not likely biologically significant. Spring wheat yields ranged from 12 to 59 bu/A among all treatments. AVEFA competition appeared to be greater than the broadleaf competition based on the crop yield response to AVEFA control. However, this was not always the case because AVEFA control with fenoxaprop + thifensulfuron & tribenuron averaged only 54% control with the second highest wheat yield. Wheat yields with fenoxaprop alone and fenoxaprop + fluroxypyr + thifensulfuron averaged 59 and 54 bu/A, respectively and had the correspondingly best AVEFA control. All of the herbicide treatments had wheat yields greater than the untreated check, which was only 12 bu/A.

Table. Wild oat and broadleaf weed control with fenoxaprop tank mixed with broadleaf herbicides near Kimberly, Idaho.

		Crop	Weed control[1]				Grain
Treatment[2]	Rate	injury	AVEFA	KCHSC	CHEAL	AMARE	yield
	lb ai/A	%					bu/A
Check	-	-	-	-	-	-	12
Fenoxaprop	0.0825	0	78	52	48	100	59
Fenoxaprop +	0.0825 +	0	53	97	100	100	51
bromoxynil & MCPA	0.5						
Fenoxaprop +	0.0825 +	0	53	100	100	100	47
bromoxynil & MCPA +	0.375 +						
fluroxypyr	0.062						
Fenoxaprop +	0.0825 +	0	46	82	100	100	40
bromoxynil & MCPA +	0.375 +						
thifensulfuron	0.0047						
Fenoxaprop +	0.0825 +	0	74	100	73	100	54
fluroxypyr +	0.062 +						
thifensulfuron	0.014						
Fenoxaprop +	0.0825 +	0	48	100	99	99	47
bromoxynil & MCPA +	0.375 +						
fluroxypyr +	0.062 +						
thifensulfuron	0.0047						
Fenoxaprop +	0.0825 +	0	56	100	100	100	42
fluroxypyr +	0.062 +						
MCPA LVE	0.347						
Fenoxaprop +	0.0825 +	0	55	51	100	100	36
thifensulfuron +	0.014 +						
MCPA LVE	0.347						
Fenoxaprop +	0.0825 +	0	49	83	100	100	43
thifensulfuron & tribenuron +	0.014 +						
MCPA LVE	0.347						
Fenoxaprop	0.0825 +	0	54	99	100	100	58
thifensulfuron & tribenuron +	0.014 +						
bromoxynil	0.25						
Fenoxaprop +	0.0825 +	0	49	100	100	100	47
thifensulfuron +	0.014 +						
bromoxynil	0.25						
Fenoxaprop +	0.0825 +	0	49	94	100	99	49
bromoxynil & MCPA	0.375						
Tralkoxydim +	0.208 +	0	60	99	99	96	38
bromoxynil & MCPA +	0.5 +						
fluroxypyr +	0.062 +						
Supercharge	0.5% v/v						
LSD (0.05)		ns	18	18	12	5	13

[1] Weeds evaluated for control were wild oat (AVEFA), common lambsquarters (CHEAL), kochia (KCHSC), and redroot pigweed (AMARE).

[2] Supercharge is a proprietary adjuvant.

Wild oat control with imazamox plus MCPA in spring wheat. Joan Campbell and Donn Thill. (Crop and Weed Science Division, University of Idaho, Moscow, Idaho 83844-2339) An experiment was established near Moscow, Idaho to determine wild oat control in imidazolinone two gene resistant spring wheat with imazamox plus MCPA. Treatments were applied with a CO_2 pressurized backpack sprayer delivering 10 gpa at 3 mph and 32 psi. Wheat was 8 to 10 in. tall with two to four tillers. Wild oat was 6 to 8 in. tall with two to four tillers and ranged from four to eight plants/ft^2. Relative humidity, air and soil temperatures were 60%, 60 and 60 F, respectively. Soil pH, organic matter, CEC and texture were 5, 2.6%, 19 cmol/kg, and silt loam, respectively. The experimental design was a randomized complete block with four replications and 8 by 30 ft experimental units. Weed control and wheat injury was evaluated visually and wheat grain was harvested at maturity.

Spring wheat was not visibly injured with any treatment. Wild oat was controlled 98 to 99% with all treatments except fenoxaprop/safener plus thifensulfuron/tirbenuron plus 2,4-D ester which controlled wild oat 59% (Table). Grain yield and test weight did not vary among treatments.

Table. Wild oat control with imazamox in tolerant spring wheat.

Treatment[1]	Rate	Wild oat control	Grain yield	Test weight
	lb ae/A	%	lb/A	lb/bu
Untreated control	-	-	2311	60
Imazamox	0.0312	98	2170	60
Imazamox	0.0469	99	2308	60
Imazamox/MCPA ester	0.281	99	2406	60
Imazamox/MCPA ester	0.422	99	2260	60
Imazamox + MCPA ester	0.0312 0.25	99	2292	60
Imazamox + MCPA ester	0.0469 0.375	99	2262	59
Imazamox + MCPA ester	0.0312 0.165	99	2444	60
Imazamox + MCPA ester	0.0469 0.25	99	2210	61
Fenoxaprop/safener + thifensulfuron/tribenuron + 2,4-D ester	0.0825 0.0188 0.25	59	2563	59
LSD (0.05)		5	NS	NS

[1] Urea ammonium nitrate at 1% v/v was added to imazamox treatments and nonionic surfactant (R-11) at 0.25% v/v was added all treatments.

Spring wheat tolerance to imazamox. Joan Campbell and Donn Thill. (Crop and Weed Science Division, University of Idaho, Moscow, Idaho 83844-2339) An experiment was established near Moscow, Idaho to determine tolerance of a two-gene resistant imidazolinone spring wheat to imazamox. Wheat was planted on May 14, 2003 with a double disk drill. Treatments were applied with a CO_2 pressurized backpack sprayer delivering 10 gpa at 3 mph and 32 psi (Table 1). Soil pH, organic matter, CEC and texture were 5, 2.6%, 19 cmol/kg, and silt loam, respectively. The experimental design was a randomized complete block with four replications and 8 by 30 ft experimental units. Wheat injury was evaluated visually on June 8, June 18, and July 21 and wheat grain was harvested at maturity.

Table 1. Application weather data and wheat growth stage.

Application date	June 1, 2003	June 9, 2003	June 25, 2003
Spring wheat growth stage	2 to 3 leaf	2 tiller	1 to 2 joints on main stem
Air temperature (F)	68	81	80
Soil temperature (F)	67	73	62
Relative humidity (%)	44	40	53
Cloud cover (%)	50	0	10

Imazamox plus MSO applied at the 2 to 3 leaf growth stage stunted spring wheat compared to the untreated check, and stunting was worse with the 0.0937 lb ai/A rate (14 to 21%) than with the 0.0625 lb ai/A rate (5 to 14%) (Table 2). Imazamox at 0.0937 lb ai/A plus MSO applied at the joint growth stage stunted wheat compared to the untreated check and wheat grain yield was lowest compared to other treatments. All treatments except imazamox at 0.0625 lb ai/A plus NIS applied at the 2 to 3 leaf and joint growth stage reduced grain yield 11 to 55% compared to the untreated check. Test weight did not vary among treatments.

Table 2. Grain injury and yield with imazamox in tolerant spring wheat.

		Wheat	Wheat injury (stunting)				
Treatment[1]	Rate	growth stage	June 8	June 18	July 21	Grain yield	Test weight
	lb ai/A		--------- % of untreated ---------			lb/A	lb/bu
Untreated	-	-	-	-	-	2590	62
Imazamox + NIS	0.0625	2-3 leaf	0	0	0	2465	61
Imazamox + MSO	0.0625	2-3 leaf	14	7	5	2198	61
Imazamox + NIS	0.0937	2-3 leaf	0	0	5	2279	62
Imazamox + MSO	0.0937	2-3 leaf	21	18	14	2051	61
Imazamox + NIS	0.0625	2 tiller	0	0	4	2142	61
Imazamox + MSO	0.0625	2 tiller	0	0	1	2269	62
Imazamox + NIS	0.0937	2 tiller	0	0	6	2179	61
Imazamox + MSO	0.0937	2 tiller	0	4	3	2203	62
Imazamox + NIS	0.0625	Joint	0	0	1	2332	62
Imazamox + MSO	0.0625	Joint	0	0	1	2305	61
Imazamox + NIS	0.0937	Joint	0	0	0	2262	61
Imazamox + MSO	0.0937	joint	0	0	14	1159	60
LSD (0.05)			5	5	6	273	NS

[1] Urea ammonium nitrate at 1% v/v was added to all treatments. NIS (nonionic surfactant, R-11) was added at 0.25% v/v and MSO (methylated seed oil, McGregor) was added at 1% v/v.

Evaluation of prohexadione calcium for reducing lodging in spring wheat. Robyn C. Walton, Don W. Morishita, and Michael P. Quinn. (Twin Falls Research and Extension Center, University of Idaho, Twin Falls, ID 83303-1827). A study was conducted at the University of Idaho Research and Extension Center near Kimberly, Idaho to evaluate the effects of prohexadione calcium for reducing lodging in spring wheat. 'Iona' was planted April 11, 2003, at 100 lb/A. Experimental design was a split plot randomized complete block with four replications. Main plots were nitrogen fertilizer rate and sub-plots were prohexadione rate. Sub-plots were 10 by 30 ft. Soil type was a Rad silt loam (20% sand, 71% silt, and 9% clay) with a pH of 8.1, 1.5% organic matter, and CEC of 17-meq/100 g soil. Fertilizer applied on the first application date is shown in Table 1. Nitrogen fertilizer was weighted for each main plot and applied with a hand-held whirling applicator. Herbicides were applied June 12, 2003, using a CO_2-pressurized bicycle-wheel sprayer with 11001 flat fan nozzles calibrated to deliver 10 gpa at 20 psi. Environmental conditions at herbicide application were as follows: air temperature 67 F, soil temperature 55 F, relative humidity 27%, wind speed 3 mph, and 15% cloud cover. Crop height was determined by measuring the height of 10 randomly selected plants in each plot and calculating the average. Crop injury was evaluated visually 28 days after treatment on July 10. Grain was harvested August 20 with a small-plot combine.

Table 1. Environmental conditions at application.

Application date	March 28	June 12
Application timing	Pre plant	3 nodes
Air temperature (F)	34	67
Soil temperature (F)	32	55
Relative humidity (%)	95	27
Wind velocity (mph)	3	3
Cloud cover (%)	20	15

The prohexadione calcium treatment caused 1 to 15% injury to the grain 28 DALT (Table 2). The treatment that applied nitrogen @ 1X, prohexadione calcium at 0.137 & 0.069 lb A/A, non-ionic surfactant, and urea ammonium nitrate had a significantly higher amount of injury. The high amount of injury to these treatments as well as the other treatments could be caused by the extremely late first watering and not receiving enough water through the hot growing season. There was no significant difference in the average height of the plants in different treatments. Wheat yields responded to nitrogen rate and prohexadione calcium rate individually and there was no interaction. Nitrogen applied at 1.66X rate had the highest yield at 29 bu/A. Prohexadione calcium applied at 0.24 lb ai/a had the highest yield with 28 bu/A. The short height and low yield numbers could have been caused by the lack of water through out the growing season.

Table 2. Crop injury, average height, and grain yield in response to prohexadione calcium to reduce lodging in spring wheat near Kimberly, Idaho.

Treatment[a]	Rate	Crop injury	Average height	Grain yield	
				Nitrogen	Prohexadione
		%	ft	bu/A	
Nitrogen @ 1X + prohexadione calcium	0	6	1.83	18	19
Nitrogen @ 1X + prohexadione calcium + NIS + UAN	0.069 lb A/A + 0.25% v/v + 1 qt/A	10	1.78		20
Nitrogen @ 1X + prohexadione calcium + NIS + UAN	0.137 lb A/A + 0.25% v/v + 1 qt/A	15	1.69		22
Nitrogen @ 1X + prohexadione calcium + NIS + UAN	0.24 lb A/A + 0.25% v/V + 1 qt/A	5	1.72		28
Nitrogen @ 1.33X + prohexadione calcium	0	3	2.08	21	
Nitrogen @ 1.33X + prohexadione calcium + NIS + UAN	0.069 lb A/A + 0.25% v/v + 1 qt/A	1	1.99		
Nitrogen @ 1.33X + prohexadione calcium + NIS + UAN	0.137 lb A/A + 0.255 v/v + 1 qt/A	5	1.87		
Nitrogen @ 1.33X + prohexadione calcium + NIS + UAN	0.24 lb A/A + 0.25% v/v + 1 qt/A	4	1.91		
Nitrogen @ 1.66X + prohexadione calcium	0	3	1.97	29	
Nitrogen @ 1.66X + prohexadione calcium + NIS + UAN	0.069 lb A/A + 0.25% v/v + 1 qt/A	5	1.86		
Nitrogen @ 1.66X + prohexadione calcium + NIS + UAN	0.137 lb A/A + 0.25% v/v + 1 qt/A	4	2.01		
Nitrogen @ 1.66X + prohexadione calcium + NIS + UAN	0.24 lb A/A + 0.25% v/v + 1 qt/A	5	1.73		
Nitrogen @ 2X + prohexadione calcium	0	4	1.86	22	
Nitrogen @ 2X + prohexadione calcium + NIS + UAN	0.069 lb A/A + 0.25% v/v + 1 qt/A	4	1.87		
Nitrogen @ 2X + prohexadione calcium + NIS + UAN	0.137 lb A/A + 0.25% v/v + 1 qt/A	4	1.89		
Nitrogen @ 2X + prohexadione calcium + NIS + UAN	0.24 lb A/A + 0.25% v/v + 1 qt/a	4	1.96		
LSD (0.05)		4	ns	4	3

[a] NIS is nonionic surfactant. UAN is a 28% urea and ammonium nitrate solution.

Tolerance of spring barley, sugar beet, and potato follow crops to imazamox applied on imidazolinone-tolerant winter and spring wheat. Pamela J.S. Hutchinson, Brent R. Beutler, and Felix E. Fletcher. (Aberdeen Research and Extension Center, University of Idaho, Aberdeen, ID 83210).

The objective of this trial is to determine spring barley, sugar beet, and potato follow crop responses to 1X and 2X rates of imazamox applied the previous season to imidazolinone-tolerant spring wheat, or applied 30 or 24 months previously as fall or spring treatments to imidazolinone-tolerant winter wheat. In Trial 1, (Table 1) imazamox at 0, 0.04, or 0.08 lb/A (0, 1X, 2X rates) was applied to imidazolinone-tolerant winter wheat November 2, 1999 or May 1, 2000 at the Aberdeen Research and Extension Center near Aberdeen, ID, in a 'Declo' loam soil with 1.1% organic matter and pH 8.3. A fall + spring sequential 0.04 lb/A treatment was included in the trial. Simulated winter-kill treatments with fall 1999 applied 1X or 2X imazamox, followed by a May 01, 2000 glyphosate application and plant-back to non-imidazolinone-tolerant spring wheat ('Treasure' planted May 30, 2000), also were included in the trial.

Experimental design was a randomized complete block with four replications. Plot size was 50 by 40 feet. Imidazolinone-tolerant and 'Treasure' wheat was harvested fall 2000, and plots were kept intact. The trial was maintained weed-free throughout all growing seasons. Insect and disease control, and irrigation and fertilizer plot maintenance was performed as necessary throughout all growing seasons. In fall 2000, winter wheat was planted 10 and 4 months after fall 1999, and spring 2000 imazamox applications, and spring 2001, spring wheat, sugar beet, and potato were planted approximately 18 and 12 months after fall 1999 and spring 2000 imazamox applications. The trial was maintained and harvested fall 2001 (data previously reported).

In Trial 2, (Table 2) imazamox at 0, 0.032, 0.04, 0.064, or 0.08 lb/A (0, 0.8X, 1X, 1.6X, 2X rates), was applied on May 21, 2001 to imidazalinone-tolerant spring wheat planted at the Aberdeen Research and Extension Center April 11, 2001. Experimental design, plot size, soil characteristics, and plot maintenance was similar to Trial 1. The 2001 wheat crop was maintained throughout the growing season and harvested in August 2001.

Sugar beet, '2984RZ', and potato, 'Russet Burbank', were planted April 23, and May 3, 2002, respectively, approximately 30 and 24 months after treatment (MAT) in Trial 1, and 11 MAT in Trial 2. 'Baroness' barley was also planted in Trial 2 on May 6, 2002. Both trial areas were hand-weeded throughout the growing season, and maintained with appropriate irrigation and fertilization, and insect and disease control. Visual injury ratings were performed during the season, and barley, potato and sugar beet were harvested August 22, September 4, and October 10, 2002, respectively.

In Trial 1, although 2001 crop injury by all imazamox treatments on sugar beet planted 18 and 12 MAT was significant compared to the untreated control, and yield in fall 2X and fall + spring treated plots was numerically less while yield in fall 1X/winter kill plots was significantly less than yield in the untreated control plots, there was no visible crop injury, and no yield reduction in sugar beet planted in 2002, 30 and 24 MAT (Table 1). Similarly, although fall 1X and 2X/winter kill treatments resulted in significant injury and numerically reduced tuber yields of potato planted in 2001, 18 MAT, potato planted 30 and 24 MAT in 2002 had no visible crop injury, and no tuber yield reduction in treated plots compared to the untreated control. This is the last season follow crops will be planted in this trial.

In Trial 2, no visible crop injury in barley, sugar beet, or potato planted 11 months after spring 2001 treatments to imidazolinone-tolerant spring wheat, was observed, and there were no yield differences between treatments, including the untreated control (Table 2). Plots have been kept intact, and sugar beet and potato follow crops will be planted spring 2003.

Table1. Response of sugar beet and potato follow crops planted in 2002, 30 and 24 months after fall 1999 and spring 2000 imazamox applications in imidazolinone-tolerant winter wheat at Aberdeen, ID.

				Sugar beet crop response		Potato crop response		
			Planting					
	Rate		timing	Injury		Injury	Yield	
Treatment[1]	lb/A	App. Code[2]	(MAT)[3]	7/23	Yield	7/23	U.S. No. 1	Total
				%	T/A	%	-----------cwt/A----------	
Weed-free control	-	-	-	0	25	0	294	377
Imazamox	0.04	A	30	1	29	0	226	296
Imazamox	0.08	A	30	0	28	0	329	410
Imazamox + Imazamox	0.04 + 0.04	A B	30 30	0	26	0	290	367
Imazamox WK[4]	0.04	A	30	3	22	0	265	365
Imazamox WK	0.08	A	30	5	21	0	233	299
Imazamox	0.04	B	24	0	22	0	260	335
Imazamox	0.08	B	24	1	28	0	277	363
LSD (0.05)	-	-	-	ns	Ns	Ns	ns	Ns

[1] All herbicide treatments applied with 1 qt/A 32% N + 0.25% v/v NIS.

[2] A = November 2, 1999 application date; B = May 1, 2000 application date.

[3] MAT = months after treatment.

[4] WK = winter kill. Glyphosate applied May 1, 2000, 'Treasure' spring wheat planted May 30, 2000.

Table 2. Response of spring barley, sugar beet, and potato follow crops planted in 2002, 11 months after spring 2001 application of various imazamox rates to imidazolinone-tolerant spring wheat at Aberdeen, ID.

		Barley crop response		Sugar beet crop response		Potato crop response		
	Rate	Injury		Injury		Injury	Yield	
Treatment[1]	lb/A	6/20	Yield	6/20	Yield	6/20	U.S. No.1	Total
		%	bu/A	%	T/A	%	-------cwt/A--------	
Untreated control		0	111	0	27	0	289	364
Imazamox	0.032	0	113	0	28	0	279	343
Imazamox	0.04	0	91	0	25	0	256	343
Imazamox	0.064	0	99	0	29	0	281	360
Imazamox	0.08	0	91	0	30	0	266	340
LSD (0.05)	-	ns	ns	ns	ns	ns	ns	ns

[1] All treatments applied with 1 qt/A 32% N + 0.25% v/v NIS

Yellow mustard response to imazamox persistence. Traci A. Rauch and Donald C. Thill. (Crop and Weed Science Division, University of Idaho, Moscow, ID 83844-2339) Studies were established near Lewiston and Moscow, Idaho to evaluate injury and yield of three imidazolinone-resistant winter wheat varieties in 2002 and yellow mustard response in 2003 to imazamox. The experimental design was a randomized complete block, complete factorial with four replications. Main plots were three wheat varieties (24 by 48 ft), subplots were two application times (24 by 24 ft), and sub-subplots were two imazamox rates and an untreated check (8 by 24 ft). Imazamox treatments were applied in 2002 using a CO_2 pressurized backpack sprayer calibrated to deliver 10 gpa at 32 psi and 3 mph (Table 1). The study at Moscow was cultivated in the fall 2002 and spring 2003, and the study at Lewiston was moldboard plowed and cultivated in the spring 2003. 'IdaGold' yellow mustard was seeded on May 8 and May 14, 2003 at Lewiston and Moscow, respectively. The studies were oversprayed with carbaryl at 1 lb ai/A on May 28, 2003 at Lewiston and on May 29, June 5 and 11, 2003 in Moscow for flee beetle control. Yellow mustard injury was evaluated visually, and plant biomass was harvested from a 2.7 ft^2 area in each plot on July 7 and 8, 2003 at Moscow and Lewiston, respectively. At both locations, only three replications were included due to insect damage, and yellow mustard seed was not harvested due to poor seed production likely caused by herbicide persistence.

Table 1. Application and soil data.

	Lewiston		Moscow	
Application date	3/29/2002	4/16/2002	4/8/2002	5/15/2002
Wheat growth stage	3 to 4 tiller	7 to 8 tiller	2 to 3 leaf	3 to 5 tiller
Air temperature (F)	50	50	55	56
Relative humidity (%)	58	58	49	45
Wind (mph, direction)	1, W	0	1, NW	3, SW
Cloud cover (%)	100	100	0	60
Soil temperature at 2 in (F)	43	45	46	50
pH	5.4		4.3	
OM (%)	2.8		5.1	
CEC (meq/100g)	21		33	
Texture	silt loam		loam	
Primary tillage	moldboard plow		field cultivator	

At Lewiston, yellow mustard injury (stand reduction and vigor) was greater with imazamox at 0.094 lb ai/A (98%) than imazamox at 0.047 lb ai/A (90%) [LSD (0.05) = 1] and greater at the 7 to 8 tiller (64%) than the 3 to 4 tiller application time (62%) [LSD (0.05) = 1]. At both application times, injury increased and biomass decreased with imazamox rate (Table 2). Compared to the untreated check, imazamox at 0.047 and 0.094 lb ai/A reduced yellow mustard biomass 76% and 95%, respectively (Table 3).

At Moscow, imazamox at 0.047 and 0.094 lb ai/A injured yellow mustard 73 and 91% [LSD (0.05) = 5]. Yellow mustard biomass when compared to the untreated check was reduced 61% and 87% with imazamox at 0.047 and 0.094 lb ai/A, respectively (Table 3).

Table 2. Yellow mustard injury and biomass at Lewiston averaged over wheat variety in 2003.

		Lewiston	
Application time	Imazamox rate[1]	Injury[2]	Biomass
	lb ai/A	%	oz/yd^2
3 to 4 tiller	0	--	8.4
	0.047	87	3.2
	0.094	97	0.7
7 to 8 tiller	0	--	11.2
	0.047	92	1.4
	0.094	99	0.3
LSD (0.05)		2	2.1

[1] Imazamox treatments were applied with 90% nonionic surfactant (R-11) at 0.25% v/v and 32% urea ammonium nitrate at 1 qt/A.

[2] June 23, 2003 evaluation.

Table 3. Yellow mustard biomass averaged over wheat variety and application time at Lewiston and Moscow, Idaho in 2003.

Imazamox rate[1]	Yellow mustard biomass Lewiston	 Moscow
lb ai/A	---oz/yd^2---	
0	9.8	2.3
0.047	2.3	0.9
0.094	0.5	0.3
LSD (0.05)	1.5	0.5

[1] Imazamox treatments were applied with 90% nonionic surfactant (R-11) at 0.25% v/v and 32% urea ammonium nitrate at 1 qt/A.

Newly reported exotic species in Idaho. Sandra S. Robins and Timothy S. Prather. (Idaho Agricultural Experiment Station, University of Idaho, Moscow, Idaho, 83844-2339). The Lambert C. Erickson Weed Diagnostic Laboratory received 289 specimens for identification in 2003. One species reported was new to the Pacific Northwest, black horehound (*Balota nigra).* A second species was new to the state, dotted St. John's wort (*Hypericum maculatum)* and two other species were reported for only the second time in the state, rough hawkbit (*Leontodon nudicaulis)* and American pokeweed (*Phytolacca Americana)* (see Table 1). A total of 33 counties submitted samples, up from submissions from 26 counties last year. The lab identified 34 exotic species that were new to county records not previously documented for Idaho by the Erickson Weed Diagnostic Laboratory (see Table 2).

Table 1. Identified exotic species new to the state.

County	Family	Scientific Name	Common Name
Nez Perce	Lamiaceae	*Ballota nigra*	black horehound
Bonner	Clusiaceae	*Hypericum maculatum*	dotted St. John's wort
Ada	Asteraceae	[1] *Leontodon nudicaulis*	rough hawkbit
Nez Perce	Phytolaccaceae	[1] *Phytolacca americana*	American pokeweed

[1] Second reported occurrence in Idaho

Table 2. Identified exotic species new to a county based on the Invaders database.

County	Family	Scientific Name	Common Name
Ada	Asteraceae	*Leontodon nudicaulis*	rough hawkbit
Bannock	Poaceae	*Festuca arundinacea*	tall fescue
Bear Lake	Scrophulariaceae	*Veronica arvensis*	common speedwell
Bingham	Plantaginaceae	*Plantago lanceolata*	buckhorn plantain
Bonner	Solanaceae	*Solanum rostratum*	buffalobur
Bonner	Apiaceae	*Myrrhis odorata*	sweet cicely
Bonner	Clusiaceae	*Hypericum maculatum*	dotted St. John's wort
Bonneville	Euphorbiaceae	*Euphorbia cyparissias*	cypress spurge
Caribou	Brassicaceae	*Conringia orientalis*	hare's ear mustard
Gem	Campanulaceae	*Campanula*	creeping bellflower
Gem	Lamiaceae	*Nepeta cataria*	catnip
Gem	Scrophulariaceae	*Veronica persica*	Persian speedwell
Gem	Asteraceae	*Senecio vulgaris*	common groundsel
Gooding	Poaceae	*Digitaria ischaemum*	smooth crabgrass
Jerome	Poaceae	*Eragrostis cilianensis*	stinkgrass
Jerome	Rosaceae	*Sanguisorba minor*	small burnet
Kootenai	Poaceae	*Digitaria ischaemum*	smooth crabgrass
Kootenai	Caprifoliaceae	*Lonicera tatarica*	Tatarian honeysuckle
Kootenai	Thymelaeaceae	*Daphne burkwoodii*	daphne
Kootenai	Celastraceae	*Euonymus japonicus*	Japanese euonymus
Latah	Araliaceae	*Hedera helix*	English ivy

Table 2. cont.

County	Family	Scientific Name	Common Name
Latah	Polygonaceae	*Polygonum japonicum*	low Japanese fleeceflower
Latah	Elaeagnaceae	*Elaeagnus angustifolia*	Russian olive
Latah	Fabaceae	*Onobrychis viciifolia*	sainfoin
Lincoln	Campanulaceae	*Campanula*	creeping bellflower
Madison	Asteraceae	*Tanacetum vulgare*	common tansy
Nez Perce	Rubiaceae	*Galium verum*	yellow spring bedstraw
Nez Perce	Lamiaceae	*Ballota nigra*	black horehound
Nez Perce	Ranunculaceae	*Nigella damascena*	love-in-a-mist
Twin Falls	Fabaceae	*Onobrychis viciifolia*	sainfoin
Twin Falls	Euphorbiaceae	*Euphorbia myrsinites*	myrtle spurge
Twin Falls	Asteraceae	*Cirsium vulgare*	bull thistle
Twin Falls	Lamiaceae	*Lamium amplexicaule*	henbit
Valley	Rosaceae	*Potentilla recta*	sulfur cinquefoil

Vegetation management in and around utilities with various herbicides. Mark A. Ferrell and Steven D. Aagard (Department of Plant Sciences, University of Wyoming, Laramie, WY 82071). This research was conducted 40 miles north of Laramie, Wyoming to evaluate vegetation control, for use in and around utilities, with vegetation management herbicides. Plots were 10 by 27 ft. with four replications arranged in a randomized complete block. Herbicide treatments were applied broadcast with a CO_2 pressurized hand-held sprayer delivering 20 gpa at 40 psi on June 17, 2003 (air temp. 70 F, soil temp. 0 inch 105 F, relative humidity 30%, wind north at 3 mph, 30% cloud cover).

Vegetation stage of growth at application was: hoary cress (CADDR) full bloom, 6 to 8 inches tall; poverty sumpweed (IVAAX) pre-bloom, 6 to 8 inches tall; kochia (KCHSC) rosette, 1 to 2 inches tall; and perennial grasses pre-bloom (western wheatgrass, foxtail barley, smooth brome), 6 to 10 inches tall. Evaluations were taken 35 days after treatment on 22 July 2003 and 63 days after treatment on 19 August 2003. Visual estimation was used for percent control.

Hoary cress control was 91% or better for all herbicides for both evaluation dates. Poverty sumpweed control was 85% or better 35 days after treatment and 75% or better 63 days after treatment for treatments that included sulfonylurea herbicides. Kochia control was 81% or better 35 days after treatment for all treatments except where A13998 was applied alone. Only treatments that included sulfonylurea herbicides provided good kochia control, 85% or better, 63 days after treatment. Grass control was very good, 69% or better, for all treatments for both evaluation dates except where metsulfuron was applied alone.

Table. Vegetation control 35 and 63 days after treatment.

		Vegetation control 2003[2]							
		July 22				August 19			
Treatment[1]	Rate	CADDR	IVAAX	KCHSC	Grass[6]	CADDR	IVAAX	KCHSC	Grass[6]
	lb/A	%							
A13998	3.0 lb/A	100	3	18	79	100	5	10	68
A13998	3.7 lb/A	100	45	55	93	100	24	31	91
A13998 +sulfometuron[3]	3.0 lb/A+3.7 oz/A	99	99	99	95	100	99	97	95
A13998 +sulfometuron[3]	3.7 lb/A+3.7 oz/A	100	100	99	96	100	99	95	98
Glyphosate[4]	3.0 lb/A	100	93	81	94	100	63	50	94
Glyphosate[4]	3.7 lb/A	100	68	86	96	100	50	59	98
Glyphosate[4] +sulfometuron[3]	3.0 lb/A+3.7 oz/A	100	99	100	95	100	75	98	93
Glyphosate[4] +sulfometuron[3]	3.7 lb/A+3.7 oz/A	100	100	98	98	100	99	96	98
Glyphosate[5]	3.7 lb/A	100	46	85	95	99	23	58	95
Metsulfuron[3]	1.2 oz	91	85	88	0	100	80	85	0
A13998 +metsulfuron[3]	3.0 lb/A+1.2 oz/A	100	98	99	100	100	100	91	100
(LSD 0.05)		5	42	26	10	1	46	36	12
(CV)		4	41	23	9	1	52	38	11

[1] Treatments applied June 17, 2003

[2] Visual estimation was used for percent control.

[3] X-77 added at 0.25% v/v.

[4] Roundup Pro® - Monsanto

[5] Touchdown Pro® - Syngenta

[6] Perennial grasses: western wheatgrass, foxtail barley, smooth brome

Timing Downy brome seed set based on growing degree days. Sandra M. Frost, Larry H. Bennett, and Daniel A. Ball. (Columbia Basin Agricultural Research Center, Oregon State University, Pendleton, OR 97801) A study was conducted to investigate the relationship between heat unit accumulation and timing of seed set in downy brome (*Bromus tectorum*) at the Columbia Basin Agricultural Research Center, Pendleton, OR in spring 2003. Downy brome panicles were collected from a population of downy brome in a growing wheat crop. Three samples consisting of ten panicles each were clipped and bagged on ten sequential sampling dates (Table). Seed was cleaned, weighed and dry stored for a four month after-ripening period. The study was designed as a completely randomized design with three replications. Dry stored seed was planted into flats of potting soil (Professional Growing Mix from SunGro Horticulture) and put in a greenhouse maintained at 70F/65F with 12 hours of daylight under natural and supplemental light. If a seed lot weighed more than 5 g, only 5 g were planted due to space available in flats. Flats were irrigated with overhead misters. Fourteen days after planting the germinated downy brome seedlings in each flat were counted. The germination count data was adjusted for total clean seed weight if a 5 g sub-sample was planted. From the adjusted germination count data, germination per panicle was calculated. Growing degree days (GDD) were calculated using local, daily maximum and minimum air temperature data.

$$\text{GDD} = (\text{daily max temp} + \text{daily min temp}) / 2$$

where temperatures were recorded in degrees Celsius. If the resulting daily GDD value was negative, it was reset to zero (base temperature). Cumulative GDD was calculated from 1 January by totaling daily GDD values. A non-linear regression model was fit to the data to determine the cumulative GDD value at which seed germination occurred (i.e., the seed set GDD).

Analysis of germination data using a non-linear regression (PROC NLIN, SAS Institute) resulted in an estimated seed set of 1052 GDD, a figure within the range of results from previous experiments at Pendleton sites (879 to 1088 GDD). Further, the estimate of 1052 does not change our current recommendation to growers in most areas of the PNW that they control downy brome before 1000 GDD have accumulated[1].

Table. Sampling dates, cumulative GDD and adjusted germination per panicle of Downy brome at Pendleton, OR.

Date	Cumulative GDD	Germination*
		-----s/p-----
5/16/03	987	0
5/19/03	1014	0
5/27/03	1151	0
5/29/03	1192	2
6/2/03	1267	8
6/6/03	1333	45
6/9/03	1395	18
6/13/03	1466	35
6/16/03	1518	19
6/20/03	1598	28

* Germination reported in seeds germinated /panicle

1. Ball, D.A., S.M. Frost and A.I. Gitelman. In Press. Predicting timing of downy brome (*Bromus tectorum*) seed production using growing degree-days. Weed Sci.

Persian darnel and crop density impact on crop quality of spring wheat, canola and sunflower. Johnathon D. Holman and Alvin J. Bussan. (Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717)

Most research investigating the impact of weeds on crop productivity and net return focus solely on weed effects on crop yield loss or crop yield components. However, crop prices are commonly influenced by quality attributes. Grain quality is especially important for Montana wheat producers who try to achieve high protein and bread making quality which receive considerable price benefits or discounts when standards are exceeded or not met, respectively. Dockage (grain contamination by foreign material such as weed seed) also directly reduces price per unit of crop. This research was initiated to evaluate the impact of Persian darnel on grain quality characteristics such as dockage, spring wheat protein, and canola and sunflower oil content. Future research might include an economic analysis of Persian darnel on gross economic returns.

A study was conducted in 2000 and 2001 to evaluate the effect of crop and Persian darnel density on crop yield and quality. The experimental design was a randomized complete block, with a split-plot restriction on randomization and three replications. The whole plot (0.42 by 6.72 m) treatment factor was crop type (spring wheat, canola and sunflower). The sub-plot (0.42 by 0.35 m) treatment factor was crop seeding rate, seeded at 1X, 1.5X and 2X seeding rates. The 1X seeding rate was 500,000, 250,000 and 12,000 plants/A for spring wheat, canola and sunflower, respectively. Crop and weed density was recorded at the 2-4 leaf stage of Persian darnel. In 2000 and 2001, crop quality attributes measured were test weight and protein or oil content. In 2001, dockage due to contamination by weed seed was also measured. Crops were hand harvested from four 0.25 m^2 quadrats per sub-plot, and submitted to the state grain lab for analysis.

Spring wheat test weight and protein content were not affected by Persian darnel, but protein content decreased with increasing crop density in 2001 (Table 1). Canola test weight decreased in 2000 and increased in 2001 with weed density (Table 2). Canola oil content decreased with increasing weed and crop density in 2000, and was negatively correlated with weed density in 2001 (Table 2). Sunflower test weight increased with crop density in 2000 and 2001, but was not affected by Persian darnel density (Table 3). Sunflower oil content increased with weed density in 2001 (Table 3). Persian darnel and crop density effect on crop quality varied between study years, which might have been attributed to differences in environmental conditions and resource availability. Early growing season precipitation was greater in 2000 than 2001, while late growing season precipitation was greater in 2001 than 2000. Minimal variation in crop quality response could be explained by either crop or Persian darnel density, as indicated by the proportion of the variance explained, R^2. Other independent factors were principally affecting crop quality. Primary factors might include soil fertility, temperature, and precipitation.

Persian darnel increased dockage in harvested spring wheat and canola, but not in sunflower (Table 4). Dockage did not occur in sunflower because Persian darnel grew below the crop canopy and combine cutting height. Increasing the crop density of spring wheat reduced dockage. In contrast, increasing canola density was negatively correlated with dockage. Of all crop quality attributes measured, Persian darnel only had an economic impact on spring wheat and canola dockage (data not shown).

Table 1. Spring wheat test weight and protein content response to crop and weed density. Parameter estimates were fit using multiple linear regression.

		Intercept[1]		Crop density		Persian darnel density		
Attribute	Year	B_0 (SE)[2]	Sig[3]	B_1 (SE)	Sig	B_2 (SE)	Sig	R^2
Test weight	2000	61.87 (0.74)	***	0.0014 (0.0034)	NS	0.0025 (0.0015)	NS	0.079
	2001	61.98 (.040)	***	0.0007 (0.0016)	NS	0.0000 (0.0003)	NS	0.002
Protein	2000	13.27 (0.24)	***	0.0004 (0.0012)	NS	-0.0007 (0.1622)	NS	0.024
	2001	14.41 (0.523)	***	-0.0059 (0.0066)	**	-0.0000 (0.0004)	NS	0.086

[1] Parameter estimates: intercept (B_0), response to crop density (B_1), and response to Persian darnel density (B_2)

[2] Standard error: SE

[3] F-test significant at: * $P < 0.1$; ** $P < 0.01$; *** $P < 0.001$; NS, not significant

Table 2. Canola test weight and oil content response to crop and weed density. Parameter estimates were fit using multiple linear regression.

		Intercept[1]		Crop density		Persian darnel density		
Attribute	Year	B_0 (SE)[2]	Sig[3]	B_1 (SE)	Sig	B_2 (SE)	Sig	R^2
Test weight	2000	54.23 (0.47)	***	-0.0025 (0.0032)	NS	-0.0052 (0.0025)	*	0.191
	2001	52.47 (0.36)	***	-0.0008 (0.0071)	NS	0.0111 (0.0022)	***	0.188
Oil content	2000	36.49 (0.50)	***	-0.0210 (0.0099)	*	-0.0117 (0.0031)	***	0.402
	2001	30.45 (0.65)	***	0.0033 (0.0045)	NS	-0.0034 (0.0035)	NS	0.234

[1] Parameter estimates: intercept (B_0), response to crop density (B_1), and response to Persian darnel density (B_2)

[2] Standard error: SE

[3] F-test significant at: * $P < 0.1$; ** $P < 0.01$; *** $P < 0.001$; NS, not significant

Table 3. Sunflower test weight and oil content response to crop and weed density. Parameter estimates were fit using multiple linear regression.

		Intercept[1]		Crop density		Persian darnel density		
Attribute	Year	B_0 (SE)[2]	Sig[3]	B_1 (SE)	Sig	B_2 (SE)	Sig	R^2
Test weight	2000	35.42 (0.36)	***	0.126 (0.073)	*	0.0006 (0.0004)	NS	0.297
	2001	28.95 (0.49)	***	0.415 (0.127)	**	-0.0002 (0.0007)	NS	0.269
Oil content	2000	49.72 (0.54)	***	0.043 (0.110)	NS	-0.0008 (0.0006)	NS	0.170
	2001	45.44 (0.56)	***	0.215 (0.145)	NS	0.0029 (0.0008)	***	0.299

[1] Parameter estimates: intercept (B_0), response to crop density (B_1), and response to Persian darnel density (B_2)

[2] Standard error: SE

[3] F-test significant at: * $P < 0.1$; ** $P < 0.01$; *** $P < 0.001$; NS, not significant

Table 4. Weed dockage of spring wheat and canola in response to increasing crop and weed density in 2001. No weed dockage occurred in sunflower. Parameter estimates were fit using multiple linear regression.

		Intercept[1]		Crop density		Persian darnel density		
Crop	Log Transformed[2]	B_0 (SE)[3]	Sig[4]	B_1 (SE)	Sig	B_2 (SE)	Sig	R^2
Spring wheat	N	0.178 (0.187)	NS	-	NS	0.0266 (0.0018)	***	0.954
Canola	Y	3.155 (0.324)	***	-0.0007 (0.015)	NS	0.0015 (0.0003)	***	0.691

[1] Parameter estimates: intercept (B_0), response to crop density (B_1), and response to Persian darnel density (B_2)

[2] Log transformation on dependant variables with non-homogenous variances.

[3] Standard error: SE

[4] F-test significant at: * $P < 0.1$; ** $P < 0.01$; *** $P < 0.001$; NS, not significant

Population response of feral rye and jointed goatgrass to management strategies. Randy Anderson (USDA-ARS, Brookings SD 57006). Producers in the Central Great Plains are still striving to manage feral rye and jointed goatgrass in winter wheat. Ecological research has shown that these species differ in three demographic characteristics that may affect management strategies:

1. Jointed goatgrass seed survives longer in soil than feral rye.
2. Feral rye seedlings emerge earlier in the fall and in a compact time frame, whereas jointed goatgrass emergence is later and prolonged over several weeks.
3. Feral rye produces almost 3 times more seeds/plant than jointed goatgrass.

Our objective with this project was to estimate impact of management strategies on population changes with these species. We hypothesized that these species would respond differently to cultural strategies because of their demographic characteristics; thus, best management practices may differ between species.

To estimate population changes, we conducted an empirical life cycle simulation, following the example of Sagar and Mortimer (Advances in Applied Biology 1:1-47; 1976). The simulation was based on five transitions during the life cycle: % seedling emergence from the seed bank; % of emergence occurring after planting winter wheat; seed production/plant; combine removal of seed with grain during harvest; and seed bank survival over time. Transition values for each species were based on research conducted in the Central Great Plains (Table 1). The simulation did not include a parameter for seedling mortality. To estimate emergence from the age-structured seed bank population, we followed the matrix design described by Cousens et al. (Reviews of Weed Science 3:93-112; 1987). Seed production/plant was estimated based on an average emergence period for each species. Also, we assumed that seedlings emerging during intervals between winter wheat crops would be controlled, thus not producing seeds.

Table 1. Transition parameters for feral rye and jointed goatgrass, based on demographic research conducted in the Central Great Plains.

Transition Parameters	Feral rye	Jointed goatgrass
Emergence (%)	20	20
Emergence after wheat planting (%)	45	80
Seed production (no./plant)	546	193
Combine removal (%)	25	15
Seed bank survival (%)		
1 year	5	30
2 years	1	10

Production practices for winter wheat were a semi-dwarf cultivar planted at 45 kg/ha with N fertilizer broadcast before planting. The production system was no-till. A competitive canopy treatment also was evaluated and consisted of a tall cultivar planted at 67 kg/ha with N fertilizer placed near the seed in a band. We also simulated a tillage treatment with multiple sweep plow operations during fallow, assuming that seed survival of both species in the seed bank would be reduced 45% by tillage. However, winter wheat biomass production is 30% less in tilled systems compared to no-till (J. Prod. Agric. 12:95-99; 1999). Thus, the simulation assumed feral rye and jointed goatgrass would produce 15% more seeds/plant in the tilled system.

Three management strategies in winter wheat-fallow (W-F) were compared to conventional practices in W-F for impact on weed population:

1) imazamox applied to every other winter wheat crop (assuming 90% seedling control);
2) competitive canopy in winter wheat (tall cultivar, increased seeding rate, and N placement near the seed); and
3) delayed planting (2 weeks after optimum date of September 15).

We also compared population change as affected by tillage with the sweep plow compared to no-till weed control during fallow in W-F, and by two rotations, winter wheat-corn-fallow (W-C-F) and W-F.

The simulation started with 10 plants of each species in the first winter wheat and processed population dynamics across 12 years; data represent plant densities in winter wheat in the 13th year.

The population of jointed goatgrass increased more rapidly than feral rye with all management strategies (Table 2). This trend reflects differences in seed bank dynamics between the two species; jointed goatgrass seed survival in soil is six- to 10-fold greater than feral rye during the first two years after shedding (Table 1). To rank management strategies within a species, we divided plant densities in each strategy by the density in W-C-F, and termed this value *selection pressure.*

Table 2. Change in winter annual grass densities in winter wheat, as affected by cultural strategy. Simulation started with 10 plants in the first winter wheat crop; treatment means represent number of plants infesting winter wheat after 12 years. Selection pressure was determined by comparing strategies to the mean for the diverse rotation (W-C-F).

	Plant density		Selection pressure	
Strategy	Feral rye	Jointed goatgrass	Feral rye	Jointed goatgrass
Diverse rotation (W-C-F)	0.2	474	1	1
Imazamox (90%)	0.4	2380	2	5
Competitive canopy	10.8	19,815	540	42
Tillage	43.5	152,980	2,175	325
Delayed planting	1.0	825,870	5	1,740
Conventional practices (W-F)	394	2,380,000	19,700	5,020

With both species, adding corn to the rotation and applying imazamox were the most effective in minimizing population growth. The species differed in response to delay of planting, with feral rye being more affected by later planting of winter wheat. This trend reflects feral rye emergence within a short time frame after fall precipitation, contrasting with jointed goatgrass emerging over several weeks. Delay of planting was least effective among all strategies with jointed goatgrass. Improving competitiveness of winter wheat impacted jointed goatgrass population change more than feral rye.

Compared with other strategies, tillage during fallow was less effective with both species. Our simulation used data that suggested extensive decline of seed density in soil occurs with tillage. However, other studies in the Western U.S. have shown opposite results, indicating that tillage is inconsistent in affecting seed survival of either species in soil.

Management of these species can be improved considerably with combinations of strategies. For example, we also estimated population change with jointed goatgrass when a diverse rotation (W-C-F) was included with a competitive wheat canopy. Only 19 plants were present after 12 years, in contrast with 474 plants remaining in W-C-F (Table 2). If imazamox is combined with a competitive winter wheat canopy, only 20 plants of jointed goatgrass were present after 12 years, contrasting with 2380 plants in the imazamox treatment with conventional winter wheat practices. Similar trends occur with feral rye when delayed planting is combined with a diverse rotation or imazamox application.

Even though jointed goatgrass and feral rye respond differently to management tactics, producers can greatly impact population dynamics of both species with cultural practices. Jointed goatgrass will be more difficult to manage due to its seed longevity in soil and prolonged seedling emergence.

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